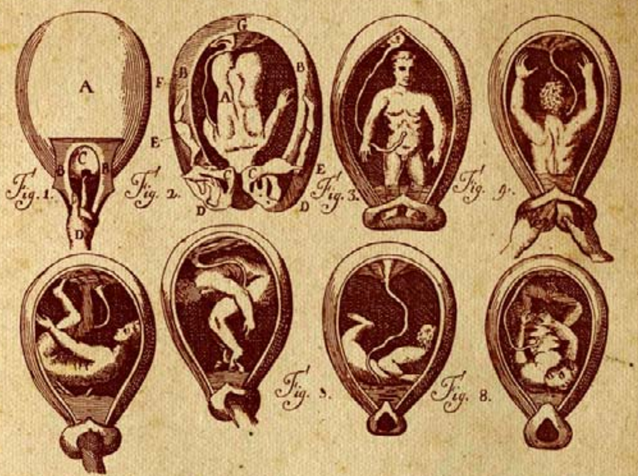

Death *before* Birth

Fetal Health & Mortality in Historical Perspective

ROBERT WOODS

OXFORD

DEATH BEFORE BIRTH

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For Alison

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Preface

I have worked for many years on infant and child mortality, and the problems surrounding their explanation, mainly in historical populations. This has been done without particular reference to fetal health and mortality. I now appreciate that such neglect was certainly a mistake. The circumstances that affect infants and children after live births are closely associated with their experience in the womb and at delivery. The extent of fetal wastage will have been considerable and worthy of study in its own right. Today, in medically advanced countries only four or five in every thousand viable fetuses are not live-born. In some African countries the figure is believed to be between 40 and 60, about the same level it probably was in early modern Europe. The stories of how the declines occurred, their causes, the turning-points and phases of stability, these will all be of interest. They are the subjects of this belated study.

I owe a particular debt of gratitude to the Wellcome Trust, which gave me a research-leave award for three years, 2005–7. Without the Trust's support this study would not have been possible. I am also grateful to the Wellcome Library, London, for allowing me to reproduce images from their collection. The Warden and Fellows of All Souls College, Oxford, elected me to a Visiting Fellowship for Michaelmas Term 2005. A number of individuals have been particularly kind in allowing me to use their data or they have been instrumental in shaping my comparative approach to fetal health and mortality: Anne Løkke (Copenhagen), Frans van Poppel (The Hague), Lucia Pozzi (Sassari, Sardinia), Graham Mooney (Baltimore), Catherine Rollet (Versailles), and Diego Ramiro Fariñas (Madrid). Many of these ideas were discussed during the workshop on 'Fetal and Neonatal Mortality: Historical Perspectives on the Borderline between Life and Death' which was held at the Spanish Council for Scientific Research, Madrid, 10–11 June 2008. In Britain, Anne Crowther, Bill Gould, Clare Holdsworth, Paul Williamson, Godfried Croenen, Chris Galley, Irvine Loudon, and Michael Weindling have been generous with their time and comments. Members of the University of Liverpool, Department of Geography Graphics Unit—Sandra Mather, Suzanne Yee, and Ian Qualtrough—have been especially helpful, in preparing the diagrams and illustrations. Finally, Alison, Rachel, and Gavin have contributed more than they can ever know.

Chester, Christmas 2008

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APH	antepartum haemorrhage
CEMACH	Confidential Enquiry into Maternal and Child Health
CNS	central nervous system
DHS	Demographic and Health Survey
ENMR	early-neonatal mortality rate
ET	embryo transfer
FDR	fetal-death ratio
GRR	gross reproduction rate
ICD	international classification of diseases
IMR	infant-mortality rate
ISTAT	Istituto Nazionale di Statistica
IUFD	intrauterine fetal demise
IUGR	intrauterine-growth retardation/restriction
IVF	*in vitro* fertilization
IVF-ET	*in vitro* fertilization and embryo transfer
LBW	low birthweight
LMP	last menstrual period
MMR	maternal-mortality rate
PDN	perinatal-death notification
PSANZ-PDC	Perinatal Society of Australia and New Zealand perinatal death classification
RR	relative risk
SGA	small for gestational age
SBR	stillbirth rate
SPL	spontaneous pregnancy loss

TPRW	total perinatally related wastage
UN	United Nations
US	ultrasound
WHO	World Health Organization

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1

Introduction to fetal health and mortality

The history of fetal health and mortality remains a rather neglected area considering its importance. Not only did miscarriages, abortions, and stillbirths make up a substantial proportion of all mortality losses in the past, but the very process of defining and recording fetal wastage brought under scrutiny the ways in which live birth, gestational age, pregnancy, and conception were recognized. Uncertainty over the vital signs necessary to define an infant's live birth will have had a significant bearing on the numbers of births and deaths that are believed to have occurred and the overall level of mortality in a population. Life expectancy at birth is very sensitive to the level of child mortality, especially infant deaths related to live births. When the distinction between fetal death and infant death is blurred it will be difficult to ascertain the true level of mortality and, since the broad picture of morbidity is often judged via the absence of death, the health of a society, its improvement, and comparative position cannot be assessed with any certainty. Further complications arise when it is unclear at what age a fetus should normally be regarded as viable, and therefore capable of survival outside the womb. Stillbirths are viable fetuses that are born dead, while miscarriages or spontaneous abortions have not yet reached a viable stage of development. These distinctions and considerations need to have an important role in demographic research on the history of life chances. Among medical historians there has been a tendency to focus on the mother and her children, to emphasize issues of gender and professional rivalry among birth attendants, to place instruments before epidemics, to favour cultural practices over the prospects for progress and improvement, and to neglect the unborn and their survival chances.[1]

This account redresses the balance. The fetus becomes the centre of attention, especially the potentially viable fetus in its third trimester. We need to establish what the level and trend of stillbirth mortality was in past centuries, whether there were any marked turning-points, and if they coincided in different populations. Because registration practices differed between countries, as well as changing over time, it will be important to assess the reliability of resulting mortality rates. Only the Scandinavian countries have a long and relatively distortion-free history

[1] J. D. M. Nicopoullos, 'Midwifery is not a fit occupation for a gentleman', *Journal of Obstetrics and Gynaecology*, 23 (6) (2003), 589–93 traces the history of some of these gender rivalries in an engaging fashion.

of fetal-deaths registration. Elsewhere in Europe stillbirths and early-neonatal deaths became confused or, as in Britain, stillbirths were not recorded until well into the twentieth century. The filling of this lacuna demands the estimation of mortality rates based partly on what is known for other times and places but also on models that sketch the hypothetical pattern of survival from conception to childhood. What do these time-series reveal that provides safe and consistent evidence on intrauterine demise? It is also necessary to understand the factors that could, in principle, affect the risk of fetal loss. Did they relate primarily to the skills of birth attendants, whether female midwives or male obstetricians; to the health of the pregnant woman, which would have been influenced by her nutritional status, by the prevailing disease environment, as well as her social, economic, and demographic circumstances; or to more ill-defined biological and genetic factors that are now known to be responsible for most early fetal losses?

Maternal, infant, and child mortality have all received considerable attention from specialists in a wide range of disciplines. Irvine Loudon's influential study, *Death in Childbirth* (1992) demonstrated the value of taking a quantitative approach.[2] It began by attempting to establish what the risk to the life of a recently delivered woman was: how that risk varied according to her age and birth history, where she lived, which social group she was a member of, and, of most importance as it transpired, where she was delivered and by whom. Loudon made comparisons—countries, age-groups, institutions—and, above all, he looked for the origins of secular changes. When did the pattern of risk take a significant and continuous downward trajectory in developed countries? Most likely in the late 1930s or early 1940s, when antibiotics became available which could effectively treat puerperal infections common after childbirth. The dangers of childbirth were further reduced by the development of blood transfusion, prenatal screening including the use of ultrasound techniques, improved postnatal care, induction for post-term pregnancies, routine use of Caesarean section for abnormal presentations, hospitalization in specialist maternity units for primiparae and at-risk cases, and the professionalization of maternity services in general, including highly trained staff. Loudon's approach proved very effective not only in its description of level and trend, but also in the way it identified *the* key turning-point and proposed a convincing explanation, one that allowed for differences in timing as well as the cumulative supporting influence of new medical advances.

Work on infant mortality has proven less successful, and this despite considerable effort over many decades.[3] One reason relates to the observations made

[2] Loudon, *Death in Childbirth: An International Study of Maternal Care and Maternal Mortality, 1800–1950* (Oxford: Clarendon, 1992). His *The Tragedy of Childbed Fever* (Oxford: Oxford University Press, 2000), 186, fig. 11.2 illustrates the late 1930s decline in maternal mortality.

[3] Roger Schofield, David Reher, and Alain Bideau (eds.), *The Decline of Mortality in Europe* (Oxford: Clarendon, 1991) discusses the general characteristics of mortality decline. Alain Bideau, Bertrand Desjardins, and Héctor Pérez Brignoli (eds.), *Infant and Child Mortality in the Past*

in the opening paragraph: live births and deaths within twelve months need to be defined and recorded with care. But it is also the case that infant mortality is an awkward and rather arbitrary aggregate. Survival chances in the early days will be affected by prematurity and the complications of childbirth, while in the latter months of infancy rearing practices, poverty, and exposure to the infectious diseases of childhood will be of paramount importance. Postneonatal mortality is especially sensitive to environmental insults, while neonatal risks during the first month after live birth stem from *in utero* conditions and the trauma of birth. The two elements did not move in harmony, they had separate histories. In most European countries there was also a coincidental point at which the downward secular trend in infant mortality began. That is the 1880s and 1890s, but this was influenced particularly by the reduced contribution of postneonatal mortality, which followed an earlier decline in early-childhood mortality (ages 1–4). In general, the timing of decline in infant and maternal mortality did not coincide, therefore; different factors were at work.[4] One would anticipate that maternal, neonatal, and fetal mortality would be more closely associated.

It is clear that any study of fetal health and mortality employing a historical perspective will not be straightforward. It will have to break new ground in several areas, use a variety of sources, and make informed assumptions, since it cannot build directly on most of the findings from research on early-age mortality concerned with the risks to life after birth. There are several important issues that need to be outlined at this introductory stage, ranging from definitions to causes.

First, the language that is used to discuss questions of fetal health and mortality must be chosen with care. Not only is there much scope for euphemism—stillborn for dead-born, for example—but also there are distinctions between vernacular and clinical usage. 'Intrauterine fetal demise' is in common use among medical professionals, which smacks of obfuscation. Even the spelling of 'foetus' or 'fetus' is subject to convention. The vagaries of translation from language to language pose a challenge to comparison, especially because the lexicons employed in each culture are themselves subject to change.

Second, although the concept of stillbirth, for instance, is fairly simple—viable yet born dead—devising a practical definition that can be used to recognize such a category by parents, medical professionals, and the registrars of vital events has proved troublesome, a source of continuing uncertainty and conflict among the parties concerned. Equivalent difficulties arise in the definition of embryo and fetus, miscarriage and abortion, induced and spontaneous abortion. The term

(Oxford: Clarendon, 1997) and Eilidh Garrett et al., *Infant Mortality: A Continuing Social Problem* (London: Ashgate, 2006) focus specifically on infants and children. The fetus is mentioned occasionally.

[4] See Jacques Vallin, 'Mortality in Europe from 1720 to 1914: long-term trends and changes in patterns by age and sex', in Schofield, Reher, and Bideau (eds.), *Decline of Mortality*, pp. 38–67, esp. p. 50, fig. 3.4, which shows trends in the infant mortality rate, and Irvine Loudon, 'On maternal and infant mortality, 1900–1960', *Social History of Medicine*, 4 (1) (1991), 29–73.

'induced miscarriage' has been coined. It relates to 'bringing on the menses' during the early stages of pregnancy. Even pregnancy itself has proved to be a difficult state to recognize among historical populations. When the woman feels the fetus move (quickening), clinical recognition via chemical tests or more recently ultrasound examination, the first or second missed period—these have all had some currency. Attempts to standardize definitions in one common language have largely failed because there is so much cultural and legal history tied to life before birth and being with child.

Third, conventions for the recording of age are also culturally bound. 'Time elapsed since live birth' is in common use, or since christening when date of birth is not known, but in Japan babies start life aged one *sai* and acquire an additional *sai* after each new-year's day. Gestational age is usually made equivalent to menstrual age and set in relation to the pregnant woman's last menstrual period. Conception occurs at about two weeks after menstruation and full term is reached at forty weeks. But periods may be irregular or pass unremarked, so that the crucial age categories are blurred; 'due dates' are uncertain, and fetal age rather approximate.

Fourth, efforts to register fetal deaths, particularly stillbirths, have been affected by the purpose of the exercise, the responsibilities of participating parties, as well as the various definitional issues just mentioned. Where, as in the Scandinavian states during the nineteenth century, well-trained, motivated, and rewarded midwives combined with the local clergy and medical officers one should expect a relatively accurate system, especially when the purpose was to guard against infanticide and ensure the correct recording of the live-born. Elsewhere registration practices often contained anomalies: the unborn fetus might be baptized, the live-born counted as stillborn if they died before registration, or fetal deaths could be ignored altogether.

Fifth, when registration was not undertaken, or was obviously deficient, then it may be possible to make estimates using data for other age-groups; mortality in the first week after live birth, or maternal mortality, for example. The World Health Organization has proposed methods for deriving stillbirth rates for those developing countries lacking routine vital statistics, methods that at least to some extent rely for their credibility on historical European precedents. Historical demographers have also taken up the challenge of estimating mortality rates for centuries prior to the twentieth. Their procedures and assumptions will be of considerable interest here.

Sixth, following earlier developments in the study of fertility patterns, it is now normal practice to distinguish between proximate or immediate and background or ultimate causes of mortality. While it is generally appreciated that the proximate causes of fetal mortality will vary by gestational age, the particular conditions that are directly responsible for loss of life are often difficult to specify in individual cases and to generalize in broad cause-of-death categories. The class 'unknown or indeterminate causes' is still the largest in most fetal-death nosologies. Not only do pathologists specializing in perinatal cases find it difficult to be precise, but only a minority of fetal deaths are subjected to post-mortem examination.

Seventh, it is a simpler matter to list the most likely background causes of fetal mortality. Circumstances particular to the mother, the fetus, and the delivery process are the most obvious, but since the proximate causes are often poorly understood it may be difficult to disentangle the effect of, say, poor nutrition and maternal infections. Poverty, conception outside marriage, maternal age, and parity, these have certainly been important factors contributing to relatively high fetal mortality in the past, but then so have medical ignorance and certain destructive folklore practices. Fetal mortality, unlike postneonatal infant mortality and child mortality, is influenced by genetic factors, which will contribute to a majority of spontaneous abortions as well as antenatal stillbirths. The role of distinctly biological factors, as opposed to social ones, is therefore very important. It is possible that such factors will have had effects that have been more or less constant over time.

These seven points cover some of the key issues that will need to be tackled in this study. There are also some distinctive sources of evidence, examples of which will be considered here in order to illustrate some of the issues raised above.

Between 1630 and 1660 John Richardson, the parish clerk of Hackness, Yorkshire, kept a remarkably detailed register of vital events. It included the burial of both the stillborn and those infants who were live-born, but who died before baptism and naming.[5] Table 1.1 has a selection of entries from the parish register. It illustrates both the different forms of language used and the variety of ways in which a fetal death might be listed. The dead fetuses are variously described as abortive, stillborn, dead-born or 'died before it was born'. We are left to assume that each of these words or phrases refers to a viable fetus born with no vital signs. The women who died during labour (in childbed) were, most likely, undelivered, since there is no reference to either a burial or a baptism in any of the cases. Fetal deaths are concealed in these instances. William Baxster's wife was delivered prematurely of Siamese twins, both dead. William Consett's wife had twins, one of whom was live-born; she survived to be baptized the following day. Not only is the Hackness register unusually detailed during the mid-seventeenth century, but there is clear evidence that the stillborn were formally buried even though no christening had taken place. In this respect the stillborn were treated in the same way as those infants who, although live-born, died before baptism. Most Anglican parish registers of the period ignore fetal and neonatal deaths

[5] Donald Woodward, 'Some difficult confinements in seventeenth-century Yorkshire', *Medical History*, 18 (4) (1974), 349–53 discusses the reproductive histories of Hackness residents in more detail.

Table 1.1. Selected entries relating to stillbirths in the parish register of Hackness, North Yorkshire, England, 1630–60

An abortive childe of Thomas Coulson buryed the 30 Novembr. [1632]
The abortive daughter of John Cockerell buryed the 9 October [1633]
A child of Robert Lawson's buryed (being dead borne) 1 August [1634]
Ann the wife of Josua Allenson buryed the 27 June who dyed in child bedd [1636]
A stillborne child of Thomas Birkeld buryed the 4 Octobr. [1645]
Mary the wyffe of John Beswicke dyed in Childbedd buryed 13 Nov. [1652]
A young sonne and Child of William Cockerell of Hacknes dyed the 1st of July [1655] before it was borne and was buryed the same day in the Eveninge
Grace the wyffe of William Baxster beinge aboute three weekes before her tyme was brought to bedd the first day of December [1655] [birth of Siamese twins] the Midwives name was Jaine Cockerell who is a good old woman ['that good old widow' died 3 October 1660]
The two abortive Children of William Baxster that were grown and joyned together from their breastes to their navell the one of them being a female child and the other as yt was supposed to be a male child were buryed the second day of December [1655]
William Consetts wyffe was brought in bedd of two children the xiijth day of January [1656] the one was an abortive sonne borne dead and the other was a daughter and was Baptised the xiiijth day of the same and named Ann
A younge daughter of William Cockerell of Hacknes dyed the 24 day of May before yt was borne and was buryed the 25th day of the same [1656]
A daughter of Mary Birkeldes was buryed the xjth of June wch was borne dead [11 June 1656]

Source: Charles Johnstone and Emily J. Hart (eds.), *The Register of the Parish of Hackness, 1557–1783*, Publications of the Yorkshire Parish Register Society, 25 (Leeds: Yorkshire Parish Register Society, 1906).

like these because only those admitted to God's Church at baptism, and given a Christian name, should have been buried in consecrated ground. Quite why Hackness was an exception remains a mystery.

The influential Dutch physician and man-midwife Hendrik van Deventer (1651–1724) provided the following case note:

I remember that I was once called into a certain town not far from my own house, where a woman had lain some days in labour; the infant came very well turned, and the mother and midwife affirmed, before me and my wife, who was with me, that she had not for two days perceived the infant move, and therefore doubted not but it was dead; nor could we learn anything else by all the signs that we enquired after; therefore we did all we could to save the woman, who was in danger of her life, by no means sparing the infant, pressing the head sometimes this way, sometimes that, and a linen roller, like a Frisian collar, being put in behind it, we pulled it considerably by both ends; at the same time doing our utmost endeavour to dilate the passage that was very close, by which means the woman, as we thought, brought forth a dead child, nor did any body about her doubt of it: But the miserable infant a little after, beyond expectation filled our ears with its crying, and lived a few days after. I was mightily concerned for it, upon the account of two or three lumps which it had got on its head by too much compression, and I confess that this mistake for so many years has been a warning to me, and will so continue, whilst I live, never to deal with an infant as if it were dead, persuaded by the testimony of the woman or the midwife; may I mistrust my own sense, taking nothing as certain, but the dissolution of the skin upon the top of the head, which is not easily dissolved there, because it sticks there by the help of the hair, nor can the infant be touched further without the greatest labour; wherefore I think it necessary to add here, that midwives cannot meet with a more grievous case than when they are obliged to handle the infant as dead to save the mother's life, which never happens, except when infants offer themselves well turned, with a head very big, and too small a passage, not subject to extend; or if the infant, by reason of an oblique womb sticks in the passage like an elbow bent.[6]

Deventer reminds us of several significant points here. The first relates to the signs-of-life problem. The fetus was assumed to be dead by one and all, but shortly after birth it began to cry. It became an early-neonatal death and not a stillbirth. Midwives are warned not to assume the fetus is dead just because its mother cannot detect movement. He also highlights the ethical issue—whether to regard the fetus as dead in order to save the mother—and again he advises caution. *The Art of Midwifery Improv'd* contained several case notes, which were becoming popular devices for communicating medical knowledge in the early eighteenth century; entire volumes were devoted to them. It also provided anatomical diagrams, which might be of use to midwives. For example, Figure 1.1 shows ten different fetal positions. The first English edition was printed for Edmund Curll and associates in 1716. Curll was a publisher of considerable renown, whose entrepreneurial skills have been used to symbolize the transformation of the London book trade in this period.[7] Midwifery textbooks, initially translations from Latin and French, took their place in that trade and 'the art' benefited thereby.

In 1898 Dr G. Porter Mathew published some notes based on his University of Cambridge MD thesis.[8] He had been working as an obstetrician at St Mary's Hospital and Queen Charlotte's Hospital in London, as well as conducting a

[6] Hendrik van Deventer, *The Art of Midwifery Improv'd. Fully and plainly laying down Whatever Instructions are requisite to make a Compleat Midwife, and the many Errors in all the Books hitherto written upon the Subject clearly refuted. Illustrated with thirty-eight cuts curiously Engraven on Copper Plates, representing in their due Proportion the several Positions of a Foetus. Written in Latin by Henry à Daventer. Made English. To which is added, a Preface giving some Account of this Work, by an Eminent Physician* (London: Printed for E. Curll at the Dial and Bible, J. Pemberton at the Buck and Sun, both against St Dunstan's Church in Fleet Street, and W. Taylor at the Ship in Paternoster Row, 1716) (originally published in Latin and Dutch in 1701). Deventer's wife, Cecelia, was a midwife; she died in 1694. See M. J. van Lieburg, *Nieuw licht op Hendrik van Deventer (1651–1724)*, Erasmus University Medical Historical Papers, 1 (Rotterdam: Erasmus, 2002).

[7] Paul Baines and Pat Rogers, *Edmund Curll, Bookseller* (Oxford: Oxford University Press, 2007) provides an account of a turbulent career. The first section of the Bibliography (pp. 257–61) lists books published before 1800. It illustrates the dominance of London booksellers and publishers, their concentration in a very small area round St Paul's, Fleet Street, and the Strand, but also the considerable number involved even for the sale of rather specialized midwifery texts. The development of the book trade was extremely important for the dissemination of knowledge and practice in the eighteenth century.

[8] George Porter Mathew, *Clinical Observations on 2000 Obstetric Cases* (London: Simpkin, Marshall, Hamilton, Kent, 1898). The summary statistics reported here appear on pp. 54–67. Alison Nuttall, 'Passive trust or active application: changes in the management of difficult childbirth and the Edinburgh Royal Maternity Hospital, 1850–1890', *Medical History*, 50 (2006), 351–72

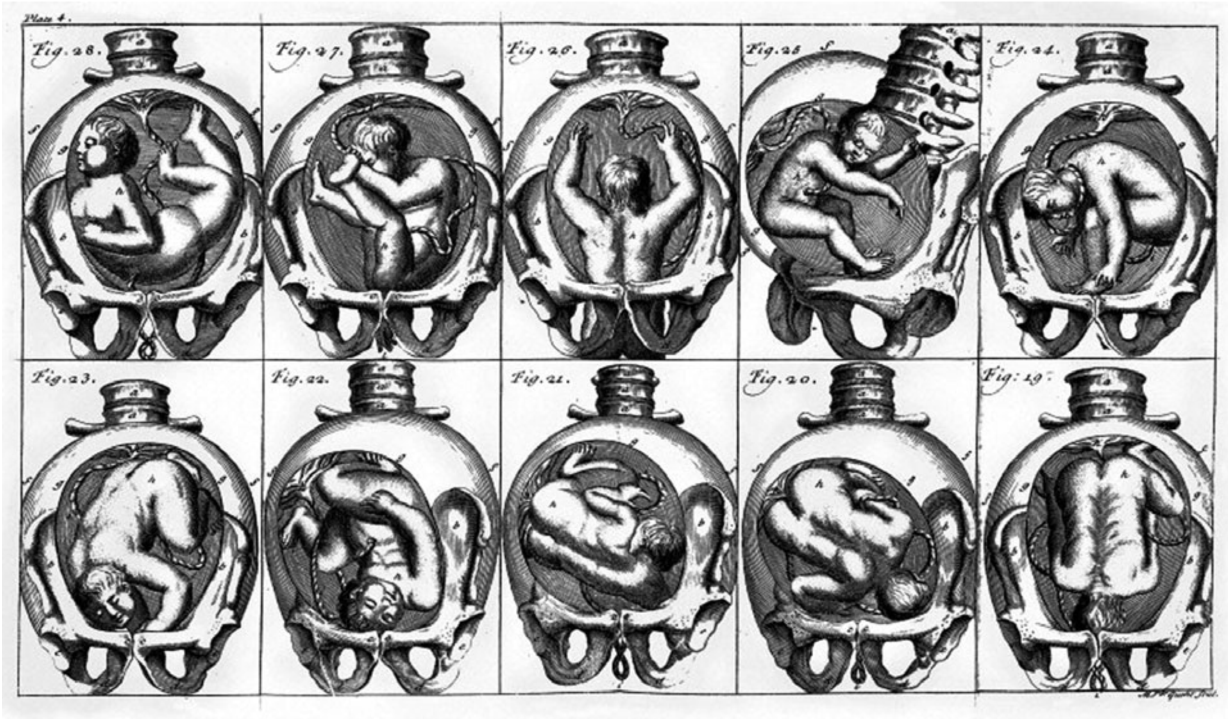

Fig. 1.1: Ten representations of a fetus in the womb, from Hendrik van Deventer, *The Art of Midwifery Improv'd* (1716), plate 4 of five fold-out diagrams following p. 328 (Wellcome Library, London). This illustration contains figures 19–28 from a set of 38. They show various fetal presentations, including some of the most dangerous, such as the shoulder (21) and the breech (27).

private practice. The notes summarize the fortunes of 2000 pregnant women. Mathew found that the stillbirth rate was 36 per 1000 total births (live births and stillbirths combined), and that infant deaths during the first 14 days represented 24 per 1000 live births, of which 86 per cent were premature births. Among the stillbirths, 44 per cent happened during labour. Of these, 42 per cent were caused by 'prolapse or compression of funis [umbilical cord]', 33 per cent were due to 'contracted pelvis', 8 per cent to 'difficult breech', and the remaining 17 per cent to 'antepartum haemorrhage'. Forceps were used in 8.4 per cent of the deliveries, always with chloroform, and there were no maternal deaths in such cases, but 6.6 per cent of the fetuses involved died or were found to be dead. Mathew gave few additional details on the social or demographic characteristics of the 2000 cases, although he did say that well over half were in-patients at Queen Charlotte's, that many were primiparae, and that this particular maternity hospital was willing to take unmarried women. A large proportion of the St Mary's cases were domiciliary and multiparae: the women concerned had already given birth at least once.

Is it possible that Mathew captured a representative sample of obstetric experiences in London during the late nineteenth century? It seems quite likely, since the stillbirth rate for London in the late 1920s and the 1930s, when registration began, was at about the same level, which was also close to that found among women delivered in their own homes by staff of the Royal Maternity Charity earlier in the nineteenth century. Mathew's figures also emphasize the importance of premature birth as a factor in neonatal mortality; that antepartum stillbirths were in the majority; that less than 10 per cent of deliveries were assisted by forceps and chloroform; and a pelvic deformity contributed to stillbirth in 14 per cent of cases. This is material of great value.

These three examples—a remarkably detailed parish register, a man-midwife's case notes, and an obstetrician's statistical summary of his clinical work—help to suggest what may be possible, but they also draw into sharp focus the limitations. We shall never know with complete certainty the extent of fetal mortality in the past, even when such events were registered. Likewise, the various senses in which 'cause' can be taken should warn us to be wary of simple explanations. The best that may be achieved is an account that draws together and compares quantitative and narrative evidence from many sources—where demographic models can sit alongside medical case notes, tables jostle with anecdotes, averages with individuals. This study is avowedly anti-disciplinary; it does not offer a history in the normal sense, rather it wants to know how and why change occurred in the long term and it will be prepared to use whatever is available and relevant to reach that goal.

Three more problems need to be set out at this stage. Historians are justifiably wary of what is often called 'presentism'; that is, projecting today's concerns

shows in a more systematic way for the same period both the low level of instrumental intervention and the increasing number of married women being delivered as in-patients.

on to past societies, believing one can see and feel their worlds as Richardson, Deventer, and Mathew did, for example. Induced abortion is now legalized in most developed countries and in some it is routinely used as a method of fertility control. It is even possible that the number of legal abortions exceeds the number of spontaneous pregnancy losses, although this rather depends on how pregnancy is defined. Similarly, the number of stillbirths may now be greater than that of infant deaths. The increasing abortion rate, even where effective contraception is available, is a current moral and social concern just as the failure to drive down further the stillbirth rate is a medical preoccupation. These are concerns of the twenty-first century, which are bound to colour our view of the past. 'Analogy' and 'borrowing' summarize a second problem. Demographers have become used to drawing analogies between high-mortality populations regardless of time period or location. They also borrow data from one well-documented society, often Scandinavia, and apply their findings to other apparently equivalent situations where direct evidence is lacking or inadequate. This modelling procedure will be employed on occasions in this study, but its legitimacy will always need to be exposed to close critical scrutiny.[9] The third problem might be labelled 'backwards and forwards'. Most histories still have a marked chronological structure: they tell stories of sequential change in a single dimension. In this account it will be necessary to move about in time and space, although at the heart of the book two chapters do consider step-by-step developments in date order. This may prove disconcerting to some readers, but there is a clear plan, which suits its subject.[10]

Chapter 2 focuses on the ways in which fetal mortality—especially stillbirths—has been defined in different cultures and periods. It stresses the fluid nature of this process and the implications for attempts to measure late-fetal mortality. Since comparison and explanation depend to a large extent on the ability to record accurately, it is important to begin by taking such problems into account and to appreciate how they have been resolved. The second chapter also outlines some of the principal factors that are believed to influence fetal mortality. It reviews the ultimate or background causes like maternal age and parity, which also influence it.

Chapter 3 asks what the age-related pattern of survival from conception to first birthday would have looked like in a population where early-age mortality was high. It begins with the biometric analysis of mortality risk during infancy,

[9] Robert Woods, *Children Remembered: Responses to Untimely Death in the Past* (Liverpool: Liverpool University Press, 2006) and 'Ancient and early modern mortality: experience and understanding', *Economic History Review*, 60 (2) (2007), 373–99 have a number of examples of the benefits of 'analogy' and 'borrowing' in historical demography.

[10] Laurence Sterne, *The Life and Opinions of Tristram Shandy, Gentleman* ([1759–67] Oxford: Oxford University Press, 1998), 379–80 lacks a clear time line typical of most biographies. It even has a diagram to illustrate its many asides, which are compared with the true 'right-line' produced by a writing-master's ruler. Tristram, it may be recalled, suffered at the hands of a man-midwife, Dr Slop.

which it extends to cover the forty weeks of pregnancy. This exercise is important because it allows us to see how the various components of the survival curve might relate one to another—an essential preliminary if one component needs to be derived from another. Particular use is made of analogy and borrowing. Data from Norway and those assembled by the World Health Organization in its quest to monitor international health conditions prove especially useful. There is much in this discussion that is theoretical, even speculative, but without such an approach further progress in the description of levels and trends in fetal mortality over time would not be possible.

Chapter 4 compares national time-series for the stillbirth rate. It begins with those states in which late-fetal deaths were registered in the eighteenth or early nineteenth centuries and proceeds to consider countries, like Britain and the USA, which only began to collect such statistics during the twentieth century. The comparison of time-series will assist the assessment of data quality, allow the identification of common turning-points in the trends, and highlight geographical differences in fetal health thereby suggesting their causes. It will also help to establish a credible range within which we should expect late-fetal mortality (stillbirth rates) to have fallen in the past. Estimates, whether historical or contemporary, can then be said to be plausible, too low or too high. This is the basis for an attempt to estimate the level of late-fetal mortality in England during earlier centuries in ways that parallel our current understanding of long-term trends in maternal and infant mortality. The demographic rates shown in Tables 4.5 and 4.6 and illustrated by Figure 4.17 represent the cornerstone of the study. They exemplify how medical history can be informed by demography. Chapter 4 also provides a preliminary account of the turning-point in the late 1930s and the 1940s in late-fetal mortality trends, a coincidence that is all too obvious in the time-series.

The next two chapters have a more chronological structure. Chapter 5 focuses on the role of midwifery, especially in eighteenth- and nineteenth-century England. It tracks the involvement of men in midwifery, as demonstrated by the early print shown in Figure 1.2, and it considers the ways in which midwives dealt with miscarriage and stillbirth, how they tackled difficult cases and described them to their readers. Case notes are used to identify common practice in the eighteenth century, while for the nineteenth retrospective surveys are used to illustrate the way pathologists attempted to establish average, population-based rates for spontaneous abortion. Chapter 6 considers what might be described as the competition between pathologists and obstetricians to explain the causes of fetal deaths. It contrasts the two methodologies, fetal autopsy and 'social obstetrics', and considers how scientific enquiry proceeded in the last century based on the work of the Victorian pioneers. How to identify and classify into formal nosologies the proximate causes of stillbirths has proved a remarkable challenge, one that remains as yet unresolved. Chapters 5 and 6 introduce a number of individuals each of whom made an important and distinctive

Fig. 1.2: Man-midwife delivering a woman, from Samuel Janson, *Korte en Bondige Verhandeling* (1711), table VI, facing p. 106 (Wellcome Library, London). The English translation of the caption reads 'A surgeon A. sits here on a chair in order to deliver the woman B. of a child'. Three women, her gossips, also attend the pregnant woman. She sits up in bed and is covered by a sheet, which is tied round the man-midwife's neck.

contribution to progress in the practice of midwifery—maternal and fetal care: Sarah Stone, the Somerset midwife who published her case notes; William Smellie, the 'father of British midwifery'; James Whitehead, the Manchester surgeon who used patient surveys; William Priestley, the leading pathologist of his day; John Ballantyne, who pioneered fetal necropsy as a specialist discipline; and Dugald Baird, who appreciated the need for medical sociology in obstetrics.

Chapter 7 returns to levels and trends in fetal mortality. It emphasizes the need to account for change by distinguishing between antenatal and intranatal stillbirths, as well as miscarriages and neonatal deaths. Two sets of arguments are set against one another. From medical history comes the contribution of midwifery: the ability to make labour safer for mother and infant. There is evidence for the positive contribution of such changes in England during the eighteenth century and since 1940. Demography supplies the argument that maternal infections, as well as the nutritional status of the mother prior to and during pregnancy, may have contributed to changes in the level of antenatal stillbirth mortality in the long term. Here there seems to be circumstantial evidence for the contribution of, for example, smallpox in pregnancy to the decline in late-fetal mortality in the eighteenth century. The question of how to evaluate the relative contributions of these two sets of explanatory arguments continues to challenge.

Finally, in Chapter 8 we turn to modern ethical and medical dilemmas. Since the legalization of induced abortion, feticide has become one of the largest contributors to intrauterine demise and yet this has happened at a time when the fetus has come to be viewed as a patient by the medical profession, the potential beneficiary of the most highly sophisticated therapy. The paradox is striking, but the 'fetus as patient' is not entirely a new concept. Obstetricians have often had to balance the survival chances of mothers, fetuses, and infants. Craniotomy or Caesarean section was a real choice even in the eighteenth century when either way death was most likely.

2

Definitions, measurement, influences

What are fetal deaths, infant deaths, and live births? How have the terms been used? This chapter considers some fundamental issues without which little further progress can be made. The most important concerns the problem of definition: how, ideally, should the various age categories of fetal deaths be recognized, and what conventions have emerged to resolve this problem? It also considers the implications for recording and measuring the extent of fetal mortality. Finally, it offers some preliminary discussion of the principal influences on, for example, late-fetal mortality, especially the distinction between 'biological' and 'socio-economic' factors.

DEFINITIONS

Table 2.1 presents a lexicon of some of the keywords we will need to define. It uses the *Oxford English Dictionary* to show their several meanings, how those meanings changed, and when they were first used in the sense closest to the one with which we will principally be concerned. Most of these words have very long histories, although some are modern inventions (e.g. 'perinatal'). The definitions in Table 2.1 relate to common usage; they are not intended to be technical terms with precise, operational meaning, even though the phrase 'in medicine' is sometimes used. It is important to distinguish between two vocabularies: a popular-vernacular and a specialist-technical one. However, the two have been in the past and still are being used interchangeably, mixed up and confused. This is bound to be the case, because they relate to the life experiences of ordinary people, as well as being part of ecclesiastical, legal, literary, medical, and statistical practices. Confusion is only to be expected in these circumstances.

We need to consider some examples in detail. Take, for instance, the words 'abortion' and 'miscarriage'; both are keywords for the study of fetal deaths. The *OED* says that the two words have been used interchangeably to refer to the premature delivery of a child; that they apply to the spontaneous expulsion of a fetus from the womb before it is viable; but that 'abortion' is used when

Table 2.1. Definitions of keywords from the *Oxford English Dictionary*

Word	*OED* definition
abort *v.*	to miscarry, disappear, to have a premature delivery of a child (1580)
abortion *n.*	the act of giving untimely birth to offspring, premature delivery, miscarriage; the procuring of premature delivery so as to destroy offspring (in medicine, 'abortion' is limited to a delivery so premature that the offspring cannot live, i.e. in the case of a human fetus before the sixth month) (1547)
abortive *adj.*	of or pertaining to abortion; produced by abortion, born prematurely (1394)
abortive *n.*	an abortive progeny; a stillborn child; an abortive delivery; a miscarriage (1300)
baby *n.*	an infant, a young child of either sex; formerly, synonymous with child, now usually restricted to an infant in arms (1377)
birth *n.*	bearing of offspring; bringing forth; nativity; beginning of individual existence; coming into the world; fruit of the womb
chrisom *n.*	chrisom-child (in full) originally a child in its chrisom-cloth (a white robe, put on a child at baptism as a token of innocence); a child in its first month; an innocent babe; also applied to a child that died during the first month or shortly after baptism and was shrouded in its chrisom-cloth at burial; may have been applied to children that died unbaptized (1275)
conception *n.*	the action of conceiving, or act of being conceived, in the womb; that which is conceived (embryo, fetus, offspring, child) (1300)
dead-born *n.*	born dead, stillborn (1330)
embryo *n.* (Gk. *embryon*)	the offspring of an animal before its birth, or its emergence from the egg; in humans, traditionally restricted to the fetus in utero before the fourth month of pregnancy; now, before eight weeks (1590)
fetus *n.* (Lat. *fetus*)	the young of viviparous animals in the womb, and of oviparous animals in the egg, when fully developed (1398)
infant *n.*	a child during the earlier period of life (or still unborn); now most usually applied to a child in arms, a babe; but often extended to include any child under seven years of age (1382)
miscarriage *n.*	the spontaneous expulsion of a fetus from the womb before it is viable (in medicine, spontaneous abortion is preferred, but in popular use abortion is associated chiefly with deliberate termination of pregnancy); originally called an effluxion if it occurred before the motion of the fetus, and an abortion between the third and seventh months (1615) (efflux: miscarriage before the tenth day (1754, Smellie))

Table 2.1. Continued

Word	*OED* definition
neonatal *adj.*	of, relating to, affecting, or designating new-born (or recently born) humans and animals (in medicine, usually defined as the first four weeks of life) (1894)
neonate *n.*	a newly or recently born individual; specifically, a human infant less than four weeks old (1925)
perinatal *adj.*	of or relating to the period comprising the latter part of fetal life and the early postnatal period (commonly taken as ending either one week or four weeks after birth) (1944)
pregnant *adj.*	that has conceived in the womb; with child or with young; gravid; of a plant or soil, fertilized, capable of germinating, fruitful, prolific, teeming (1545)
quicken *adj.*	of a female, to reach the stage of pregnancy at which the child shows signs of life (1530)
reckoning *vbl. n.*	the calculated period of pregnancy (1638)
stillbirth	birth of a stillborn child; an instance of this; formerly, birth of a child alive or with a beating heart, but not breathing (1785)
stillborn *adj.*, *n.*	born lifeless; dead at birth; abortive; formerly, born alive, but not breathing (1607)

Note: Dates in brackets show the earliest mention given in the *OED*. They may not represent the first usage of the word.

Source: *Oxford English Dictionary*, 2nd edn. (1989).

the delivery has been deliberately procured in order to terminate pregnancy.[1] More strictly, 'miscarriage' and 'spontaneous abortion' have equivalent meanings, therefore. It is also suggested that human fetuses are not viable before the sixth month of gestation, and thus that 'miscarriage' and 'abortion' apply to this previable period. 'Effluxion' has been used to refer to a miscarriage before 'the motion of the fetus' could be felt by the mother (i.e. her 'quickening', at 12–16 weeks or later), while 'abortion' has been applied to the period of gestation between the third and seventh months. The use of both 'miscarriage' and 'abortion' dates from the sixteenth century. Correct use of the words depends upon the age of the fetus, whether or not it is viable, and the reason for the pregnancy being terminated.[2]

[1] A miscarriage is a naturally occurring, spontaneous abortion. An abortion may be illegally or legally induced; it may also be safe or medically unsafe. Most of this study is concerned with miscarriages or spontaneous abortions, but the possibility that some, perhaps a substantial minority of, fetal deaths were deliberately induced cannot be ignored at any period. Chapter 8 discusses induced abortion in relation to spontaneous miscarriage. WHO, *Unsafe Abortion: Global and Regional Estimates of the Incidence of Unsafe Abortion and Associated Mortality in 2000*, 4th edn. (Geneva: World Health Organization, 2004) focuses on abortion in developing countries.

[2] The terms 'viable', 'viability', and 'previable' have technical meanings in clinical practice. A fetus may now be viable at 23 weeks' gestation, in the sense that it is able to survive outside the

'Embryo' and 'fetus' provide a second example. The former has a Greek root, while the latter is the Latin word for 'offspring' or 'act of bearing young', both words relating to the product of conception. In humans, they refer to the unborn in the womb, but while 'embryo' has been applied to the early stages of development (from implantation in the uterus to 8 weeks' gestation), 'fetus' applies to the fully developed (from 8 weeks' gestation to full term). The concepts overlap; an embryo could be thought of as a fetus that is not yet fully developed.[3] Parallel distinctions of age and development apply to 'baby', 'infant', and 'child'.

'Dead-born' and 'stillborn' have a complicated relationship in English. The former has an older origin, while the latter appears to have taken its place during the seventeenth century. Both can mean 'dead at birth', 'dead before birth', and 'born lifeless'; however, 'stillborn' has also been used to refer to the 'birth of a child alive or with a beating heart, but not breathing'. The word 'still' suggests the following: motionless, not moving from one place, stationary, quiescent, abstaining from action, quiet, silent. 'Dead-born' is precise and restrictive; it means lifeless, lacking in any vital signs. 'Stillborn' has been employed in a rather more literal sense—born without movement, not necessarily lifeless—although, as we shall see, it has come to mean 'dead-born'. The noun 'abortive' helps to confirm the potential for confusion. It can mean the product of an abortion, a miscarriage, a stillbirth, and a dead-born fetus. Although rarely used today, the term 'abortives' occasionally occurs in English parish registers, while 'abortions and stillbirths' was used as a reporting category in the eighteenth-century London Bills of Mortality. In neither case is it clear exactly what is being referred to.

The modern words 'neonatal', 'neonate', and 'perinatal' bear interesting comparison with the medieval term 'chrisom', or 'chrisom-child'. 'Neonatal' is applied to newly born infants, particularly their first four weeks after birth, while, according to the *OED*, 'perinatal' applies to the antenatal, intranatal, and postnatal periods; that is, late-fetal plus neonatal or early-neonatal. The words 'antepartum', 'intrapartum', and 'postpartum' are also used to refer to the periods before, during, and after labour, but stillbirths, or late-fetal deaths, are now regularly divided into those occurring before labour (antepartum stillbirths), which may be macerated, and those occurring during labour (intrapartum stillbirths). It is possible for the terms 'neonate' and 'chrisom-child' to be

womb, but not without sophisticated medical assistance, and its subsequent physical and mental development may be impaired. The availability of massive medical intervention may allow some very premature fetuses to become viable (i.e. able to survive), yet disabled. See, for example, Neil Marlow, 'Outcome following extremely preterm birth', *Current Obstetrics and Gynaecology*, 16 (3) (2006), 141–6 and other publications of the EPICure project.

[3] Joseph Needham, *A History of Embryology* (Cambridge: Cambridge University Press, 1934; 2nd edn. 1959) offers an invaluable account of the development of the science from ancient times to 1800.

considered equivalent, but 'chrisom' has wider connotations. It is linked to christening and the practice of wrapping the infant in a white cloth, which it might continue to wear until its mother was 'churched' at a ceremony of purification after about one month. If death occurred shortly after baptism, then the same cloth would be used as its burial shroud. However, 'chrisom' also came to be applied to those infants dying before baptism and, for this reason, confusion with the stillborn was possible, since both groups were unbaptized and were not to be buried in consecrated ground.[4]

Although Table 2.1 provides a useful starting-point, a level of technical precision is required that the *OED* cannot be expected to supply. The *New Oxford Dictionary of English* (2001) definition of 'stillbirth' comes closer: 'birth of an infant that has died in the womb (strictly, after having survived through at least the first 28 weeks of pregnancy, earlier instances being regarded as abortion or miscarriage)'. And for 'fetus' we have: 'an unborn human more than eight weeks after conception'. It is clear that any technical definition of stillbirth must resolve the question of fetal age and thus level of development. Length of pregnancy is normally gauged in terms of time since last menstrual period, that is days or weeks LMP (technically, time since first day of last menstrual period). For convenience, gestational age may be recorded in the same way. So conception occurs at about two weeks or 14 days LMP and full term is at 40 weeks or 280 days LMP. Strictly speaking, a fetus is fully grown after 38 weeks. Pregnancy is also divided into trimesters: weeks 1–12, 13–24, and 25–40 since LMP. The confusion of gestational age or intrauterine age with duration of pregnancy and menstrual age or postmenstrual time can cause problems, especially because the date of LMP may not be known and menstrual periods may be irregular. Other methods are now available to estimate gestational or intrauterine age and thus to predict the date of full term, such as the crown-to-rump length of the fetus. However, weeks or days LMP is still a convenient device.[5]

The two dictionary definitions mentioned above help to illustrate these distinctions between the timing of pregnancy and gestation. An embryo is still

[4] Will Coster, 'Tokens of innocence: infant baptism, death and burial in early modern England', in Bruce Gordon and Peter Marshall (eds.), *The Place of the Dead: Death and Remembrance in Late Medieval and Early Modern Europe* (Cambridge: Cambridge University Press, 2000), 266–87 discusses the changing meaning of 'chrisom' in detail.

[5] The phrase 'gestational age in weeks or days LMP' will be used here for 'reckoning'. Although it is appreciated that the gestational or intrauterine age of the embryo/fetus dates from fertilization/conception and that menstrual age and length of pregnancy may not be the most appropriate way of recording stage of development, 'months, weeks, days LMP' has become conventional. When Dr William Hunter attended Queen Charlotte, the wife of George III, he was informed that she had very regular menses and that her last was 27 October 1761 'from which therefore the reckoning was to commence'. She was delivered on 12 August 1762 (see J. Nigel Stark (ed.), 'An obstetric diary of William Hunter, 1762–65', *Glasgow Medical Journal*, 70 (1908), 167). Ultrasound techniques now provide the means of assessing gestational age precisely (see Jonathan S. Wigglesworth, *Perinatal Pathology* (Philadelphia, Pa.: Saunders, 1984; 2nd edn. 1996)).

reclassified as a fetus after 8 weeks' gestation, that is 10 weeks or 70 days LMP.[6] The other definition stipulates that during the first 28 weeks of pregnancy the terms 'abortion' or 'miscarriage' should be applied to a fetal death, but that after 28 weeks 'stillbirth' is appropriate. This reflects the British practice, adopted for registration purposes during the 1920s, of employing the following usage:

'Stillborn' and 'stillbirth' shall apply to any child which has issued forth from its mother after the twenty-eighth week of pregnancy and which did not at any time after being completely expelled from its mother breathe or show any other signs of life.[7]

Twenty-eight weeks was chosen because it was believed that a fetus could not be viable if it was born before this time. It was recognized that an infant born between 28 and 38 weeks LMP, although premature, could survive. A stillbirth was a viable fetus born dead. Birth required complete expulsion from the mother and death meant failure to display any vital signs, including respiration.

Three general points are at issue here. Should gestational age (assessed by length of pregnancy, postmenstrual time) be used to establish viability? If only gestational age is to be used, where should the critical point lie? What vital signs ought to be used, and should breathing be given a privileged position?

In their study *Fetal and Neonatal Death* (1940) Edith L. Potter and Fred L. Adair set out ranges of criteria that they believed could be used to define abortion, prematurity, postmaturity, and viability, since they believed that menstrual history was an insufficient criterion upon which to base intrauterine age.[8] They combined gestational age (measured by what they called menstrual age), weight, and length (crown to heel). Table 2.2 lists their criteria. Viability could be defined by any two from: a gestational age beyond 196 days (28 weeks), LMP, or a weight above 1000g or a length over 350mm. Maturity was indicated by a gestational age of 266 days LMP, a weight of 2500g, and a length of 470mm. Potter and Adair were using evidence derived from their own long experience at the Chicago Lying-in Hospital during the 1930s and 1940s. Other obstetricians of the time used their own criteria. For example, C. H. Peckham, at the Obstetrical Department of the Johns Hopkins Hospital, Baltimore, defined aborted fetuses as less than 1500g and less than 350mm in length, while those born premature were defined as less than 2500g and less than 450mm.[9]

[6] In a glossary of terms prepared for his lecture course in 1745 the great eighteenth-century obstetrician Dr William Smellie defined embryo as '[t]he child from conception to the third month', and a fetus as '[t]he child from the third to the ninth month' (see Ch. 5, pp. 120–33).

[7] Quoted from the Births and Deaths Registration Act, 1926, in the Registrar General's *Annual Statistical Review of England and Wales for the Year 1927: Text* (London: HMSO, 1929), 130. This was the first report on the registration of stillbirths in England and Wales. The defining gestational age was reduced to 24 weeks in 1992.

[8] Potter and Adair, *Fetal and Neonatal Death* (Chicago, Ill.: University of Chicago Press, 1940; 2nd edn.1949), p. 8. See also Edith L. Potter, *Pathology of the Fetus and the Newborn* (Chicago, Ill.: Year Book, 1952), 56, table 7, in which Potter reports causes of death for fetuses weighing more than 1000g, her sole criterion.

[9] C. H. Peckham, 'Statistical studies on prematurity', *Journal of Pediatrics*, 13 (1938), 474–97.

Table 2.2. Potter and Adair's criteria for classifying period of fetal development

Two criteria or more in each of the five groups (1)–(5)
(1) *Abortion*
1. Gestation less than 154 days LMP
2. Weight less than 400g
3. Length less than 280mm
(2) *Premature* A. Previable
1. Gestation from 155 to 195 days LMP
2. Weight from 400 to 999g
3. Length from 280 to 349mm
(3) *Premature* B. Viable
1. Gestation from 196 to 265 days LMP
2. Weight from 1000 to 2499g
3. Length from 350 to 469mm
(4) *Term*
1. Gestation from 266 to 294 days LMP
2. Weight from 2500 to 4500g
3. Length from 470 to 540mm
(5) *Postmature*
1. Gestation more than 295 days LMP
2. Weight more than 4500g
3. Length more than 540mm

Note: Length is crown to heel. Potter and Adair used this five-point scale to classify births at the Chicago Lying-in Hospital.

Source: Based on Potter and Adair, *Fetal and Neonatal Death* (1949), p. 10, table 7.

The guideline used today for viability is 154 days (22 weeks) LMP in terms of gestational age, corresponding to 350g and 190mm (crown to rump), while the old 196 days (28 weeks) LMP now relates to 1100g and 250mm.[10] Of these various markers, only 2500g still retains its position as the indicator of low birthweight. Figure 2.1 illustrates the typical modern British fetal-growth pattern in terms of weight and length (crown to heel). The period between 22 and 28 weeks (154–196 days) LMP is shaded to emphasize the way in which notions of viability have shifted.[11]

[10] Stuart Campbell, *Watch Me Grow!* (London: Carroll & Brown, 2004). Campbell gives most of his length measurements as crown to rump (sitting height) because they are easier to judge using ultrasound techniques on the fetus *in utero* than crown to heel (standing height) measurements. Ultrasound techniques have made it possible to assess fetal growth *in utero* and to identify growth restriction.

[11] It should be noted that American and European practices have often differed in these matters, with the former using weight and/or length and the latter focusing on gestational age. For example, the American authority Frederick J. Taussig, in *The Prevention and Treatment of Abortion* (London: Keener, 1910), 2, defined abortion as 'the pre-viable expulsion of the human ovum. Abortion occupies the same relationship to the first six months of pregnancy that labor does to the last

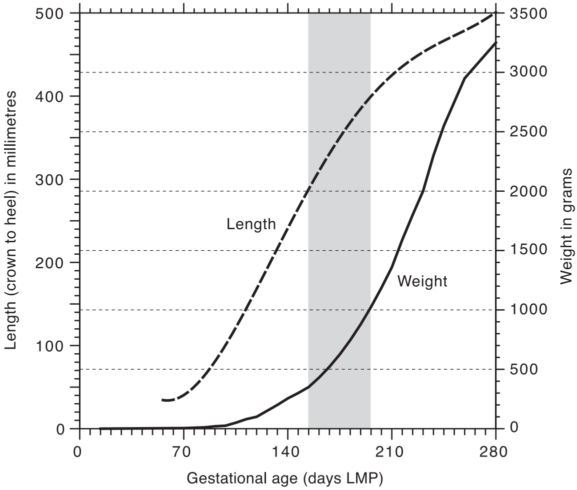

Fig. 2.1: Fetal-growth pattern in terms of length and weight. (This is a very generalized picture, which does not allow for birth order or sex.)

Source: Based on Tanner, *Foetus into Man* (1989), p. 38, fig. 16; Campbell, *Watch Me Grow!* (2004).

The question of which appropriate vital signs to use is even more difficult to answer. Here, again, conventions vary and change. In the early decades of the twentieth century there was considerable discussion among British medical statisticians about how stillbirths should be defined and how they might be registered. In 1912 a special committee of the Royal Statistical Society proposed the following:

A 'stillborn child' means a child born after a period of gestation of not less than seven lunar months (twenty-eight weeks) whose heart has ceased to function before the whole of the body (including the head and limbs) of such child has been completely extracted from the body of the mother; and a 'still-birth' means the birth of a 'stillborn child'.[12]

The chairman of the committee, Reginald Dudfield, also prepared a paper for the Society, which set out some of the arguments for its proposal, as well as a number of criticisms and a new revised definition.[13] Dudfield began with the

three months', while his *Abortion: Spontaneous and Induced, Medical and Social Aspects* (London: Kimpton, 1936), 485 defined a stillborn child as 'a viable child (i.e. over 1250g in weight or 32cms in length) that dies without any spontaneous effort at respiration'.

[12] Royal Statistical Society, *Infantile Mortality: Report of the Special Committee Appointed by the Council of the Royal Statistical Society to Enquire into the Systems Adopted in Different Countries for the Registration of Births (Including Stillbirths) and Deaths with Reference to Infantile Mortality* (London: Royal Statistical Society, 1912), 16.

[13] Reginald Dudfield, 'Still-births in relation to infantile mortality', *Journal of the Royal Statistical Society*, 76 (1) (1912), 1–57. Today's approach is outlined in Gordon C. S. Smith and Ruth C. Fretts, 'Stillbirth', *Lancet*, 370 (2007), 1715–25.

legal definition of 'life': 'able to stir in the mother's womb'. He related this to 'quickening' during the fourth month of pregnancy (weeks 12–27 LMP, but normally weeks 14–18 LMP). Medical evidence for life *in utero* was provided by the 'auscultation of the fetal heart sounds', which might be detected in weeks 15–16 LMP. Fetal life should best be dated 'from the time when the heart sounds become audible', therefore. Since births before 20 weeks LMP were hardly ever capable of independent existence, and a viable birth was possible after 26 weeks LMP, Dudfield recommended the use of 'child' to mean born after 28 weeks LMP. He insisted that the 'persistence of the heart's action' should be made the test of 'live-born', partly because such a test was 'within the capacities of a competent midwife' and partly because the other possible signs, of breathing, crying, and movement, could be regarded as secondary; that is, ultimately dependent on the heart's function. However, he also recognized the difficulty of specifying gestational age, and turned to length at birth as a proxy for stage of development, and thus viability. After criticism from the Royal Society of Medicine, Dudfield finally made this new proposal:

> A 'stillborn child' means a child whose body at birth measures [more than] 320mm (crown to heel) and who when completely born (the head, body and limbs of the child, but not necessarily the afterbirth, being extruded from the body of the mother), exhibits no sign of life—that is to say, whose heart has ceased to function, as demonstrated by absence of pulsation in the cord at its attachment to the body of the child and absence of any heart sounds or impulses.
>
> NOTE.—Crying and/or breathing—being secondary signs of life, manifested only when the heart is acting—can be relied upon as signs of life, but the absence of either or both is not to be held to be proof of the absence of life in the child.[14]

Not surprisingly, Dudfield's definition was thought to be too complicated. However, its development and elaboration raise some important points.

The use of length as a proxy for fetal development was borrowed from the Prussian registration system. A crown-to-heel length of 320mm was believed to correspond, approximately, to 28 weeks LMP. But length could be assessed by a midwife with a tape measure and was a simple, practical device, therefore.[15] The eminent Scottish obstetrician and pathologist John W. Ballantyne, whose work is discussed in detail in Chapter 6, took Dudfield and his Royal Statistical Society report to task by offering some new approaches to the definitions of key terms.[16] Ballantyne drew a sharp distinction between antenatal and postnatal by

[14] Dudfield, 'Still-births in relation to infantile mortality', p. 12.

[15] Reginald Dudfield, 'Stillbirths: the case for their compulsory registration and their definition', *Proceedings of the Royal Society of Medicine: Section of Epidemiology and State Medicine*, 17 (1914), 81–106, esp. p. 93.

[16] Ballantyne, 'Still-births' registration', *Journal of Obstetrics and Gynaecology of the British Empire*, 25 (3) (1914), 132–49. This is probably the most careful, well-informed, and thus important discussion of definitions written in the early twentieth century. Interestingly, it too began by considering dictionary definitions in what was called a 'legislative and lexicographic jungle'.

emphasizing the need to define life and death in both circumstances. He refused to regard dead-born and stillborn as synonymous. And he recognized the futility of creating a fixed definition of viability, although in practice he was obliged to adopt one:

I am aware that such things as viability and its date are spoken of; but I lay no great stress on the former from the standpoint of still-births, and I affirm that the latter cannot be fixed because every invention for the keeping alive of prematurely born infants and every improvement in infantile hygiene must push back the date of viability nearer to conception.[17]

Of the four signs of life—movements, heartbeat or its resulting pulsation (in the umbilical cord, at the wrist, at the ankle, and elsewhere), breathing, crying—Ballantyne regarded the first two as antenatal and the second pair as postnatal, with breathing as the best test of (postnatal) live birth and heartbeat the favoured test of antenatal life. This led to further distinctions between antenatal, intranatal, and postnatal deaths: deaths *in utero* that might be subject to maceration (the dead-born, antepartum stillbirths); fetuses showing signs of life at the start of labour but showing no signs of antenatal life at the moment of birth (dead-in-birth children, intrapartum stillbirths); and two varieties of live-born children: those which after complete expulsion from the mother show only the signs of antenatal life, and consequently soon die; and those showing signs of antenatal life prior to assuming the signs of postnatal life (breathing, crying, indications of pulmonary respiration). This line of argument allowed Ballantyne to separate dead-born and stillborn, with some who were apparently stillborn (i.e. showing 'temporary stillness at birth, not the definitive stillness of death') being resuscitated to full postnatal life:

There are, therefore, three classes of occurrences: the antenatal deaths, in which the signs of antenatal vitality have been extinguished before the complete expulsion of the child [Ballantyne preferred 24 weeks LMP, but was willing to accept 28 weeks] from the mother's body [i.e. antenatal deaths or dead births]; second, the postnatal or infantile deaths, which take place after the child has been born alive, after it has taken on the peculiar and characteristic signs of postnatal as distinguished from antenatal vitality [i.e. postnatal infant deaths]; third, the cases in which the antenatal type of life is maintained for a short time after the complete expulsion from the mother's body, in which the assumption of the characters of postnatal life may not take place, and in which, therefore, antenatal life may give place to postnatal death without the interim establishment of postnatal life [i.e. stillbirths, but with the potential to realize postnatal life].[18]

Finally, Ballantyne set out what he regarded as revolutionary new definitions:

That the definition of dead-birth, live-birth, still-birth and abortion should be so constructed as to be in accordance with the physiology of the time of life dealt with.

[17] Ballantyne, 'Still-births' registration', p. 140.
[18] Ballantyne, 'Still-births' registration', p. 146

(a) For *dead-birth* I suggest the complete expulsion from the maternal birth-canals of a child which during or before birth has lost the characters of antenatal life, especially heart-beat, arterial pulsation, and movement.
(b) For *live-birth*, the complete expulsion from the maternal birth-canals of a child which, whilst it loses pulsation in the cord, adds on to the other characters of antenatal life the signs of postnatal vitality, viz., pulmonary respiration and crying.
(c) For *still-birth*, the complete expulsion from the maternal birth-canals of a child which, whilst continuing to exhibit one or more of the signs of antenatal life (heart-beat, arterial pulsation, movement) fails for a time to assume those of postnatal life (pulmonary respiration, crying, etc.), and then either loses even the characters of antenatal life or is successfully resuscitated (transanimated), and assumes those of postnatal existence.
(d) For *abortion* or miscarriage, I suggest the termination of antenatal life before the end of the sixth lunar month [24 weeks LMP] by the expulsion of the uterine contents. A *premature birth* is expulsion of the uterine contents after the sixth lunar month but before the full term, and it may be a dead-birth, a live birth, or a still-birth.[19]

We have already seen on page 19 that when stillbirths were first registered in England and Wales the definition used was rather simple, open to interpretation in ways that both Dudfield and Ballantyne were trying to avoid. After 28 weeks LMP, complete expulsion and no respiration or other vital signs were the three essential points. More recent attempts to define the key terms and make them practical and universally applicable have not fared any better than those of Dudfield and Ballantyne in the early twentieth century. For example, the World Health Organization in its *International Classification of Diseases, Version 10* (ICD-10, 1992) makes the following proposals.

live birth the complete expulsion or extraction from its mother of the product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered liveborn

stillbirth or *fetal death* death prior to the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy; the death is indicated by the fact that after such separation the fetus does not breathe or show any other evidence of life; such as beating of the heart; pulsation of the umbilical cord or definite movement of voluntary muscles

perinatal period commences at 22 weeks of gestation and ends seven completed days after birth

neonatal period begins with birth and ends 28 completed days after birth

early-neonatal deaths occurring during the first seven days of life (0–6 days)[20]

[19] Ballantyne, 'Still-births' registration', 149.
[20] WHO, *Neonatal and Perinatal Mortality: Country, Regional and Global Estimates* (Geneva: World Health Organization, 2006), 6, based on ICD-10 (1992).

The phrase 'irrespective of the duration of pregnancy' and making stillbirths and fetal deaths synonymous are two new developments. However, they appear to be confounded by the definition of perinatal mortality as deaths between 22 weeks' gestation (154 days LMP), during childbirth, and before 7 completed days after live birth. Demographers normally count perinatal deaths as the combination of stillbirths (as registered) and early-neonatal deaths (0–6 days after live birth). But the WHO guidelines also suggest that fetuses delivered beyond 22 weeks gestation or with a birthweight over 500g should be counted as perinatal deaths, although it is recognized that for international comparisons 1000g may need to be used. Birthweights of 500g and 1000g correspond roughly to 24 and 28 weeks LMP. In practice, the WHO encourages use of the term 'late-fetal deaths' instead of stillbirths, and recognizes that such deaths may occur after 20, 22, 24, 26, or 28 weeks' gestation (in terms of LMP) according to the registration conventions of individual countries. So, late-fetal plus early-neonatal equals perinatal deaths.

By taking this line, the WHO recognizes that 'stillborn' and 'stillbirth' are confusing English words, partly because in other languages there is no distinction between 'dead-born' and 'dead birth'. For 'stillborn' we have *nato morto* in Italian (with *parto di un feto morto* for stillbirth), *nacido Muerto* in Spanish, *mort-né* in French, *totgeboren* in German, *dødfødt* in Norwegian, and *dödfödda* in Swedish. But English also has 'dead-birth', which may not mean stillbirth, as in Ballantyne's usage above. The WHO definitions also reflect the arrangements adopted in the USA. There the definition of fetal death is even more complicated, with each state taking its own position in terms of legal definition and registration practice. Current model definitions of 'live birth' and 'fetal death' are as follows in the USA:

'Live birth' means the complete expulsion or extraction from its mother of a product of human conception, irrespective of duration of pregnancy, which after such expulsion or extraction, breathes, or shows any other evidence of life such as beating of the heart, pulsation of the umbilical chord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached. Heartbeats are to be distinguished from transient cardiac contractions; respirations are to be distinguished from fleeting respiratory efforts or gasps.

'Fetal death' means death prior to the complete expulsion or extraction from its mother of a product of human conception, irrespective of the duration of pregnancy and which is not an induced termination of pregnancy. The death is indicated by the fact that after such expulsion or extraction, the fetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles. Heartbeats are to be distinguished from transient cardiac contractions; respirations are to be distinguished from fleeting respiratory efforts or gasps.[21]

[21] J. Kowaleski, *State Definitions and Reporting Requirements for Live births, Fetal Deaths, and Induced Terminations of Pregnancy*, rev. edn. (Hyatsville, Md.: US National Center for Health

Table 2.3. Definitions of fetal death currently adopted in US registration areas

Definition of fetal death used	Areas
All products of human conception	11 (7)
20 weeks (LMP) gestation or more	25 (25)
Birthweight of 350g or more *or* 20 weeks (LMP) gestation or more	13 (12)
Gestation of 20 weeks (LMP) or more *or* birthweight of 400g or more	1 (1)
Gestation of 20 weeks (LMP) or more *or* birthweight of 500g or more	1 (0)
Birthweight of 350g or more	1 (1)
Birthweight of 500g or more	3 (3)
Gestation of 16 weeks (LMP) or more	1 (1)
Gestation of 5 months (LMP) or more	1 (0)

Note: The number of registration areas in the US vital-registration system is given, followed, in brackets, by the number of states. The registration areas include the 50 states, plus New York City, Washington DC, Puerto Rico, and other US territories in the Caribbean and Pacific. The definitions relate to the 1992 Revision of the Model State Vital Statistics Act and Regulations.

Source: Kowaleski, *State Definitions* (1997), pp. 3–4.

The recommended reporting requirement for fetal death makes more specific demands in terms of gestational age or weight:

Each fetal death of 350g or more, or if weight is unknown, of 20 completed weeks gestation or more, calculated from the date last normal menstrual period began to the date of delivery, which occurs in this state shall be reported within 5 days after delivery to the (Office of Vital Statistics) or as otherwise directed by the State Registrar.

But only 13 registration areas (12 states) have adopted this recommendation. Current registration practice is shown in Table 2.3. According to Figure 2.1, the three key birthweights of 350g, 400g, and 500g correspond to 22, 23, and 24 weeks LMP, respectively.

Clearly definitions of fetal deaths and stillbirths are still evolving. Despite the encouragement of the WHO, there is no agreed international approach to definition and registration practice. Key gestational ages vary; some prefer to use weight alone or in conjunction with age, and others have used, or contemplated using, length. Viability shifts with medical technology to earlier, lighter, shorter standards, as Ballantyne predicted. There is also considerable scope for euphemism; the phrase ‘intrauterine fetal demise’ (IUFD) is now commonly used for fetal death. However, there are indications that live births are more likely to be recorded in a broadly consistent way now that the vital signs

Statistics, 1997). See also D. L. Hoyert, *Perinatal Mortality in the United States, 1985–91*, US National Center for Health Statistics, *Vital Health Statistics*, 20 (26) (1995), esp. pp. 17–20, ‘Technical notes’, where some of the definition, registration, and measurement problems are set out.

required have been elaborated and 'breathes or shows any other evidence of life' has become the accepted phrase.[22]

MEASUREMENT

Measurement depends on clear and consistent definition, and accurate registration. We have already seen that even in the twenty-first century definition continues to pose many problems, especially over 'viability' and 'vital signs', and that these will have implications for accurate recording. Although the various practical issues associated with registration conventions will be considered in greater detail in Chapter 4, this short section outlines the various ways in which measures of the risk of fetal and infant mortality have been constructed.[23] Demographic rates are usually constructed from the ratio of a numerator (e.g. number of vital events occurring during a specified period of time) to a denominator (e.g. the number 'at risk' of those events occurring to them in the same specified period of time). The ratio is expressed per 1000 or per 10 000. Thus, the infant-mortality rate (IMR) is the number of infant deaths in a given year per 1000 live births in that same year. Both the number of live births (denominator) and the number of infants born alive but dying within 12 months (numerator) must be registered correctly to allow accurate measurement. Late-fetal mortality may be measured as follows: the number of registered stillbirths or dead-born (numerator) per 1000 stillbirths plus live births (i.e. total births) (denominator). In US vital statistics two fetal mortality rates are regularly tabulated. One uses all fetal deaths over 20 weeks LMP (or its weight equivalent) as the numerator, while the other only uses late-fetal deaths (28 weeks LMP or 1000g) as the numerator, since fetal deaths from 20 to 27 weeks LMP are referred to as 'early-fetal deaths'. The denominator should approximate the number of fetuses that have survived

[22] Paediatricians still use the Apgar score, which was first proposed by the American anaesthetist Virginia Apgar in 1953. Her score uses five signs: heart rate, respirations, muscle tone, reflex irritability, and colour. Each sign is scored 0, 1, or 2. For example, no heart rate or respirations would each score 0, while more than a hundred beats per minute and a good, strong cry would score 2. Cumulative scores of 8, 9, and 10 indicate a vigorous infant, while 5–7 show mild depression, and 0–4 show severe depression requiring resuscitation. Score assessments were originally made at 1 minute after birth and are now also taken at 5 minutes if there is cause for concern (see Mieczyslaw Finster and Margaret Wood, 'The Apgar score has survived the test of time', *Anesthesiology*, 102 (4) (2005), 855–7). The Apgar score appears again in Table 6.7, p. 184. CEMACH, *Perinatal Mortality, 2006: England, Wales and Northern Ireland* (London: Confidential Enquiry into Maternal and Child Health, 2008), 94 uses the following definition on the perinatal death notification form (PDN): 'stillbirth, a baby delivered without life after 23 weeks of pregnancy where there are no signs of life at birth and no heartbeat was ever detected'. Early-neonatal deaths are those following live births of all gestations where babies die before seven completed days of age.

[23] Roland Pressat, *The Dictionary of Demography*, ed. Christopher Wilson (Oxford: Blackwell, 1985) provides helpful guidance to the standard demographic rates and ratios; see also 'foetal mortality' (p. 83).

to the critical gestational age (or weight or length) used to define viability (e.g. 20, 22, 24, 28 weeks LMP) and are thus at risk of being born dead. The stillbirth rate (SBR) will be used to measure late-fetal mortality throughout this study. This will normally mean fetal deaths of 28 weeks LMP or more.

During the early years of registration in Britain and the USA the stillbirth ratio was often reported; here registered stillbirths are simply expressed per 1000 live births. The rate (SBR) is preferable to the ratio, since it gives a clearer idea of the risk of fetal death. The fetal-death ratio (FDR) was also used in the USA during the early decades of vital registration. All registered fetal deaths, regardless of gestational age, are expressed per 1000 registered live births. This is an especially confusing measure, which lacks any serious statistical or demographic credibility. It stems from the fact that each state is allowed to use its own definition of fetal death and to register such deaths accordingly (Table 2.3). The fetal-death ratio merely aggregates data gathered under all of these various conventions.

The construction of miscarriage or spontaneous-abortion rates so that the risk of miscarriage can be measured and compared between populations poses some additional problems. The ideal solution would require two gestational ages to be specified, say 8 and 22 weeks LMP or 10 and 28 weeks LMP, and for the number of miscarriages occurring during the interval to be expressed as a ratio of the number of pregnancies that had reached the first critical point. Since miscarriages are not normally included in national vital-registration systems, most data come from hospital studies where pregnancy outcomes are being monitored or where *in vitro*-fertilization (IVF) treatment is being used, or from retrospective surveys asking women to report the number of miscarriages they have had as part of their full reproductive histories. While continuous monitoring may yield accurate pregnancy-failure rates, they will only apply to specially selected, often sub-fecund, groups. Retrospective surveys suffer from denominator problems; specifically, the need to state the number of pregnancies at risk of miscarrying. It is also a matter of judgement as to which initial-gestational age should be used. Conception, implantation, chemical recognition, clinical recognition of pregnancy, and 'quickening' are all possible choices. The terminal age should coincide with 'viability' and the defining age for registering late-fetal deaths or stillbirths. It would also be very useful to know the conception-to-live-birth ratio—whether it is significantly different from 2 to 1 in a large modern population, for instance.[24]

[24] It is also common for textbooks to take their own individual and often idiosyncratic approach. For example, Thomas F. Baskett, *Essential Management of Obstetric Emergencies*, 4th edn. (Bristol: Clinical, 2004), 25 has the following definition and accompanying estimates: miscarriage applies to a fetus weighing less than 500g or of less than 20 weeks' gestation if weight is unavailable, and pregnancy loss is 15 per cent after clinical diagnosis, while total pregnancy loss after implantation is 31 per cent (a conception-to-live-birth ratio of 1.45: 1). Enid Gilbert-Barness and Diane Debich-Spicer, *Embryo and Fetal Pathology: Color Atlas with Ultrasound Correlation* (Cambridge: Cambridge University Press, 2004), 23 uses 'Stillbirth or fetal death is the delivery of an infant with no signs of life between 20 weeks gestational age and term' and claims that late intrauterine fetal death with stillbirth accounts for 1 per cent of pregnancies.

Finally, we should mention some of the more specialized measures of infant mortality. The early-neonatal mortality rate (ENMR) relates the number of deaths during the first 7 complete days (i.e. 0–6 days) after live birth to the number of live births, while the neonatal-mortality rate has deaths within the first 28 days or 4 weeks after live birth as its numerator and live births as denominator. The perinatal-mortality rate is the most recent construction. As we saw in the WHO definitions above, it takes late-fetal plus early-neonatal deaths as the numerator (i.e. registered stillbirths plus deaths 0–6 days after live birth) and expresses them per 1000 stillbirths plus live births (total births). Although something of a hybrid, the perinatal-mortality rate is now the internationally favoured guide to health-care provision for the fetus and neonate.

The following chapters contain numerous examples of these definitional and measurement problems, and how they have affected analysis of fetal-mortality causes over the centuries. Just two examples will be given here, to illustrate the way in which definition and measurement can interact. First, Figure 2.2 shows what happens to apparent levels of late-fetal and infant mortality when stillbirths are reclassified. Supposing that the true rates are 40 for the SBR and 150 for the IMR (e.g. 42 stillbirths, 1000 live births, 1042 total births, 150 infant deaths), then if half the stillbirths are reassigned as deaths during infancy, SBR will be reduced to 20 and IMR increased to 167. But if the number of stillbirths is increased by 50 per cent and the appropriate reduction made to the number of

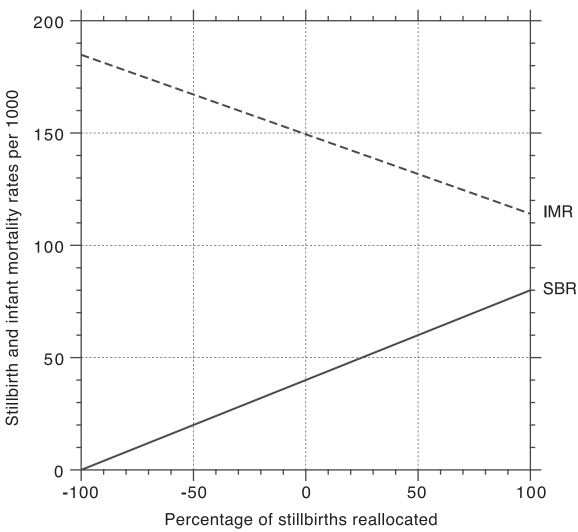

Fig. 2.2: Influence of reallocating stillbirths on late-fetal mortality (SBR) and infant mortality (IMR). (The true stillbirth rate (SBR) is 40 per 1000 total births and infant-mortality rate (IMR) is 150 per 1000 live births.)

infant deaths, then SBR will be 60 and IMR will be 132. In this instance, moving half the late-fetal deaths about the critical defining line of live birth can make the stillbirth rate move from 20 to 60.

Second, the village of Terling, Essex, had a particularly well-kept parish register in the early seventeenth century.[25] Between 1601 and 1665, 1284 baptisms were recorded, as well as 25 unbaptized infants and 58 stillbirths. This would give a stillbirth rate of 42.4 per 1000 total births, but if all of the unbaptized were actually dead-born then the SBR would be 60.7. The minimum rate was probably 42 and the maximum 61, therefore, because only some of the baptized were born without sufficient signs of life. The full significance of these example rates will emerge as we discuss historical experiences in Chapters 3 and 4.[26]

INFLUENCES

The factors that affect intrauterine mortality are clearly very particular ones, unlike those influencing infant or maternal mortality, or the general risks to adult women of reproductive age.[27] One approach would be to distinguish between factors in operation before pregnancy and those acting at the various distinct phases of pregnancy. By this means we could trace the competing risks involved and establish which influences were most likely to be responsible for gestational-age-related deaths. Another approach would emphasize the differences between biological-physiological factors and those that could be regarded as more behavioural, where individual agency is involved, although such an oversimplification would require considerable elaboration to make it meaningful. We might also focus explicitly on the causes of fetal deaths by distinguishing between risk factors, the underlying cause, and the immediate mechanism of death. None of these approaches is entirely appropriate. We need to begin with a model that provides a general account of the factors that are likely to influence fetal mortality, a working model that sketches the bigger picture, one that can be taken apart, examined in detail, and reassembled at a later time.[28]

[25] Keith Wrightson, 'Infanticide in earlier seventeenth-century England', *Local Population Studies*, 15 (1975), 10–22, reported on p. 18.

[26] It seems most likely that late-fetal mortality, as measured by the stillbirth rate (SBR), was about 40 per 1000 total births in England during much of the nineteenth and early twentieth centuries, and that a rough guide to credible SBRs in substantial historical populations would be 20–60.

[27] Four recent review articles cover the topic: Sven Cnattingius and Olof Stephansson, 'The epidemiology of stillbirth', *Seminars in Perinatology*, 26 (1) (2002), 25–30; Robert L. Goldenberg and Cortney Thompson, 'The infectious origins of stillbirth', *American Journal of Obstetrics and Gynecology*, 189 (2003), 861–73; Robert L. Goldenberg, R. Kirby, and J. F. Culhane, 'Stillbirth: a review', *Journal of Maternal–Fetal and Neonatal Medicine*, 16 (2) (2004), 79–94; and, Robert M. Silver, 'Fetal death', *Obstetrics and Gynecology*, 109 (1) (2007), 153–67.

[28] There is a strong tradition of developing conceptual models in research on infant mortality. The following provide three important examples, but none is concerned explicitly with fetal mortality

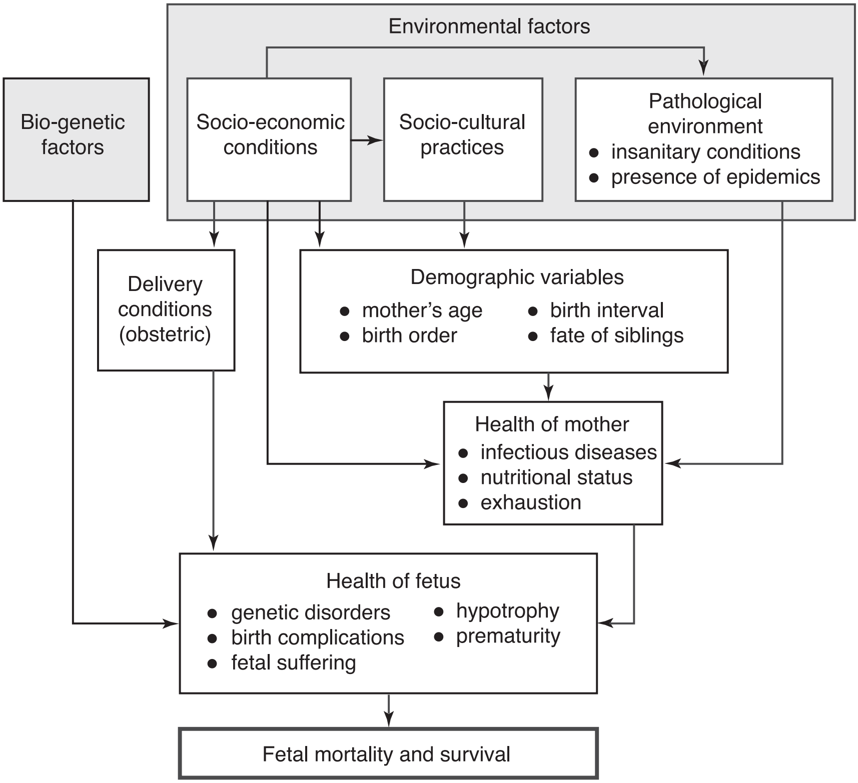

Fig. 2.3: Simple model for analysing the determinants of fetal mortality.
Source: Developed from Lalou, 'Endogenous mortality' (1997), p. 206, fig. 12.2.

Figure 2.3 outlines such a model.[29] It begins with two broad categories of factors mentioned above: the biogenetic and the environmental. But the latter is further broken down to enable distinctions to be drawn between the effects of socio-economic circumstances (e.g. poverty and work patterns), socio-cultural

as well as neonatal or child mortality: W. Henry Mosley and Lincoln C. Chen, 'An analytical framework for the study of child survival in developing countries', *Population and Development Review*, supplement to vol. 10 (1984), 26, figs. 1–2; Massimo Livi Bacci, 'Introduction', in Alain Bideau, Bertrand Desjardins, and Héctor Pérez (eds.), *Infant and Child Mortality in the Past* (Oxford: Clarendon, 1997), p. 4, fig. 0.1, and Marie Vandresse, 'Estimation of a structural model of the determinants of neonatal mortality in Hungary, 1984–88 and 1994–98', *Population Studies*, 62 (1) (2007), 87–8, figs. 1–2.

[29] The model in Figure 2.3 develops the one presented by Richard Lalou, 'Endogenous mortality in New France: at the crossroads of natural and social selection', in Bideau, Desjardins, and Brignoli, *Infant and Child Mortality*, 203–15, which focuses on neonatal mortality. See also Jacques Dupâquier, 'For a history of prematurity', ibid. 188–202.

practices which may be especially important in relation to fertility levels, and the pathological environment, which has a strong epidemiological component. The environmental factors, individually and in combination, influence the mother's health both directly and indirectly through a number of intermediary demographic variables. The health of the fetus is influenced by the mother's health, by delivery conditions (i.e. direct obstetric factors associated with the quality of birth attendants, as well as the physical conditions in which delivery takes place), and by those biogenetic factors with which the model begins. The final-outcome box of the model covers fetal mortality and survival (i.e. abortion and stillbirth, but also the possibility of survival to live birth and beyond).

The model takes on greater meaning if it is used to trace through the anticipated consequences of particular conditions. For example, suppose that an unmarried woman became pregnant. She would most likely be young and probably this would be her first child. Her ability to secure good-quality delivery conditions would be limited and she might well face poverty and malnutrition during her pregnancy. In these circumstances, she and her unborn child would be at high risk. Consider the example of a population with high incidence of venereal infections or malaria or smallpox; in each case the disease environment would place additional burdens on any pregnancy, making the risk of an abortion or miscarriage considerably higher regardless of socio-economic conditions. And, again, imagine that the pathological environment could be controlled and that high-quality delivery conditions could be secured for all, regardless of socio-economic background, what then would be left to influence fetal mortality and survival? The demographic variables might still play their parts, but the biogenetic factors would dominate outcomes—the factors influencing intrauterine-growth restriction, for instance. The model also helps one to hypothesize about the consequences of making certain health interventions, therefore. Suppose that obstetric care was improved and made independent of socio-economic conditions, how might the beneficial effects work through the model to reduce fetal mortality? The links between boxes in the model indicate direction of influence, but they do not suggest how strong it might be. A fully specified model would show strength of association as well as its sign, whether positive or negative, and it would be time- and place-specific, relating to eighteenth-century England or twentieth-century America, for instance.

One example will be used to illustrate how the contents of the model's individual boxes will also need to be examined in more detail. The demographic-variables box lists 'mother's age' and 'birth order'. Both have long been known to have a bearing on fetal mortality, although it is also understood that the variables are not independent of one another. Women under 20 and over 40 are more at risk in terms of maternal age. First and fourth-plus births are more at risk in terms of order. However, women having a first pregnancy in their late thirties or forties are at the highest risk of a fetal death. Table 2.4, based on

Table 2.4. Examples of late-fetal mortality (SBR) patterns by birth order and maternal age-group: based on Denmark, 1951–3

	Maternal age-group						
Birth order	< 20	20–4	25–9	30–4	35–9	> 40	All ages
(a)							
1	956	934	**1219**	**1874**	**3049**	**3383**	**1142**
2	563	557	667	874	**1393**	**2481**	732
3	**1115**	546	743	869	**1445**	**1770**	863
4	—	661	814	934	**1339**	**2284**	**1049**
5	—	**1246**	**1197**	863	**1328**	**1694**	**1169**
> 6	—	**1033**	**1098**	**1240**	**1885**	**2634**	**1760**
Total	901	765	874	**1038**	**1574**	**2322**	**1000**
(b)							
1	38	37	49	75	122	135	46
2	23	22	27	35	56	99	29
3	45	22	30	35	58	71	35
4	—	26	33	37	54	91	42
5	—	50	48	35	53	68	47
> 6	—	41	44	50	75	105	70
Total	36	31	35	42	63	93	40

Note: Panel (a) shows the pattern if the national stillbirth rate of 18.3 for all pregnancies is set equal to 1000. Panel (b) shows the birth-order and maternal-age-specific SBRs per 1000 total births if the overall SBR was 40. An SBR of 40 represents a general guide to what might be expected in the nineteenth century.

Source: Derived from Matthiesen et al., *Infant and Perinatal Mortality in Denmark* (1967), p. 13, table N.

the experience of Denmark 1951–3, illustrates this pattern.[30] The total stillbirth rate was 18.3, with a range of from 10.0 (third birth to women aged 20–4) to 61.9 (first birth to women aged 40 and over). Table 2.4, panel (a) sets the national rate equal to 1000 and adjusts the individual cells accordingly. Early, late, and high-order pregnancies are located round the rim of the basin-shaped surface (highlighted in bold type), with those at low risk towards the centre. If the total stillbirth rate were 40, say, then one might expect the entire basin to be

[30] The original Danish data come from P. C. Matthiesen, D. Trolle, and B. Zachau-Christiansen, *Infant and Perinatal Mortality in Denmark*, US National Center for Health Statistics, 3rd ser., 9 (Washington, DC: US Government Printing Office, 1967). It is unusual to have detailed data for even relatively high SBR populations. Another example is A. C. Stevenson et al., 'Observations on the results of pregnancies in women resident in Belfast', *Annals of Human Genetics*, 23 (4) (1958), 382–420, which gives details of all the pregnancies terminating in Belfast in 1957, where the SBR was 25.7. Anne-Marie Nybo Andersen et al., 'Maternal age and fetal loss: population-based register linkage study', *British Medical Journal*, 320 (2000), 1708–12 illustrates the persistence of these age effects using Danish data for 1978–92, when the SBR was 4.3 and induced abortions exceeded spontaneous abortions by 2.8: 1. Uma M. Reddy, Chia-Wen Ko, and Marian Willinger, 'Maternal age and the risk of stillbirth throughout pregnancy in the United States', *American Journal of Obstetrics and Gynecology*, 195 (2006), 764–70 illustrates how the risk of stillbirth increases both with maternal age and gestational age.

raised but for it to be substantially deeper, since the extreme values at the rim would be higher.[31] This hypothetical pattern is illustrated in Table 2.4, panel (b). The lowest stillbirth rate is 22 and the highest is 135 per 1000 total births. The demographic-variables box in Figure 2.3 also includes 'fate of siblings'. This is an important consideration because it is also well known that miscarriages and stillbirths are clustered, that some women may experience several during their reproductive lives, and, thus, that the pregnancies of a minority of women may contribute substantially to the total burden of fetal wastage.[32]

The model described in Figure 2.3 is far from perfect. It does not differentiate between antepartum and intrapartum fetal deaths, and yet the two are likely to have very different causes. The former are responsive to genetic and physiological problems, also certain infections passed on to the fetus by its mother, while the intrapartum deaths will relate specifically to delivery problems. Ideally, it would be helpful to develop specific models for miscarriages, antepartum stillbirths, and intrapartum stillbirths, but this will certainly prove difficult as far as historical populations are concerned. The model is probably best seen as an exploratory device, useful for sketching possible causal pathways between key factors; subject to revision; only temporary.

[31] This is an interesting and not entirely abstract exercise. We do not have 'maternal age by birth order' data for a population with an SBR of 40. Such a population would probably have higher fertility than Denmark in the early 1950s, with higher birth orders and longer reproductive histories. The SBR for first birth among women aged under 20 would also be higher if a substantial minority of women were unmarried and at higher risk.

[32] See Jennie Kline, Zena Stein, and Mervyn Susser, *Conception to Birth: Epidemiology of Prenatal Development* (New York: Oxford University Press, 1989).

3

The prospects for survival from conception to childhood

Here we focus mainly on age and the ways in which the chances of survival vary during gestation and during the first year after live birth. We describe the normal pattern of age-related mortality between conception and first birthday, a period of from 80 to 94 weeks, as modern obstetricians, gynaecologists, and demographers understand it. This is not a simple matter. Evidence for the embryo and early-fetal stages of development is poor, and several important assumptions have to be made. But this chapter also speculates on what the age pattern of mortality might have looked like in earlier centuries, when the level of early-age mortality was far higher. For example, if the infant-mortality rate were 150, 200, or 250 per 1000 live births, how would the associated age-specific probabilities of dying or surviving have been affected? How would the general pattern vary? Which particular ages would contribute most to change as overall mortality increased or declined? Again, these are very difficult questions to answer directly and conclusively. Their importance is not in doubt, however. Once resolved, we would have clear expectations for the extent of miscarriages and natural abortions, the number of stillbirths, the levels of neonatal and postneonatal mortality, as well as the ways in which these age components are likely to interrelate. It would be known whether the level of late-fetal mortality might be accurately derived from early-neonatal mortality, for instance.

This chapter is organized into four sections. The first considers the biometric analysis of infant mortality. The second assesses the current medical evidence on the variation in fetal mortality with gestational age. The third attempts a mathematical integration of findings from the first two sections. It proposes a hypothetical model of the conception-to-first-birthday survival pattern over the normal period of 92 weeks. The final section sets out some implications for historical research.

BIOMETRIC ANALYSIS OF INFANT MORTALITY

In a series of articles published in the late 1940s and early 1950s the distinguished French demographer Jean Bourgeois-Pichat (1912–90) examined the distribution of infant deaths by exact age in a variety of European, North American, and Australasian countries.[1] His objective was to focus attention on national and international variations in infant-mortality rates and the varying quality of cause-of-death statistics. He assumed that all infant deaths could be classified as either endogenous (those associated with congenital abnormalities and the trauma of birth itself) or exogenous (those associated with the postnatal environment, especially infections). He also devised a method that allowed the total infant-mortality rate (deaths between live birth and one year of age per 1000 live births) to be split into endogenous and exogenous components without the need for direct information about cause of death in infancy. This method relied upon the biometric analysis of infant deaths during the first twelve months. Bourgeois-Pichat noticed that if he cumulated the number of deaths, or the death rate, and related the series to age in days after live birth (x) transformed by $[\log(x+1)]^3$ the result normally produced a straight line for mortality over 30 days (i.e. postneonatal mortality). The equation for this straight line could be found simply by using regression techniques. Further, the fact that in the equation

$$y = \boldsymbol{a} + \boldsymbol{b}[\log(x+1)]^3$$

the constant $\boldsymbol{b}$ gave the slope of the regression line, while the constant $\boldsymbol{a}$ as well as giving the intercept of the regression line with the vertical axis (i.e. the value of the dependent variable (y) when that of the independent variable (x) is zero) also provided an estimate of the level of endogenous mortality. Since the total infant-mortality rate was made up of either endogenous or exogenous mortality, the latter could be found by subtracting the endogenous estimate from the total rate.[2]

This approach has proved especially influential among historical demographers concerned to evaluate the quality of family-reconstitution studies based on ecclesiastical parish registers. The linking of nominal entries from baptism to burial registers offers a means of deriving estimates not only of the total infant-mortality rate, but also of infant mortality distinguished by age. By applying Bourgeois-Pichat's transformation, estimates of both endogenous and exogenous mortality could be found, as well as the slope of the regression line ($\boldsymbol{b}$). If the endogenous-mortality estimate was too low (and $\boldsymbol{b}$ too high) this should indicate that a number of deaths at very early ages, especially early-neonatal deaths during the first few days after live birth, had been missed from the baptism register and

[1] An appreciation of his life and work is provided in the anonymous 'Hommage à Jean Bourgeois-Pichat', *Population*, 45 (4–5) (1990), 731–72.

[2] These arguments were developed at length in the following papers by Jean Bourgeois-Pichat: 'De la mesure de la mortalité infantile', *Population*, 1 (1946), 53–68; 'Analyse de la mortalité infantile', *Revue de l'Institut International de Statistique*, 1–2 (1950), 45–68; 'La mesure de la mortalité infantile', *Population*, 6 (1951), 233–48, 459–80; 'An analysis of infant mortality', *Population Bulletin of the United Nations*, 2 (1952), 1–14.

Table 3.1. The biometric analysis of infant mortality: Quebec Province, Canada, 1944–7

Age in days (x)	Transformation of x by $[\log(x+1)]^3$	Cumulative mortality rate up to age x
30	3.355	31.5
60	5.735	37.9
90	7.587	43.1
120	9.105	46.9
150	10.430	49.7
180	11.590	52.1
210	12.650	54.1
240	13.650	55.8
270	14.505	57.2
300	15.335	58.3
330	16.100	59.3
365	16.840	60.2

Note: The following equations may be fitted to the cumulative mortality rate (y) and transformed x: linear $y = 2.11x + 26.44$ ($R^2 = 98.30\%$); quadratic $y = -0.07x^2 + 3.59x + 20.03$ ($R^2 = 99.97\%$). The quadratic regression is illustrated in Figure 3.1.

Source: Bourgeois-Pichat, 'La mesure' (1951), p. 248, table IV.

thus that the registration process for the parish under analysis was insufficiently comprehensive to merit further study. Bourgeois-Pichat's method is still used for the derivation of endogenous- and exogenous-mortality estimates, but a quadratic best-fit line is now preferred because in some well-documented cases the age pattern of postneonatal mortality is decidedly non-linear.[3]

Table 3.1 gives an illustration from Bourgeois-Pichat's own work of his transformation in operation. But Quebec is not a straightforward example because the curve is slightly convex and Bourgeois-Pichat was obliged to derive his endogenous-mortality estimate in a rather ad hoc fashion. He favoured an endogenous mortality of 31.6, but the linear equation would give 26.4 and the best-fit quadratic only 20.0. The problem is illustrated by Figure 3.1, which also shows the age pattern of neonatal mortality.

Although all of Bourgeois-Pichat's examples were from contemporary populations, it is now clear that some of the most interesting cases come from work on historical societies. Figure 3.2 provides further illustrations from England in the parish-register period (1538–1837). In each of the four cases the quadratic curve is either slightly convex (late sixteenth and late seventeenth centuries) or slightly concave (mid-eighteenth and early nineteenth centuries).

[3] See E. A. Wrigley, 'Births and baptisms: the use of Anglican baptism registers as a source of information about numbers of births in England before the beginning of civil registration', *Population Studies*, 31 (1977), 281–312, and Wrigley et al., *English Population History from Family Reconstitution, 1580–1837* (Cambridge: Cambridge University Press, 1997), 225–7.

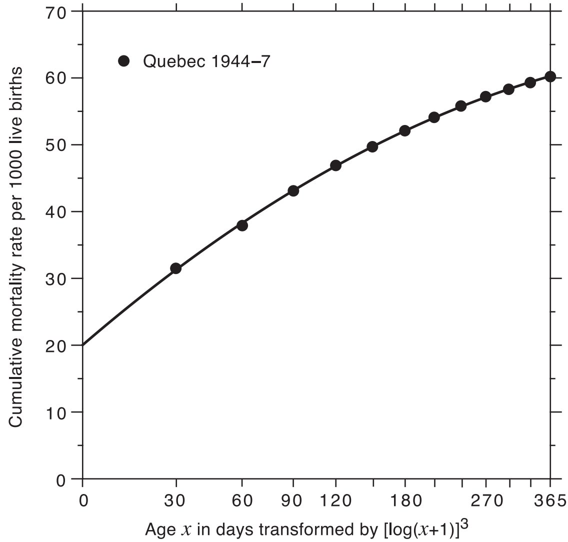

Fig. 3.1: Bourgeois-Pichat's illustration of the biometric analysis of infant mortality: Quebec Province, Canada, 1944–7.

Source: Table 3.1.

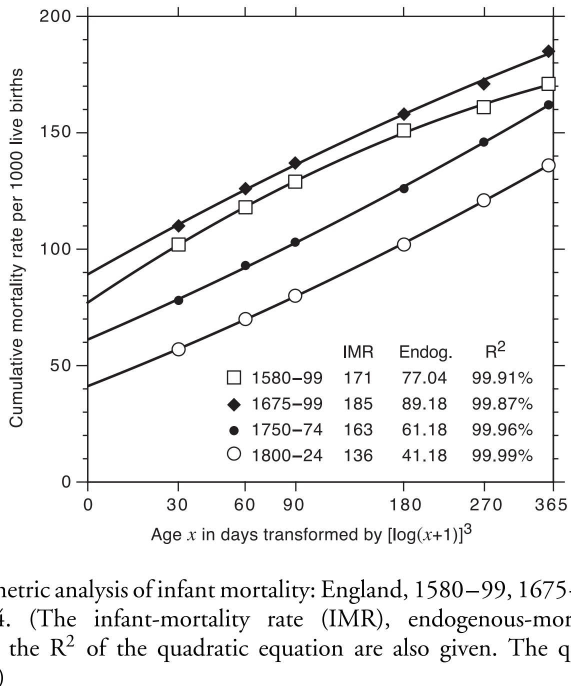

Fig. 3.2: Biometric analysis of infant mortality: England, 1580–99, 1675–99, 1750–74, and 1800–24. (The infant-mortality rate (IMR), endogenous-mortality estimate (Endog.), and the R^2 of the quadratic equation are also given. The quadratic curves are illustrated.)

Source: Based on data in Wrigley et al., *English Population History* (1997), p. 226, table 6.4.

The total infant-mortality rate for legitimate births, the endogenous-mortality estimate, and the R^2 are also shown. It is an interesting exercise, but not necessarily a fruitful one, to speculate on the underlying causes of the changes in age patterns. For example, it is likely that high levels of the infectious diseases of childhood particularly associated with urban environments in the past would make the curve more concave, while the early termination of breastfeeding would have similar effects. Concave patterns, on the other hand, could suggest relatively high neonatal mortality and lower postneonatal mortality secured by universal breastfeeding well into an infant's second year.[4] In the English case, it is quite likely that the increasing concavity can be related to the effects of urbanization during and after the eighteenth century. The slight convexity in earlier centuries is more of a mystery.

However, while it is certainly true that Bourgeois-Pichat's approach, especially his transformation of age and method of estimating endogenous mortality, still has considerable value, it tends to focus undue attention on post-neonatal mortality and rather neglects the need for empirically based studies of the neonatal phase. One reason for this neglect is that detailed, accurate data on age at death during the first thirty days after live birth are required for the full biometric analysis of infant mortality to be possible, and this evidence has not been generally available from historical civil-registration systems or thought to be sufficiently reliable if the product of family-reconstitution studies. The curve for neonatal mortality shown in Figure 3.1 is only hypothetical, therefore, although it often appears in Bourgeois-Pichat's own illustrations.

The registration data collected in Norway is believed not only to be of particularly good quality since the 1870s but also to offer especially detailed tabulations of age at death during infancy and childhood (see Ch. 4, pp. 57–61). This evidence has been used to describe the entire age pattern of mortality during infancy for Norway 1876–80, and to distinguish between the experiences of infants born in different physical and social environments. Figure 3.3 still uses Bourgeois-Pichat's age transformation, but it shows four rather distinctive age patterns. As anticipated by Bourgeois-Pichat, the cumulative-mortality curve rises steeply during the early-neonatal period (first week: 0–6 days) and then begins to level out in the way already indicated. But the four different subpopulations in Figure 3.3 reveal the effects of environmental and social disadvantage too. Infants born in the countryside to married women experienced an infant-mortality rate of 88, while for those born to unmarried mothers in the same rural environment the

[4] Some of these possibilities are discussed by John E. Knodel and Hallie Kintner, 'The impact of breast feeding patterns on the biometric analysis of infant mortality', *Demography*, 14 (1977), 391–409, Katherine A. Lynch, Joel B. Greenhouse, and Anders Brändstrom, 'Biometric modeling in the study of infant mortality: evidence from nineteenth-century Sweden', *Historical Methods*, 31(2) (1998), 53–64, and Chris Galley and Robert Woods, 'On the distribution of deaths during the first year of life', *Population: An English Selection*, 11 (1999), 35–60.

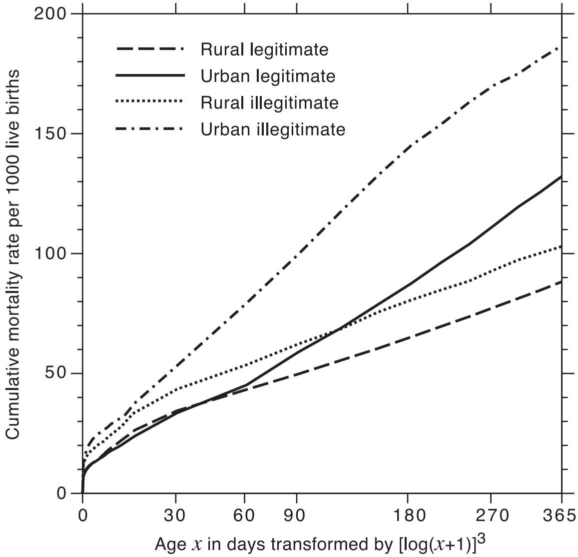

Fig. 3.3: Biometric analysis of infant mortality: Norway, 1876–80.

Source: Derived from age-at-death data reported in *Statisk over Folkemaengdens Bevaegelse i Aarene 1876–1880* (1883), 55C. no. 1, table 16.

IMR was 95. In the towns the equivalent IMRs were 132 and 187. Comparison of 'urban legitimate' with 'rural legitimate' clearly illustrates the influence of higher postneonatal mortality in the towns (curve concavity), while both 'illegitimate' groups appear to have had higher early-neonatal mortality. These Norwegian data are particularly revealing not only of the general shape of the full curve (e.g. 'rural legitimate'), but also its capacity to vary and become non-linear depending on circumstances.[5]

Before turning to fetal mortality there is one final issue relating to Bourgeois-Pichat's biometric approach; namely, the way he linked mortality and infant-growth curves.[6] He noticed that the cumulative-mortality curve and the curve for log of weight by age since birth had a similar convex shape up to five years,

[5] Margit Rosenberg, 'Birth weights in three Norwegian cities, 1860–1984: secular trends and influencing factors', *Annals of Biology*, 15 (1988), 275–88, esp. p. 281, fig. 2 shows the differences in infant birthweights to married and unmarried women in Norway and points out that 80 per cent of the unmarried group had been born in the countryside.

[6] Bourgeois-Pichat, 'Analyse', pp. 46–7, and esp. graph (I). J. M. Tanner, *A History of the Study of Human Growth* (Cambridge: Cambridge University Press, 1981), esp. pp. 254–98, has an interesting analysis of the development of infant-growth studies and the level of understanding reached by the 1940s, while his *Foetus into Man: Physical Growth from Conception to Maturity*, 2nd edn. (Ware: Castlemead, 1989), 38, fig. 16 illustrates the entire generalized growth curve from 8 weeks LMP through to the end of the first postnatal year. (See also Fig. 2.1, on p. 21, and Fig. 6.1, on p. 156).

and went on to argue that the probability of dying between live birth and age x (p_x) could be related to weight gain since birth ($w_x - w_0$) in the following way:

$$p_x = \boldsymbol{a} + \boldsymbol{b}\,(\log w_x - \log w_0)$$

Although Bourgeois-Pichat appears not to have pursued these ideas further, his early emphasis on weight gain and upon the significance of birthweight (w_0) for future development and survival prospects was important, as we shall see.

FETAL SURVIVAL

Although in recent decades there have been remarkable medical advances in embryology and the care of the unborn fetus, many uncertainties still remain over the way in which survival chances vary with gestational age in large populations. The proportion of clinically recognized pregnancies not leading to a live birth has been a subject for debate since at least the nineteenth century. The risk of miscarriage or spontaneous abortion is now known to vary with maternal age and parity, and it is appreciated that fetal deaths tend to be clustered among women with certain genetic, physiological, socio-economic, and demographic characteristics.[7] Such 'high risk' individuals are made the subject of especially careful monitoring. This is also the case with those undergoing *in vitro*-fertilization and embryo-transfer treatment (IVF-ET). However, it is from among these high-risk or sub-fecund and specially monitored groups that much of the modern data on pregnancy loss has been assembled. The groups involved in these clinical follow-up studies tend to be both small and specially selected. It is also the case that such data as do become available are liable to what the statisticians call 'left truncation'; they are length-biased to some degree. The shorter the pregnancy the more likely it is to go unnoticed and thus unrecorded. This will certainly have an important bearing on retrospective, population-based surveys, but it may also affect studies dependent upon clinical monitoring. Generalization to the wider population must be treated with caution, therefore.[8]

Few of the large-scale population studies can match the detail of those based on the Norwegian Medical Registration of Births scheme begun in 1967. All pregnancies reaching 16 weeks LMP were included and particular efforts were made to record outcomes by gestational age in terms of fetal death, live birth followed by death during infancy distinguished by age, and live birth

[7] See, for example, Edward R. Schlesinger and Norman Allaway, 'Trends in familial susceptibility to perinatal loss', *American Journal of Public Health*, 45 (1955), 174–83, and, Allen J. Wilcox et al., 'Incidence of early loss of pregnancy', *New England Journal of Medicine*, 319 (4) (1988), 189–94.

[8] Jennie Kline, Zena Stein, and Mervyn Susser, *Conception to Birth: Epidemiology of Prenatal Development* (New York: Oxford University Press, 1989) and James W. Wood, *Dynamics of Human Reproduction: Biology, Biometry, Demography* (New York: Gruyter, 1994) provide detailed surveys of the field, including critical discussions of the quality of fetal-loss data.

Table 3.2. Fetal/infant-life table: Norway, 1967–73

Age (days LMP) (1)	Still pregnant (2)	Fetal death (3)	Early-neonatal death (4)	Late-neonatal death (5)	Postneonatal death (6)	Survive to 1 year (7)
112	100 000	35	3	0	0	10
140	99 952	28	3	0	0	4
147	99 917	39	2	0	0	5
154	99 871	42	9	0	0	6
161	99 814	43	15	0	0	6
168	99 750	38	22	0	0	8
175	99 682	39	36	2	0	8
182	99 597	35	40	3	1	17
189	99 501	34	43	3	1	29
196	99 391	32	40	4	1	41
203	99 273	31	38	3	2	57
210	99 142	51	51	4	2	100
217	98 934	47	38	3	3	154
224	98 689	55	41	3	3	226
231	98 361	60	36	3	3	340
238	97 919	63	30	4	6	569
245	97 247	69	30	4	4	1 014
252	96 126	70	27	5	9	1 737
259	94 278	74	30	4	18	3 380
266	90 772	76	35	7	27	8 023
273	82 604	86	42	15	60	18 600
280	63 801	97	50	15	75	27 211
287	36 353	80	44	11	52	20 714
294	15 452	54	27	7	27	9 838
301	5 499	24	9	2	9	2 816
308	2 639	9	4	2	3	1 048
315	1 573	7	3	0	3	499

Note: The table is based on the outcome of 440 452 pregnancies. SBR is 10.01 and IMR is 11.85.
Source: Based on Bakketeig et al., 'Fetal-infant life table' (1978), p. 219, table 2.

and survival to first birthday. Among the small number of empirically based fetal/infant-life tables that have been constructed, that for Norway 1967–73 must represent one of the most reliable and certainly the most detailed.[9] It is shown in Table 3.2. Starting with a radix of 100 000 pregnancies at 112 days

[9] The Norwegian data and the fetal/infant-life table are described in Leiv S. Bakketeig, Daniel G. Seigel, and Phyllis M. Sternthal, 'A fetal-infant life table based on single births in Norway, 1967–73', *American Journal of Epidemiology*, 107 (3) (1978), 216–25. Sam Shapiro, Ellen W. Jones, and Paul M. Densen, 'A life table of pregnancy terminations and correlates of fetal loss', *Milbank Memorial Fund Quarterly*, 40 (1962), 7–45 has an earlier example. A. C. Stevenson et al., 'Observations on the results of pregnancies in women resident in Belfast', *Annals of Human Genetics*, 23 (4) (1958), 382–420 shows what special tabulations can be produced on the frequency of

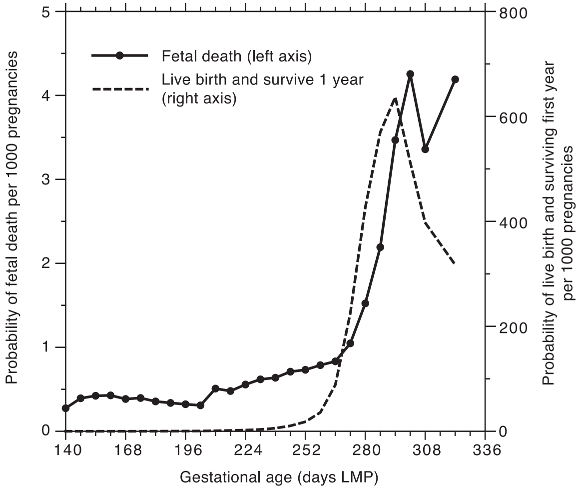

Fig. 3.4: Fetal death and survival to one year: Norway, 1967–73.
Source: Table 3.2.

LMP, there are 48 births before 140 days LMP of which 35 are born dead, 13 are born alive, and 10 of these survive at least twelve months to their first birthday. By 140 days LMP 99 952 pregnancies remain, and by full term (280 days LMP) the number has fallen to 63 801. The most valuable aspects of this table are the ways it describes the split between fetal deaths and live births and its variation with increasing gestational age. This is clearly illustrated in Figure 3.4, which shows that births prior to 196 days LMP were very unlikely to produce a child survivor and that the risk of fetal mortality increased before full term.

But the Norwegian fetal/infant-life table also has its limitations. First, it relates to a population with exceptionally low early-age mortality; the infant-mortality rate was 12 and the stillbirth rate 10. Clearly some premature births, assisted by medical technology and a high standard of paediatric care, did survive beyond infancy. Because mortality is so low, it may not provide an appropriate basis for describing other less well-documented populations with far higher risks. Second, the table is most helpful on late-fetal and neonatal mortality, but the early weeks of pregnancy are not covered. Only the small-scale clinical studies are useful here.

Table 3.3 gives two examples of attempts to summarize the general pattern of fetal survival from conception to full term. The first comes from a study by Adolph H. Schultz of the nineteenth- and early twentieth-century literature,

miscarriages and stillbirths in clinically recognized pregnancies, with 32 days LMP the earliest dated miscarriage.

Table 3.3. Two examples of generalized fetal-life tables

Schultz (1921)			Kline et al. (1989)		
Age (days LMP)	Survivors	Deaths	Stage (days LMP)	Survivors	Deaths
14	1000	117	Conception (14)	1000	272
98	883	16	Implantation (24–5)	728	160
126	867	55	Clinical recognition (28–35)	568	54
210	812	32	Fetal stage (from 63)	514	14
280	780	—	Live birth (full term 280)	500	—

Source: Derived from Schultz, 'Sex-incidence' (1921), p. 185; Kline et al., *Conception to Birth* (1989), p. 68.

much of it relying on hospital-based retrospective surveys and guesswork.[10] The second, by Kline et al., also involves elements of guesswork and assumption, but it is dependent upon five detailed surveys, principally concerned with fetal loss, as well as several others in which fetal deaths play a part.[11] Kline et al. surmise that only half of all conceptions produce live births and that as much as 80 per cent of losses occur before clinical recognition of pregnancy.[12] Schultz, on the other hand, believed that only 22 per cent of conceptions did not produce a live birth, although he too gave greater weight to losses during the embryo stage. Table 3.3 reflects both advances in knowledge and continuing uncertainty, as well as recurrent problems with definition and measurement, therefore.

[10] Schultz, 'Sex-incidence in abortions', in Franklin Paine Mall and Arthur William Meyer, *Studies on Abortuses: A Survey of Pathologic Ova in the Carnegie Embryological Collection*, Contributions to Embryology, 56 (Washington DC: Carnegie Institution of Washington (publication 275), 1921), 177–91. Many of the studies reviewed by Schultz will be considered in Chapter 6. However, it is interesting to note that in a lecture delivered in 1895 Karl Pearson made the following theoretical calculations: out of 1000 conceptions, 756 would reach the end of the first trimester, 674 the end of the second, and 622 would be live born at full term (a conception-to-live-birth ratio of 1.6: 1) (Pearson, 'The chances of death', in *The Chances of Death and Other Studies in Evolution* (London: Edward Arnold, 1897), 1–41, derived from pp. 36–7). Pearson also used stillbirth data from the Dublin Lying-in Hospital; the Maternity Charity, St Pancras; Guy's Hospital Lying-in Charity; and Arthur Newsholme's *The Elements of Vital Statistics in their Bearing on Social and Public Health Problems* (London: George Allen & Unwin, 1889), which led him to conclude that '4 to 5 per cent [was] about the percentage of stillbirths' (p. 38).

[11] Kline et al., *Conception to Birth*, pp. 43–66, esp. summary tables 4.4 and 4.5. See also Wood, *Dynamics*, p. 257, table 6.7, and the accompanying figures on pp. 274–5. The classic study and starting-point for much modern research on early-fetal loss is Fern E. French and Jessie M. Bierman, 'Probabilities of fetal mortality', *Public Health Reports*, 77 (10) (1962), 835–47. Their original survey, dating from 1953–6, was carried out on the Hawaiian island of Kauai. The other surveys, which will not be discussed individually, covered populations in New York City, California, and Sweden. Gillian C. L. Lachelin, *Miscarriage: The Facts*, 2nd edn. (Oxford: Oxford University Press, 1996), p. 38, table 1 reports the following approximate miscarriage percentages at different times in pregnancy: fertilization to implantation, not known; implantation to 4 weeks LMP, 10–30; 4–13 weeks LMP, 10–20; 14–24 weeks LMP, 2–3.

[12] Here they follow William H. James, 'The incidence of spontaneous abortion', *Population Studies*, 24 (2) (1970), 241–5, which concludes that 35 per cent of fertilized ova are lost before the first missed period and that 49 per cent 'perish naturally between fertilisation and confinement' (p. 245).

Although it has proved impossible to chart the typical pattern of early-fetal mortality with any certainty and in detail, this has not prevented attempts to model the survival curve using available empirical evidence and a range of plausible assumptions. Among researchers who have risen to this challenge, the work of Henri Leridon and of Charles E. Boklage is particularly notable.[13] Boklage believes that of 1000 conceptions, no more than 300 will survive to full term and that two-thirds will be lost before clinical recognition.[14] The fetal-survival models developed by Leridon in the 1970s and by Boklage in 1990 are set out in life-table form in Table 3.4.

Both models are based on the same small number of studies used by Kline et al., but they favour a higher survival rate at each age. The ratio of conceptions to live births might be 1.5 to 1, 2 to 1, 2.5 to 1, or 3.3 to 1, depending

Table 3.4. Two fetal-survival models

Age (days LMP)	Leridon (1977) Survivors	Deaths	Boklage (1990) Survivors	Deaths
14	1000	179	1000	484
21	821	321	516	164
28	500	40	352	76
42	460	20	276	10
56	440	34	266	4
84	406	20	262	3
112	386	6	259	3
140	380	4	256	3
168	376	1	253	3
196	375	1	250	3
224	374	1	247	3
252	373	4	244	3
280	369	—	241	—

Note: Conception, or fertilization, is assumed to be at day 14 LMP.

Source: Derived from Leridon, *Human Fertility* (1977), p. 81, table 4.20; Boklage, 'Survival probability' (1990), p. 84, fig. 2.

[13] Leridon, *Human Fertility: The Basic Components* (Chicago, Ill.: University of Chicago Press, 1977), esp. pp. 48–81: 'Intrauterine mortality'; Charles E. Boklage, 'Survival probability of human conceptions to term', *International Journal of Fertility*, 35 (2) (1990), 75–94, and 'The epigenetic environment: secondary sex ratio depends on differential survival in embryogenesis', *Human Reproduction*, 20 (3) (2005), 583–7. It is notable that both of these authorities are concerned principally with human fertility, and that they have been obliged to consider intrauterine mortality in order to estimate fecundability, in Leridon's case, and the success of IVF-ET treatment, in that of Boklage. John Bongaarts and Robert G. Potter, *Fertility, Biology, and Behavior: An Analysis of the Proximate Determinants* (New York: Academic, 1983), 39, table suggests that intrauterine mortality is 20 per cent after the fourth week of pregnancy, and a figure of 24 per cent is often quoted. Table 3.4 shows 26 and 32 per cent.

[14] Boklage, 'Epigenetic environment', p. 584.

on the assumptions one wishes to make about survival during the first two or three weeks after conception, and whether it is thought appropriate to let general-population models be influenced by the experience of groups selected by sub-fecundity or high pregnancy-failure rates. The 2 to 1 ratio favoured by Kline et al. is one of the more conservative, while Boklage's 3.3 to 1 represents fetal wastage at its most severe. However, both Leridon and Boklage follow all the empirical studies in distinguishing two distinct phases in the pattern of survival with a marked break of slope at or about the time at which clinical recognition of pregnancy becomes possible. Boklage's mathematical model combines two separate exponential relationships with the assumption that there is a 0.287 probability of survival from conception to clinical recognition. In his model the probability of survival (p_t) from conception to time t in days after conception is given by

$$p_t = 0.73e^{-0.155t} + 0.27e^{-0.00042t}$$

This has been used to derive the life table with a radix of 1000 and time in days LMP shown in Table 3.4. If we transfer attention to the last trimester of pregnancy, the period covered by the Norwegian data in Table 3.2, and focus on late-fetal mortality we find that the stillbirth rate in the Norwegian population after 196 days LMP is 10, while that in Leridon's model is 16 (per 1000 total births) and in Boklage's is 36. It seems possible that Boklage's model has unreasonably low survival chances at all fetal ages, although it is clearly very effective in capturing the overall shape of the survival pattern.

CONCEPTION-TO-FIRST-BIRTHDAY SURVIVAL: A MODEL

What might the entire conception-to-first-birthday survival curve look like? It may help to think of the curve as analogous in form to a carriage whip having a long, stiff handle (representing biologically determined embryo and early-fetal mortality) and a tail that becomes increasingly flexible towards its tip (representing environmentally sensitive postneonatal mortality). Such a pattern is sketched in Figure 3.5, which illustrates the cumulative number of deaths from 1000 conceptions distributed by age through the 40 weeks of pregnancy and the 52 weeks of infancy. It must be emphasized that what is shown here is a hypothetical, mathematical model.[15] It is equivalent to the one developed by Boklage in being theoretical yet empirically based, but it is both more sophisticated and dependent on a larger number of critical assumptions. First,

[15] The model is described fully in Paul Williamson and Robert Woods, 'A note on the fetal-infant mortality problem', *Journal of Biosocial Science*, 35 (2003), 201–12.

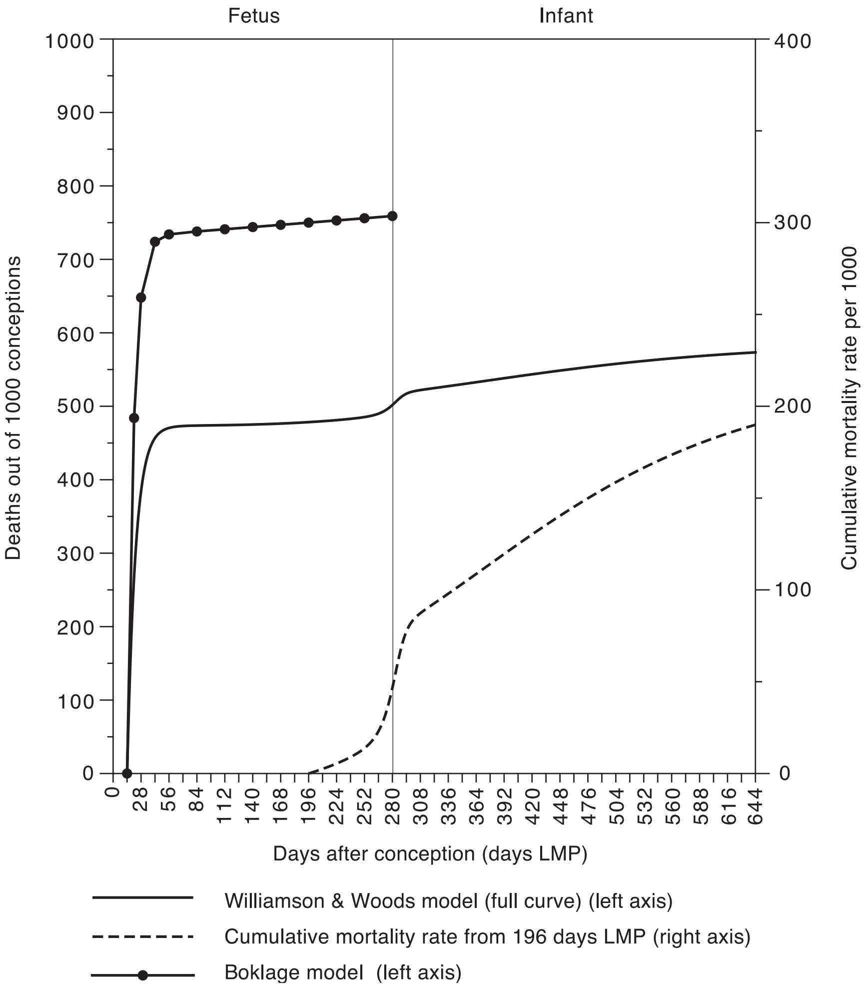

Fig. 3.5: Model fetal/infant-mortality curves.
Source: Tables 3.4 and 3.5.

the model follows Kline et al. in taking 2 to 1 as the most appropriate conception-to-live-birth ratio (Table 3.3). Second, it maintains that there is a heightened mortality risk after 140 (especially after 196) days LMP and thus that late-fetal deaths (stillbirths) need to be dealt with as a distinct and recognizable stage within the overall curve. Third, it also assumes that mortality during infancy follows a characteristic age-related shape, as in Figure 3.3, with discernible differences between the early- and late-neonatal, and postneonatal stages. Finally, the model curve not only has distinctive segments of various lengths (durations), but it is also given magnitude by making separate assumptions about the level of overall mortality. For example, we may choose to let the infant-mortality rate (IMR) fall in the range 140–150 per 1000 live births and for the stillbirth rate (SBR) to fall in the range 40–50 per 1000 total births. This would allow the model to match the level of early-age mortality found in many historical populations, Victorian England included.

The resulting model fetal/infant-life table is described in Table 3.5. With the whip-like shape shown in Figure 3.5, an IMR of 144, and an SBR of 45, about 43 per cent of conceptions would survive through fetal and infant life to reach their first birthday. There are, however, some obvious problems in such a model, apart from the assumptions required. Table 3.5 marks certain age-groups with the letters A–C. A and B indicate degrees of prematurity (here

Table 3.5. A model fetal/infant-life table (Williamson and Woods model)

Age x (days LMP)	Survivors to age x (l_x)	Fetal deaths	Infant deaths	Cumulative total deaths to age x
14	1 00 000	26 706	—	0
21	73 294	11 712	—	26 706
28	61 582	5068	—	38 418
35	56 514	2194	—	43 486
42	54 320	1365	—	45 680
56	52 955	265	—	47 045
70	52 690	62	—	47 310
84	52 628	29	—	47 372
98	52 599	29	—	47 401
112	52 570	83	—	47 430
140	52 487	59	—	47 513
154	52 428	73	A	47 572
168	52 355	196	A	47 645
196	**52 159**	271	B	47 841
224	**51 888**	417	B	48 112
252	**51 471**	1643	B	48 529
280	**49 828**	C	125	50 172
281	**49 703**	C	762	50 297
287	**48 941**	C	1146	51 059
308	47 795	—	1204	52 205
371	46 591	—	1691	53 409
462	44 900	—	1334	55 100
553	43 566	—	902	56 434
644	42 664	—	—	57 336

Note: Time since conception is expressed in terms of age in days after mother's LMP. SBR (196–280 days LMP) is 44.69 and IMR is 144.

Source: Based on the model specified in Williamson and Woods, 'Fetal-infant mortality' (2003).

birth before full term), which in high-mortality populations are likely to lead to death in early infancy, even when vital signs have been recognized and live birth accepted. C indicates the possibility that even when full term has been reached a fetal death may occur just before or during labour (intrapartum). Of course it is also possible, although unlikely, that a premature live birth will occur and that the infant will remain one of the survivors for at least a year. Among the numbers of survivors marked in bold, some will be fetuses and the remainder infants, although the balance will shift from the former to the latter with time. Pregnancies are the subjects in Table 3.2 and not fetuses or infants as in Table 3.5. The availability of data equivalent to those for Norway would make it possible to indicate numerical values for A–C, but, as we have already noted, the Medical Birth Registration system on which it is based is unique in terms of its age and quality. A–C in high-mortality historical populations can only be guessed. It would be reasonable to assume that all in A would not be born alive (miscarriages or abortions) and that the vast majority of B would be born dead, but a few viable fetuses would survive to become infants. This would also apply to C.

The chances of live birth and survival for the premature and postmature are worth considering in a little more detail at this point. The causes of premature birth are still not fully understood, but many of the associated issues are well known. For example, low birthweight is closely linked to prematurity and has been the subject of both historical research and that dealing with less developed countries. Although birthweight is the internationally favoured viability criterion for the definition of stillbirths (see Ch. 2), as a dependent variable in its own right its trends and variations remain difficult to explain. José Villar and José M. Belizán have outlined some of the remaining problems.[16] They note that in developed countries the incidence of low birthweight among live births (LBW less than 2500g) will now be less than 10 per cent, while in developing countries it is still likely to be greater than 10 per cent, with examples in the thirties and low forties. Premature birth is often defined as occurring less than 259 days LMP (Table 2.2 suggests 266 days LMP), while intrauterine-growth restriction (IUGR) is identified as occurring when gestational age is greater than 259 days LMP but birthweight is still less than 2500g (IUGR-LBW, low birthweight but not premature). On average, while for developed countries LBW was 6 per cent (3 per cent IUGR-LBW and 3 per cent premature LBW), for developing countries LBW was 24 per cent (17 per cent IUGR-LBW and 7 per cent premature LBW).[17] Intrauterine-growth restriction is a term used to describe a fetus that has failed to achieve its growth potential—for example, if a fetus

[16] Villar and Belizán, 'The relative contribution of prematurity and fetal-growth retardation to low birth weight in developing and developed societies', *American Journal of Obstetrics and Gynecology*, 143 (7) (1982), 793–98.

[17] Ibid. 796, table II.

Table 3.6. Factors affecting intrauterine-growth restriction (IUGR)

A. Stable, largely biogenetic, non-nutritional factors	B. Variable, largely socio-economic, environmental factors
• maternal diseases not associated with pregnancy • haemorrhage • twin gestation • uterine and placental abnormalities • major congenital malformations • parental genetic influences	• pre-conception maternal-nutritional status (measured by maternal height and pregnancy weight) • weight gain during gestation • maternal infection • synergistic effects of infection and malnutrition • pre-eclampsia (high blood pressure in pregnancy)

Source: Based on Villar and Belizán, 'Relative contribution of prematurity' (1982), p. 797.

is genetically determined to be 3800g but only achieves 2800g. Small for gestational age (SGA) is another term used to describe either a fetus that has grown normally but is constitutionally small, or where chronic compromise from 'placental insufficiency' has led to IUGR. It is the prominence of factors responsible for intrauterine-growth restriction, and thus the downward shift of the entire birthweight distribution, that is responsible for the far higher incidence of low birthweight in developing countries today. But what are these factors? Villar and Belizán draw a distinction between the largely stable non-nutritional and mainly biogenetic factors, and the more variable socio-economic ones. Their checklist of factors is summarized in Table 3.6. The B list emphasizes the role of maternal-nutritional status, but it does so by pointing to the importance of the health of the mother before pregnancy (the effect of her own early physical development, which for convenience is measured by height and/or weight) as well as during the last trimester of pregnancy when the critical phase of fetal-growth restriction can occur. It also highlights the importance of infection and its interaction with maternal nutrition. The A list includes the multiple-fetuses factor, since it is well known that twins, for example, have a lower chance of survival than singletons and that prematurity and low birthweight may be influential.[18] The material conditions experienced by a mother during

[18] See Louis Henry, 'Mortalité intra-utérine et fécondabilité', *Population*, 19 (5) (1964), 899–940, and Chris Galley, ' "One face, one voice, one heart, and two persons!": The survival of twins in early modern society', *Local Population Studies*, 51 (1993), 73–6; also Wrigley et al., *English Population History*, p. 244, table 6.8. Johan Fellman and Aldur W. Eriksson, 'Stillbirth rates in singletons, twins and triplets in Sweden, 1869 to 2001', *Twin Research and Human Genetics*, 9 (2) (2006), 260–5, and Aldur W. Eriksson and Johan Fellman, 'Factors influencing the stillbirth rates in single and multiple births in Sweden, 1869 to 1967', *Twin Research and Human Genetics*, 9 (4) (2006), 591–6 show that the stillbirth rates for twins in Sweden were about three times higher than for singletons, but that long-term trends were roughly parallel (see Ch. 4, p. 59).

pregnancy clearly have an important bearing on fetal development and survival, but nutritional status is certainly not the whole story.[19]

Table 3.6 raises other, more general, issues relating to fetal growth and development, and how they may be described. Most research has focused on the period after 28 weeks LMP. The consensus, illustrated by the work of Peter Gruenwald in the 1960s, is that the rate of fetal growth may slow after 32 weeks LMP and that, for example, twins, fetuses in lower socio-economic groups, and those of smokers may experience earlier and more marked slow-down.[20] There is, however, continuing uncertainty about the ways in which the genetic and environmental factors play their varying parts. Whether it is better for a mother to be tall and poor or short and wealthy remains a point of debate in terms of resulting birthweight and survival chances. Short and poor is invariably disadvantageous, however.[21]

Historians have used biometric data, including adult heights and birthweights, to form judgements concerning nutritional status. In the case of birthweights, their general argument is that such material can be used as a proxy for maternal-nutritional status and thus material living conditions. Mean birthweight and percentage with low birthweight (under 2500g) are taken as the key indicators. W. Peter Ward has illustrated the potential of this approach using birthweight series from lying-in hospitals in Dublin, Edinburgh, Boston, Montreal, and Vienna, but a more recent study, using the example of Melbourne, has demonstrated that there are still many problems in drawing the link between trends in maternal health and nutritional status.[22] The studies of lying-in hospitals also

[19] Jacques Dupâquier, 'For a history of prematurity', in Alain Bideau, Bertrand Desjardins, and Héctor Pérez Brignoli (eds.), *Infant and Child Mortality in the Past* (Oxford: Clarendon, 1997), 188–202.

[20] Peter Gruenwald, 'Growth of the human fetus, I. Normal growth and its variation; II. Abnormal growth in twins and infants of mothers with diabetes, hypertension, or isoimmunization', *American Journal of Obstetrics and Gynecology*, 94 (1966), 1112–32; see also Peter Gruenwald, 'Influence of environmental factors on foetal growth in man', *Lancet*, 1 (1967), 1026–8. Kline, Stein, and Susser, *Conception to Birth*, p. 214 also follow Gruenwald's findings. Tanner, *Foetus into Man* outlines the key issues involved in the study of fetal growth. Ultrasound techniques have made it possible to measure fetal growth directly. Frank P. Hadlock, Ronald B. Harrist, and Juan Martinez-Poyer, 'In utero analysis of fetal growth: a sonographic weight standard', *Radiology*, 181 (1991), 129–33 established a new growth standard for the USA which is regarded as superior to that derived from postnatal data.

[21] The modern medical literature on IUGR, its early identification, and the factors influencing it is considerable. See, for example, Jason Gardosi et al., 'Analysis of birthweight and gestational age in antepartum stillbirths', *British Journal of Obstetrics and Gynaecology*, 105 (1998), 524–30, and Chapter 6, p. 185.

[22] Ward, *Birth Weight and Economic Growth: Women's Living Standards in the Industrializing West* (Chicago, Ill.: University of Chicago Press, 1993); and, for Melbourne, Janet McCalman and Ruth Morley, 'Mothers' health and babies' weights: the biology of poverty in the Melbourne Lying-in Hospital, 1857–83', *Social History of Medicine*, 16 (2003), 39–56. See also Rosenberg, 'Birth weights in three Norwegian cities', pp. 275–88, and Richard H. Steckel, 'Birth weights and stillbirths in historical perspective', *European Journal of Clinical Nutrition*, 1st ser., 52 (1998), 15–20. It is clear that one has to be especially careful in using data from lying-in hospitals, since

suggest that 10 per cent LBW among live births is a reasonable guide to normal historical levels. Most hospitals in most years in Ward's extensive comparative study had percentages less than 10, with 5–6 per cent at the favourable end of the range and 15–16 per cent at the very maximum of low-birthweight experience.

HISTORICAL IMPLICATIONS

It is always a hazardous business applying modern knowledge to historical situations, especially, as in this case, where there is still much uncertainty over, for instance, the conception-to-live-birth ratio. But it must also be acknowledged that without some appreciation of what might have been the pattern of age-related survival between conception and first birthday in high-mortality historical populations it will be all but impossible to assess the efforts of midwives, obstetricians, lying-in hospitals, etc., or the role of maternal infections in past centuries. Similarly, without the ability to model the entire 92-week survival curve it will be difficult to derive the likely level of one segment (e.g. late-fetal mortality) from another (e.g. early-neonatal mortality) in circumstances where there are data for the one but not for the other. The fetal/infant-life table for Norway in Table 3.2 and the model life table in Table 3.5 offer the best available empirical and theoretical bases. The former is not universally appropriate, since it applies to a low-mortality population, and Table 3.5 has been derived using a number of critical assumptions about the likely level of first-trimester mortality and the possibility of survival after premature birth. However, without both of these tools it would be hard to draw the 'carriage-whip analogy' and to conclude that while the early segments of the curve/whip are likely to be both biologically determined and at least stable if not fixed, the later segments will be conditioned by socio-economic circumstances (e.g. poverty, nutrition/feeding practices, illegitimacy) and the prevailing disease environment. Early-fetal deaths fall into the first category, late-neonatal and postneonatal into the second, while late-fetal and early-neonatal occupy the intriguing middle position in which, as Table 3.6 makes clear, the biological-genetic and the environmental-socio-economic, as well as the effects of obstetric practice, are combined.

Two additional examples will help to illustrate the potential value of drawing analogies from recent experience. The World Health Organization has derived estimates of the stillbirth rate for its 192 member countries, including those for which there are no registration data. These estimates can be combined with others for entire-life tables for the year 2000.[23] Figure 3.6 illustrates one of

before 1940 only a small proportion of women gave birth in hospitals. They tended to be drawn from among the poor, but some hospitals deliberately excluded the unmarried, while others were more inclusive (see Ch. 4, pp. 90–4).

[23] Estimates for the stillbirth rate (SBR) and the early-neonatal mortality rate (ENMR) were based on survey or registration data where possible, and on neonatal-mortality estimates where

the implications of this work. It shows for the fourteen WHO world regions associations between the infant-mortality rate (IMR) and life expectancy at birth in years ($e(0)$), as well as the relationship between the stillbirth rate and $e(0)$. It extrapolates from these relationships the possible levels of IMR and SBR among populations with even lower life expectancies. For example, supposing that life expectancy at birth was in the low thirties, then infant mortality might be around 170 per 1000 live births, while the stillbirth rate would be about 50 per 1000 total births. The IMR/$e(0)$ relationship for Model West in the Princeton system of model life tables is shown in Figure 3.6.[24] Here, if life expectancy at birth is in the low thirties, the infant-mortality rate will be close to 300 per 1000 live births. The point of Figure 3.6 is to illustrate possibilities; to suggest what may be

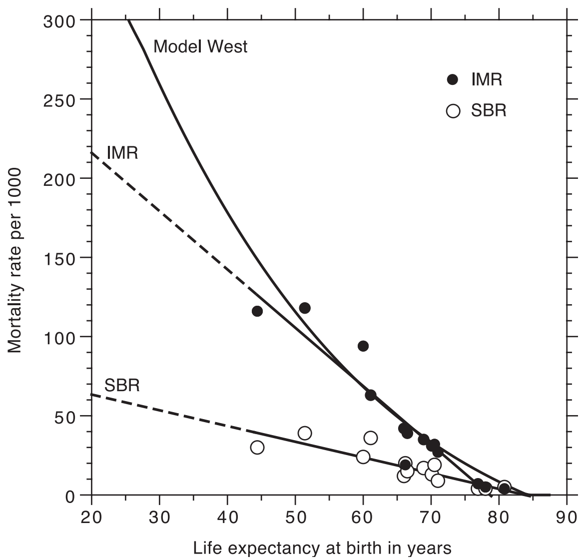

Fig. 3.6: Relationship between infant mortality (IMR), late-fetal mortality (SBR), and life expectancy at birth: UN world regions, 2000.

Source: Based on data in Lopez et al., *Life Tables* (2001); WHO, *Neonatal and Perinatal Mortality* (2006).

they were not available (see WHO, *Neonatal and Perinatal Mortality: Country, Regional and Global Estimates* (Geneva: WHO, 2006). The life tables are found in A. D. Lopez et al., *Life Tables for 191 Countries for 2000: Data, Methods, Results*, GPE Discussion Paper, 40 (Geneva: World Health Organization, 2001). Chapter 4 (pp. 56–101) returns to the problem of deriving SBR from ENMR.

24 Model West in Figure 3.6 is taken from Ansley J. Coale and Paul Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, NJ: Princeton University Press, 1966). Robert Woods, 'Ancient and early modern mortality: experience and understanding', *Economic History Review*, 60 (2) (2007), 373–99 discusses the construction and use of model life tables. Model West has often been taken as the average for West European populations—the default option in international comparisons.

expected of early-age mortality at different levels of general mortality. It is only indicative, as the difference between Model West and the other extrapolations makes clear.

The second example is also derived from WHO data for 2000.[25] The WHO report on neonatal and perinatal mortality emphasizes the distinction between antepartum and intrapartum fetal deaths after 28 weeks' gestation. The intrapartum deaths are a direct consequence of complications during labour and a reflection of the availability of skilled birth attendants (midwives, obstetricians, and maternity hospitals). Antepartum deaths during the late-fetal period can be related to genetic effects, infections, and the other factors that generally determine abortions, a substantial minority of which may be due to unidentified causes. The WHO has derived estimates of the expected proportion of stillbirths that are likely to be intrapartum deaths, and it has done this for UN world regions. Figure 3.7 illustrates the relationship between the percentage of intrapartum deaths and the stillbirth rate. In those regions where the stillbirth rate was exceptionally low in 2000 the WHO has assumed that the percentage will be below 10. But figure 3.7 indicates that the percentage is likely to taper off at

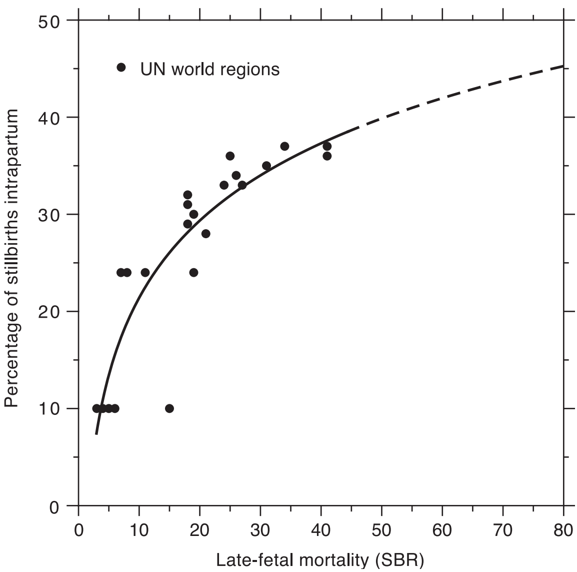

Fig. 3.7: Percentage of stillbirths intrapartum: UN world regions, 2000.
Source: Based on data in WHO, *Neonatal and Perinatal Mortality* (2006).

[25] WHO, *Neonatal and Perinatal Mortality*, pp. 21, 61–3. See also Joy Lawn, Kenji Shibuya, and Claudia Stein, 'No cry at birth: global estimates of intrapartum stillbirths and intrapartum-related neonatal deaths', *Bulletin of the World Health Organization*, 83 (6) (2005), 409–17.

very high levels of SBR. Where the stillbirth rate is 50–60, for instance, the percentage of intrapartum stillbirths may be 40–45. A 95 per cent improvement in the quality of birth attendance would be required to reduce the stillbirth rate from 50 to 10, but this would need to be accompanied by a 70 per cent decline in antepartum deaths. Faultless obstetric care on its own would only reduce the stillbirth rate from 50 to 30. This is, of course, all rather hypothetical. We cannot be sure that variations among world regions in 2000 reflect what might have been under different epidemiological, economic, and knowledge systems merely through extrapolation, yet this is likely to be the best foundation we will ever have.

Chapter 4 considers the available statistical evidence for Europe and America, particularly in the nineteenth and twentieth centuries. We will see that these data are far from perfect, even in the second half of the last century. This is partly due to problems of definition (how to define and enforce among midwives and doctors a consistent approach to stillbirths, for example) and partly due to those definitions varying over time and from place to place. But in several regions, Britain and the USA included, no attempt was made to register late-fetal deaths until the twentieth century. The stillbirth rate for England and Wales during the eighteenth and nineteenth century will be estimated using early-neonatal- and maternal-mortality rates and the arguments about the structure of the conception-to-first-birthday mortality pattern outlined above, and summarized by the model in Table 3.5. This represents our best hope of reproducing past trends for regions lacking registration data for fetal deaths.

4

Comparative historical trends and variations

Considering the problems involved, there is a remarkably long history of stillbirth registration in some countries, but in most there is only a very short one, or none at all. This chapter concentrates on late-fetal mortality as measured by the stillbirth rate (SBR: stillbirths per 1000 total births) and the comparative analysis of time-series. It considers the registration practices and changing mortality experiences of four groups of countries. The first group, which we shall call the advanced states, comprises Sweden, Norway, Denmark, and the Netherlands—a special case. Here registration began in the eighteenth or early nineteenth century, and by the 1870s it was both routine and, it is thought, reasonably accurate. These statistically advanced countries were in the vanguard of vital registration. The second group, of late countries, includes Great Britain and the USA—where individual states took responsibility for registration. Stillbirths were not registered until 1927 in England and Wales, and not until 1939 in Scotland. In the USA some states began in 1922, but each one was left to define fetal deaths in its own way and they often did this without specific reference to gestational age (see Table 2.3, on p. 26). The third group of countries comprises France, Italy, and Spain. In this group it was common practice to register as stillbirths some early-neonatal deaths. These 'false stillbirths' pose a special problem. The fourth group will be drawn from developing countries today. Vital registration is normally lacking here. Only the Demographic and Health Surveys (DHS) and the estimation work of the World Health Organization are available to shed any light on fetal mortality. The final part of this chapter discusses the estimation of late-fetal mortality for England during the eighteenth and nineteenth centuries. These estimates will be compared with registration-derived rates for the advanced states, but they can also provide the demographic basis for an analysis of the impact of obstetric care and other influences in the chapters that follow.

ADVANCED STATES

Sweden began the process of vital registration in the 1750s. The system was not only remarkably early in its development, but from the outset it included the registration of stillbirths alongside live births, deaths, and marriages. We have for Sweden an unbroken, 250-year-long record of late-fetal mortality. There were, however, changes in the way in which stillbirths were defined, both in principle and in practice. For example, early registrations are likely to have included some neonatal deaths (born with signs of life, but died within hours) or some stillbirths could have been taken as neonatal deaths. The former would inflate stillbirth mortality; the latter depress it. In the late twentieth century the critical gestational age above which stillbirth was defined was reduced from 28 weeks. Because of the length of its time-series and the generally high quality of its statistical system, Sweden will be used as a standard against which to compare the experience of other populations.[1]

In what was then the single kingdom of Denmark and Norway late-fetal deaths were first registered in the late eighteenth century, although published series are not available before 1801. In 1814 Norway became an independent kingdom and began to follow its own separate, although closely related, path as far as vital statistics were concerned. Julie E. Backer has summarized the principal developments:

> Statistical records of stillbirths were not compulsory until 1797. Stillbirths were defined as infants born without signs of life after the seventh month of pregnancy. Separate returns were to be given for males and females. The records of stillbirths sent in by the clergy were, however, unreliable, and in a circular of 24 December 1802 every midwife was instructed to notify the vicar of each child at whose birth she had been present—either born without life or dying within 24 hours of birth. The same duty was also imposed on medical practitioners assisting at childbirth. In the notification the midwife was to give information as to the month of pregnancy in which the birth took place, if the infant was alive when born and the duration of life. The vicar was to enter those reports in the parish register and include them in his annual returns to the bishops.[2]

In 1839 the stillbirths of unmarried women were distinguished from those of married ones. Also from that year, only those infants born without signs of life were to be regarded as stillborn, those born with some vital signs but who died

[1] *Historisk Statistik för Sverige, Del 1. Befolkning, Andra Upplagan, 1720–1967* (Stockholm: Statistical Central Bureau, 1967), 109, table 38 gives total stillbirth rates from 1751 and distinguishes between legitimate and illegitimate stillbirths from 1831. Up-to-date statistics can be found on the Statistics Sweden website. Frederick Hendriks, 'On the vital statistics of Sweden, from 1749 to 1855', *Journal of the Statistical Society*, 25 (2) (1862), 111–74 discusses the detail and quality of Swedish vital statistics during the first hundred years. (Table R, on p. 167, gives stillbirth rates by quinquennia.) Peter Sköld, 'The birth of population statistics in Sweden', *History of the Family*, 9 (1) (2004), 5–21 offers a modern introduction. It is possible that stillbirths were underrecorded in the eighteenth century and that this also affected the early nineteenth-century series. Roger Schofield, 'Did the mothers really die? Three-centuries of maternal mortality in "The World We Have Lost" ', in Lloyd Bonfield, Richard M. Smith, and Keith Wrightson (eds.), *The World We Have Gained* (Oxford: Blackwell, 1986), 231–60, esp. p. 240, table 9.2 indicates an SBR of 33 for rural southern Sweden in the period 1750–1850 (range 26–44 among 5 parishes). The broader, Europe-wide problems of registering live births and stillbirths in the twentieth century are outlined in C. Gourbin and G. Masuy-Stroobant, 'Registration of vital data: are live births and stillbirths comparable all over Europe?', *Bulletin of the World Health Organization*, 73 (4) (1995), 449–60.

[2] Backer, 'Population statistics and population registration in Norway, I. The vital statistics of Norway: an historical review', *Population Studies*, 1 (2) (1947), 214.

within 24 hours were to be excluded. Backer has also noted the continuing confusions and problems:

It appeared very difficult to get the clergy to observe these regulations concerning stillbirths, and far into the present [twentieth] century the returns of stillbirths caused much confusion in Norwegian vital statistics. On the one hand it seemed to be difficult to discriminate between abortions and the more developed foetus; on the other hand it was equally difficult to distinguish between children born without obvious signs of life and those in reality born alive, but who died spontaneously after the birth. As early as 1797 a stillbirth was supposed to be defined as any foetus born without obvious signs of life after 7 months of pregnancy, and this definition was also in force in all the succeeding regulations, though subsequently the period of gestation was fixed more precisely at 28 weeks. In practice, however, this discrimination in defining the stillborn and those liveborn who died within 24 hours of birth was partly due to the disadvantage of those two different categories of births being notified by the midwife on the same form.

As a result the numbers of infant deaths recorded in the statistics—particularly for the years prior to 1866—were understated, while the numbers of stillbirths were exaggerated slightly.[3]

The year 1866 is recognized as a crucial one because the clergy, as the legal registrars, were required to supply the central statistical authorities with nominal lists rather than aggregate parish totals. The independent Central Statistical Bureau was established in 1876 and this led to further improvements in the efficiency with which statistics were collected and analysed, and the detail in which they were reported.

Ibsen's Norway had a population of 883 000 in 1801, 1 702 000 in 1855, and 2 240 000 in 1900. It was predominantly a rural society with a handful of small towns scattered along its coast. The winters were long and harsh. The parish clergy, midwives, and local medical officers of health occupied especially important positions in the lives of these scattered communities. Their responsibility for the registration of vital events reflects their several roles. As far as late-fetal deaths were concerned, midwives were critical. They decided whether an infant was live- or dead-born (*levendefødte* or *dødfødte*), or whether there had been a miscarriage, and how long the child had lived. In 1801 they recorded 855 stillbirths (24 448 live births), in 1855 there were 2126 (49 438), and in 1900, 1616 (66 229). These were not large numbers, but they were drawn from more than 500 parishes spread over a wide geographical area and they did represent the decisions of many individuals, each answering for a small number of cases.[4] Hence, there was an obvious difficulty in achieving national statistical conformity. Although 1866 is often mentioned as a turning-point, 1876 is more important for the study of early-age deaths. From that year the Central Statistical Bureau began to report

[3] Backer, 215.

[4] Michael Drake, *Population and Society in Norway, 1735–1865* (Cambridge: Cambridge University Press, 1969), 1–18 discusses the Norwegian population-registration system, including stillbirths (p. 14).

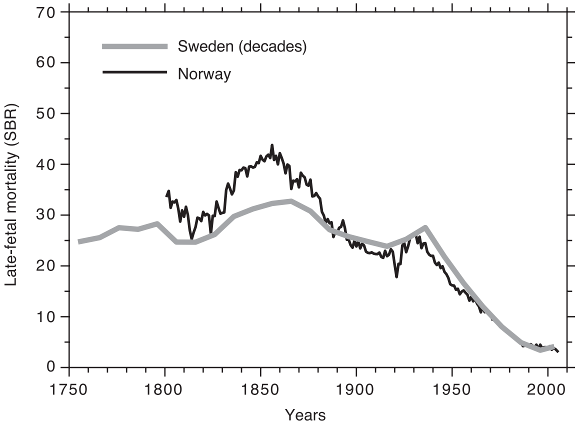

Fig. 4.1: Late-fetal mortality (SBR): Norway, with Sweden for comparison.
Source: Based on data supplied by Statistics Norway, Oslo, and Statistics Sweden, Stockholm.

not only the numbers of stillbirths, but also deaths during the first twenty-four hours after live birth. This innovation was doubtless assisted by the availability of nominal lists. An infant had to be classified as dead-born or live-born, and if the latter, then its age at and cause of death had also to be recorded.[5]

Although it would be unwise to treat Norwegian stillbirth data uncritically, especially before 1839, there is every reason to be confident about the accuracy of the statistics published by the Central Statistical Bureau from 1876, and even those for the intervening decades are unlikely to be seriously in error. Figure 4.1 shows the annual series for the Norwegian stillbirth rate (SBR: stillbirths per 1000 total births) for 1801–2005, which is compared with the Swedish series for decades 1751–60 to 1991–2000. The peak year came in 1856, when the stillbirth rate was 44. Before the 1850s there was a phase of increase from about 30 in the 1810s and after there was a period of decline to around 25 in the 1900s. It is quite likely that some of the upturn was due to improvements in the system for registering late-fetal deaths, while part of the apparent downturn was caused by the removal of some first-day deaths from the stillbirths tally. However, the scale of the nineteenth-century cycle suggests that other, more important, influences were also at work. The Norwegian cycle was also in step with the Swedish, although the latter was rather lower in level.

[5] On average, there were 59 181 live births registered annually in Norway 1876–80, 2113 stillbirths, and 468 deaths at under 24 hours. If all 468 had been recorded as stillbirths then the stillbirth rate would have been 42.11 rather than 34.47 (per 1000 total births) as the registration statistics indicate. The SBR would be 22 per cent higher if the additional deaths were included. Strict separation of stillbirths and first-24-hours deaths could give the appearance of a substantial reduction in the SBR, therefore (see *Historisk Statistikk, 1978* (Oslo: Central Bureau of Statistics of Norway, 1978), 53, table 19).

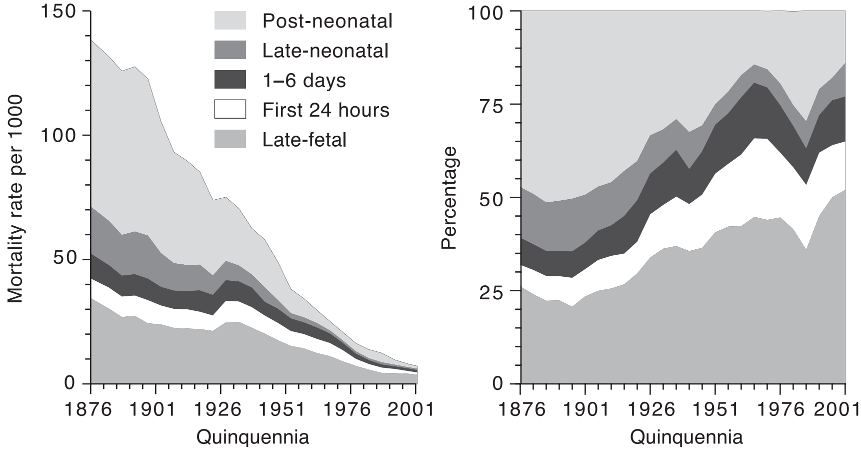

Fig. 4.2: Early-age mortality trends, rates, and percentage shares: Norway, quinquennia from 1876–80 to 2001–5.

Source: Based on data supplied by Statistics Norway, Oslo.

We have already seen in Figure 3.3 (p. 40) how mortality in Norway 1876–80 varied with age during infancy. The infant-mortality rate was highest among births to unmarried mothers in the towns and lowest for those born in the countryside to married women. But the different shapes of the cumulative-mortality curves were also interesting, with, for instance, postneonatal mortality having a dramatic impact in the urban environment. Figures 4.2 and 4.3 illustrate further the importance of age components and the effects of geographically differentiated factors on late-fetal as well as infant mortality. Figure 4.2 complements Figure 4.1. It shows how the early-age mortality has declined since the 1870s, but makes clear how the five age-groups changed in importance. Stillbirths now represent half of the total; in the late-nineteenth century they made-up about a quarter. Early-neonatal deaths have also increased in percentage share, while deaths after the first week have declined in significance. In relative terms, perinatal mortality is far more important than it ever has been, although its actual rate in Norway is extremely low. Figure 4.3 serves as a warning against making broad generalizations regarding rural-urban mortality differentials. It shows that all but one of the eighteen rural counties of Norway in 1876–80 clustered together in the lower end of the infant-mortality range (IMR 70–110), but Finnmark in the far north had an IMR of 160. Further, 5 of the 6 towns did have higher infant mortality than the rural average. As far as late-fetal mortality is concerned, the towns had both the highest and lowest SBRs, although a majority of the urban population lived in places with rates

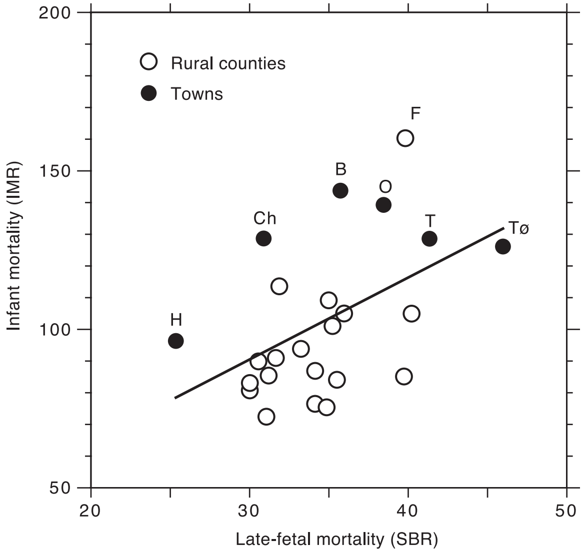

Fig. 4.3: Relationship between infant mortality (IMR) and late-fetal mortality (SBR): Norway, rural counties, and towns, 1876–80. (The towns of Hamar (H), Christiansand (Ch), Bergen (B), Oslo (O), Trondheim (T), and Tromø (Tø), and the northern county of Finnmark (F) are identified. The regression equation is IMR = 2.5859SBR + 12.9148 ($R^2 = 24.19\%, N = 24$).)

Source: Derived from data reported in *Statisk over Folkemaengdens Bevaegelse i Aarene 1876–1880* (1883).

towards the upper end of the range.[6] Tromsø, again in the far north, had the highest stillbirth rate (46). Late-fetal and infant mortality do not tell the same story about early-age mortality; they are statistically associated, but not very closely.

It has already been noted that stillbirth data are available for Denmark from the very early years of the nineteenth century. In Denmark, as in Norway, the midwife was supposed to report stillbirths to the parish clergy using the definition 'births of foetuses over 7 months which died before the age of 24 hours'.[7] The clergyman was to enter the information in a printed ledger distinguishing between males

[6] William H. Hubbard, 'The urban penalty: towns and mortality in nineteenth-century Norway', *Continuity and Change*, 15 (2) (2000), 331–50 discusses the dimensions of urban-rural infant-mortality patterns in greater detail. Gunnar Thorvaldsen, 'Rural infant mortality in nineteenth-century Norway', *Hygiea Internationalis*, 3 (1) (2002), 75–113, esp. p. 86, map 2 shows that there were 13 parishes with IMRs over 180 (far north and interior south), while in most IMR was less than 100 in 1876–80.

[7] Hans Chr. Johansen, *Danish Population History, 1600–1939* (Odense: University Press of Southern Denmark, 2002), 90.

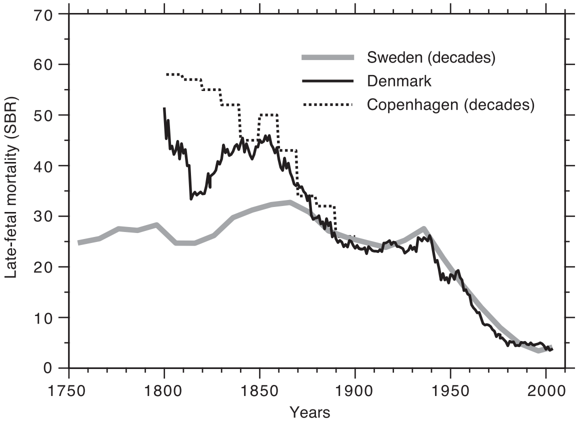

Fig. 4.4: Late-fetal mortality (SBR): Denmark and Copenhagen.
Source: Based on data supplied by Statistics Denmark, Copenhagen.

and females, and, from 1827, between legitimate and illegitimate stillbirths. The principal problem with these data from 1801 to 1834 is that stillbirths appear to have been included with infant deaths, as they were in the eighteenth century. Various correction factors have been proposed to remove the dead-born from the infant deaths and to inflate the number of live births so that it includes those born alive and who died within 24 hours or, in earlier decades, unbaptized. One proposal would reduce the number of deaths by up to 5.5 per cent in the late eighteenth century, but it is most likely an overcorrection, since the practice of stillbirth recording varied from parish to parish.[8] Reliable infant-mortality rates can only be calculated from 1835, therefore. Improvements in vital registration were made throughout the nineteenth century, although data on deaths under 24 hours were not published before 1885. Midwives and parish clergy were required to provide ever more detailed information, which the statistical authorities in Copenhagen analysed and published with growing sophistication.

Figure 4.4 illustrates the annual time-series for late-fetal mortality in nineteenth- and twentieth-century Denmark. Like Sweden and Norway, there appears to have been an increase after 1820 in the stillbirth rate with a peak in the 1850s at 46 followed by decline to 1900. Again, it is curious that the rate was increasing during a period in which stillbirths may have been overcounted by the inclusion of some live births. However, for the reasons outlined above we need to be cautious about using the series prior to 1836, by which time the SBR was in the low to middle forties. Figure 4.4 also shows the stillbirth rate for Copenhagen. During the second half of the nineteenth century SBR was only a little above the

[8] Drake, *Population and Society*, p. 14, and Johansen, *Danish Population* (2002), p. 91. Johansen observes that the Danish stillbirth rate was probably in the range 40–50 at this time (p. 227 n. 92).

national rate, but prior to 1850 it was much higher. Copenhagen had substantial maternity and foundling hospitals, which attracted unmarried women from the islands and Jutland. It is possible that the presence of these institutions helped to inflate the number of registered stillbirths, but it is also likely that the city had a severe disease environment, since it is known that infant mortality was nearly twice as high in the capital as the Danish countryside throughout the nineteenth century.[9]

It is appropriate to mention the experience of Iceland at this point, since it was part of the Kingdom of Denmark until 1944 and shared most aspects of the Danish vital-registration system. The practice of stillbirth registration dates from 1804 and is believed to have been especially accurate because infants born with any sign of life were regarded as live-born even if they died within 24 hours.[10] This should mean that the late-fetal-mortality series are reliable throughout the nineteenth century. However, it must be noted that Iceland had a population of less than 47 000 in 1804, about 61 000 in 1851, 79 000 in 1901, and has only just reached 300 000.[11] In most years of the nineteenth century there were from 50 to 80 registered stillbirths. There were dramatic fluctuations in the annual stillbirth rate as a consequence. Figure 4.5 shows these annual series as well as a smoothed series produced by using a five-year moving mean. This smoothed series demonstrates that Iceland did not follow the cyclical pattern evident in Sweden, Norway, and Denmark, that if anything the stillbirth rate was lower in the 1850s than surrounding decades, and that the stillbirth rate was usually between 30 and 40 before 1910. Iceland only conformed to the 'normal' trend of the Scandinavian countries in the late 1940s. It turns out to be an interesting and challenging case. Without the counter example of Iceland there would be a reasonable assumption of wave-like increase and decrease in late-fetal mortality through the nineteenth century followed by convergence from the late 1930s.

The Netherlands is a special case because although an advanced state, its civil-registration system was initially influenced by the application of the Code Napoleon under French occupation prior to 1813. Before 1918 it was common practice to record those fetuses born after 26 weeks' gestation that showed vital

[9] Anne Løkke, *Døden i barndommen: Spaedbørnsdødelighed og moderniseringsprocesser i Danmark, 1800 til 1920* (Copenhagen: Gyldendal, 1998) discusses changes and variations in Danish infant mortality and late-fetal mortality (esp. pp. 141–2). See also Løkke, 'No difference without a cause: infant mortality rates as a world-view generator', *Scandinavian Journal of History*, 20 (2) (1995), 75–96, esp. p. 83, fig. 1. During the 1850s, when the Danish SBR was 44, the following differentials between legitimate and illegitimate SBRs applied: Copenhagen, 42: 80; rural districts, 46: 54. If the number of unmarried mothers being delivered in Copenhagen declined between 1800 and 1850, this alone would have reduced the total-stillbirth rate for the city. Copenhagen had a population of around 150 000 in the 1850s—about 10 per cent of the national figure.

[10] Olöf Gardarsdottir, *Saving the Child: Regional, Cultural and Social Aspects of the Infant Mortality Decline in Iceland, 1770–1920*, demographic database, Umeå University, report 19 (Umeå: Umeå University, 2002), 51.

[11] These data, like the material illustrated in Figure 4.5, come from the Statistics Iceland website, especially the table on 'Population: key figures, 1703–2006'.

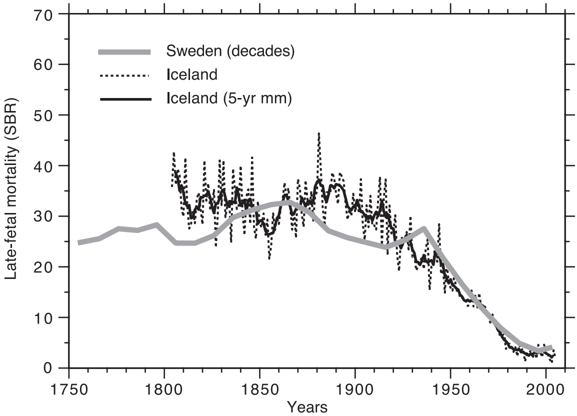

Fig. 4.5: Late-fetal mortality (SBR): Iceland. (A five-year moving mean has been applied to smooth the annual fluctuations.)

Source: Based on data supplied by Statistics Iceland, Reykjavik.

signs and died shortly after not as live births but as stillbirths. Stillbirths were not only late-fetal deaths, but also live births that died before their registration as live births had occurred. When efforts were made to correctly classify these *faux mort-nés*, the level of late-fetal mortality dropped. Recent work by Frans van Poppel has shown that stillbirths recorded for the years 1917–23 were made up of 68 per cent fetal deaths and 32 per cent live-born infants who died before notification (within 3 days of birth in principle, but up to 5 days in practice).[12] In 1950 the critical gestational age was raised from 26 to 28 weeks, and from 1991, 28 and 24 weeks were both employed. Figure 4.6, which uses Poppel's revised estimates for 1850–1923 and the official national statistics for subsequent years, shows that the Netherlands was broadly in line with most of the other countries we have seen. National stillbirth rates declined from around 35 in the middle of the nineteenth century to 25 in 1920, where they stabilized, and then declined again dramatically in 1940. After 1950 Dutch late-fetal mortality conformed in level and trend.

Figure 4.6 also shows the stillbirth rate for the Dutch province of Zeeland, which is located in the extreme south-west of the country and occupies most of

[12] Poppel, 'Historical trends in mortality around birth in the Netherlands: registration practices, trends and regional differences in the nineteenth and early twentieth centuries', unpublished paper presented at the Social Science History Association conference, Baltimore, Md., November 2003. I am especially grateful to Dr van Poppel (Netherlands Interdisciplinary Demographic Institute, The Hague) for allowing me to read his work in progress and to use his data for the Netherlands and Zeeland. See J. H. de Haas-Posthuma and J. H. de Haas, *Infant Loss in the Netherlands*, US National Center for Health Statistics, 3rd series, 11 (Washington, DC: US Government Printing Office, 1968), 1–4, which also discusses the quality of registration.

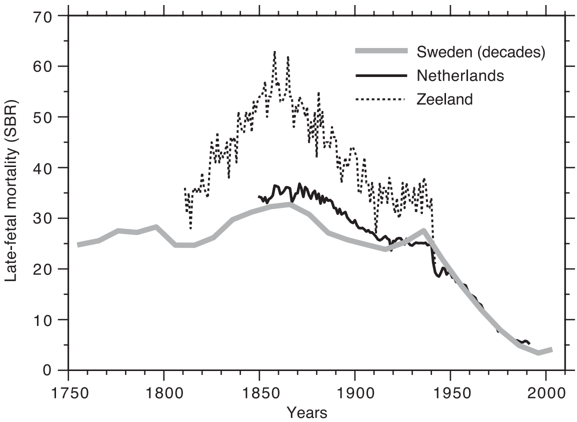

Fig. 4.6: Late-fetal mortality (SBR): the Netherlands and the Province of Zeeland. (The data for the Netherlands have been adjusted, but those for Zeeland have not.)

Source: Based on data supplied by Statistics Netherlands, The Hague; Historical Archive, Province of Zeeland.

the Rhine delta. The Zeeland series run from 1811 to 1942 and are based on an extensive analysis of death certificates. Late-fetal mortality follows a now-familiar pattern with a peak in the 1850s, but the unadjusted stillbirth rate is at a substantially higher level, some 50 per cent or more above the adjusted national rate. Zeeland was a poor, predominantly agricultural, province, which not only suffered economically, but also had a severe shortage of trained midwives and doctors. The presence of poverty and the absence of skilled birth attendants will have affected the level of the stillbirth rate, as may the presence of malaria and the generally poor public-health situation, but the inclusion of false stillbirths will also have inflated the series. The trend may reflect wider issues: changing registration practices and the initiation of effective health-intervention strategies towards the end of the nineteenth century.

The Netherlands can also help to illustrate how the relationship between late-fetal and infant mortality changed over time. Figure 4.7 shows the timepath for the infant-mortality rate with the stillbirth rate (IMR/SBR) for the Netherlands from 1850 to 2005. It emphasizes, once again, that there was relatively little movement in IMR-SBR space before 1900; thereafter, dramatic change came quickly, with acceleration in the decline of stillbirth mortality after 1940. Infant mortality increased in the 'hunger winter' of 1944–5, but quickly resumed its downward path in the late 1940s. Other advanced states followed a broadly similar timepath with some variations in detail.

These five advanced states display a high degree of similarity in terms of their late-fetal-mortality time-series, but it is also clear that the variability among national and regional series increases as we move back in time before 1940. Setting aside for the time being the reasons for the joint post-1940 reduction,

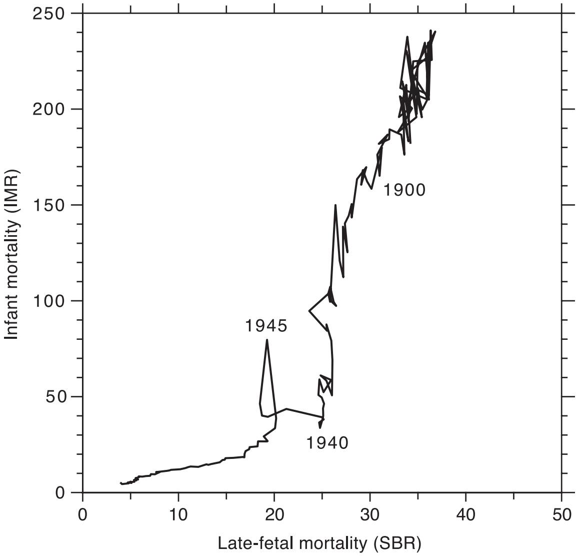

Fig. 4.7: Annual timepath for infant (IMR) and late-fetal mortality (SBR): the Netherlands, 1850–2005.

Source: Based on data supplied by Statistics Netherlands, The Hague.

several attempts have been made to explain the pattern of change between the 1850s and the 1930s in terms of advances in the quality and availability of birth attendants, both midwives and specialist obstetricians. These were advanced states in terms of both statistical practice and obstetric care.[13] In the case of Denmark, Anne Løkke has argued that the training, examination, and licensing of midwives was especially important.[14] A School of Midwifery was established at the Royal Lying-in Hospital in Copenhagen in 1787, which produced about 200 midwives per decade, and in 1810 a Midwifery Act required all parishes to employ one of the state-trained and licensed midwives. This goal was probably reached by the 1840s, but even in 1801 around 40 per cent of districts outside Copenhagen had a trained midwife, and in 1808 there were 91 such midwives in the capital alone.[15] These midwives were younger and better educated after their year of formal training than the local women who normally attended deliveries. A midwifery textbook published by Professor Matthias Saxtorph

[13] Robert Woods, Anne Løkke, and Frans van Poppel, 'Two hundred years of evidence-based perinatal care: late-fetal mortality in the past', *Archives of Disease in Childhood: Fetal and Neonatal Edition*, 91 (6) (2006), F445–7.

[14] Anne Løkke, 'Did midwives matter? 1787–1845', in Hilde Sandvik, Kari Telste, and Gunnar Thorvaldsen (eds.), *Pathways of the Past: Essays in Honour of Sølvi Sogner*, Time and Thought, 7, Department of History, University of Oslo (Oslo: Novus, 2002), 59–72.

[15] Ibid. 64.

(1740–1800) in 1790 provides an important benchmark, since he was also head of the School of Midwifery.[16] Løkke has used this to illustrate the non-invasive culture that it encouraged, the use of phantoms in teaching, and the fact that, in all likelihood and with one exception, 'no other major changes in the way midwives were trained took place between 1800 and 1900'.[17] The exception was the development of antisepsis training in the 1870s.[18] There are signs that deaths from puerperal fever among mothers did decline in the Danish towns from the 1870s, although it is also clear that mortality from this cause was in dramatic decline at the Copenhagen lying-in hospital from the early 1860s.[19] The antisepsis revolution certainly made Danish midwives, and male obstetricians, less dangerous to their patients. There were, however, other advances that helped to improve the status of midwives and confirm their role as the birth attendant of choice for normal home deliveries. For example, a journal for midwives, *Tidsskrift for Jordemødre*, was founded in 1890, which helped in the exchange of ideas and promoted professionalization. Further, the Danish medical establishment accepted the position of midwives. Not until the 1970s did the hospitalization of deliveries, which accompanied radical developments in the technology available to support mother, fetus, and infant, break the tradition by which a woman was cared for by her state-provided female midwife.[20]

The Danish experience is fairly typical of that in the other advanced states of north-western Europe, the Netherlands included. Training, examination, registration, and improving status and skill were the key features of state-organized midwifery services. If there were medical advances, like antisepsis, they could be taken advantage of relatively quickly through the local network of professional midwives who, at least in Scandinavia, also played a central role in the vital-registration system. But in order to sustain the argument that access to trained midwives had a positive and direct impact we must consider survival chances. Here we return again to the case of Sweden. Ulf Högberg has linked the course of maternal-mortality decline to the role of community midwifery.[21] His account of the pre-1940 period mirrors Løkke's for Denmark,

[16] Matthias Saxtorph, *Nyeste Udtog af Fødsels-Videnskaben til Brug for Jordemødrene* (Copenhagen:. Schubothes, 1790).

[17] Løkke, 'Did midwives matter?', p. 69.

[18] Anne Løkke, 'The "antiseptic" transformation of Danish midwives, 1860–1920', in Hilary Marland and Anne Marie Rafferty (eds.), *Midwives, Society and Childbirth: Debates and Controversies in the Modern Period* (London: Routledge, 1997), 102–33.

[19] Ibid. 111, fig. 5.2.

[20] M. J. van Lieburg and Hilary Marland, 'Midwifery regulation, education, and practice in the Netherlands during the nineteenth century', *Medical History*, 33 (1989), 296–317 stresses the importance Dutch midwives had in a country which, like Denmark, had very high rates of home deliveries until late into the twentieth century. See also Edwin van Teijlingen, et al. (eds.), *Midwifery and the Medicalization of Childbirth: Comparative Perspectives* (New York: Nova, 2004).

[21] Högberg, 'The decline in maternal mortality in Sweden: the role of community midwifery', *American Journal of Public Health*, 94 (8) (2004), 1312–20. See also Ulf Högberg and Stig Wall, 'Secular trends in maternal mortality in Sweden from 1750 to 1980', *Bulletin of the World Health*

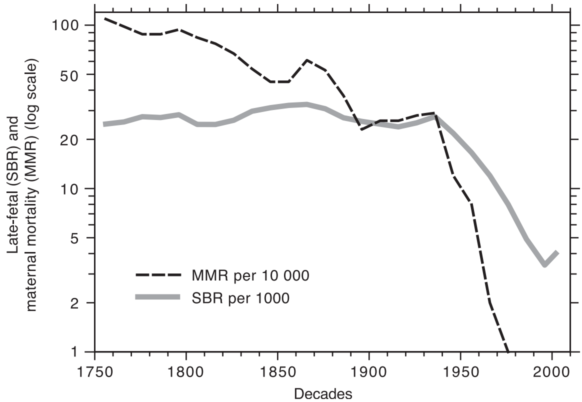

Fig. 4.8: Late-fetal (SBR) and maternal mortality (MMR): Sweden, 1750s to 1990s.
Source: Based on data supplied by Statistics Sweden, Stockholm.

but Sweden was even more rural, and progress depended on the availability and skills of midwives to a greater extent. The ratio of midwives to physicians was substantially higher; midwives were trained longer, and a very high proportion of them were authorized to use instruments. The antiseptic advances of the 1870s were reinforced by legislation in 1881. By 1900 professional midwives had become fully established and legitimized throughout Sweden. Högberg has estimated that in nineteenth-century Sweden 'two thirds of maternal deaths had direct obstetrical causes, such as difficult labour, eclampsia, haemorrhage and sepsis [especially puerperal sepsis], while one third were indirect obstetric deaths due to diseases such as pneumonia, dysentery, heart disease and malnutrition'.[22] Figure 4.8 illustrates the pattern of decline in the Swedish maternal-mortality rate (MMR: maternal deaths per 10 000 live births), as well as the familiar stillbirth rate. The decline in MMR is especially impressive between the 1860s and the 1890s, but there had been steady decline before the 1850s reversal. Comparison of maternal and late-fetal mortality indicates that although there were some periods with common trends and turning-points, particularly during the twentieth century, the two measures do not coincide exactly. In Sweden, at least, the combination of trained midwives and antiseptic techniques seems

Organization, 64 (1) (1986), 79–84; T. Andersson, U. Högberg, and S. Bergström, 'Community-based prevention of perinatal deaths: lessons from nineteenth-century Sweden', *International Journal of Epidemiology*, 29 (2000), 542–8; and Stephen Curtis, 'Midwives and their role in the reduction of direct obstetric deaths during the late nineteenth century: the Sundsvall region of Sweden (1860–1890)', *Medical History*, 49 (2005), 321–50. Curtis emphasizes the importance of women's choices whether to use a state-trained midwife or a traditional one, but he also demonstrates the significance of poverty, living conditions, and tuberculosis in a rapidly industrializing region.

[22] Högberg, 'Decline in maternal mortality', p. 1316.

to have had a greater impact on maternal mortality during the late nineteenth century than it had on fetal deaths—puerperal fever making the key difference. Figure 4.8 offers a helpful warning against overemphasis on a limited number of causes and reliance on single demographic series to gauge the effects of health interventions and patient outcomes.[23]

LATE STATES

It has already been noted that stillbirths did not become part of the regular vital-registration process until 1927 in England and Wales (1939 in Scotland, 1961 in Northern Ireland, 1995 in the Republic of Ireland) and fetal deaths were not widely registered before 1922 in the USA.[24] Although not registered, from 1874 stillbirths in England and Wales were supposed to be certified before burial could take place. However, it is likely that large numbers of stillborn were disposed of without formal certification. Considering the amount of attention given to medical statistics in Victorian England, the neglect of stillbirths is rather surprising. This is what Dr William Farr, the first Statistical Superintendent at the General Register Office, London, had to say on the matter.

Still-born children.—In the case of children born alive—or who breathe—both the birth and death are registered, but still-born children are not registered in England.

Under the provision of the new Registration Act [1874] no still-born child, however, should be buried without a *certificate*, stating that they were still-born, signed either by the registered medical practitioner who was in attendance at the birth, or by one who had examined the body. In the absence of a registered medical practitioner a declaration has to be made by the midwife or some other person qualified to give such information, stating that the child was not born alive.

Still-born children, therefore, are by the new law *certified* as such, although they are not registered. In England the proportion of still-born children to total births is supposed to be about 4 per cent, but this is uncertain.

In France, under the provisions of the Code Napoleon, children who die (either after or before birth) before registration, are recorded as still-born. Dr Bertillon estimates that

[23] Irvine Loudon, *Death in Childbirth: An International Study of Maternal Care and Maternal Mortality, 1800–1930* (Oxford: Clarendon, 1992), 406–15 has an interesting commentary on Högberg's account. It should also be noted that the very detailed Swedish studies use the Umeå Demographic Database, which focuses on Sundsvall and Skellefteå in the far north. Quite why maternal and late-fetal mortality were moving in opposite directions in Sweden before 1850 remains an interesting puzzle.

[24] Alison Macfarlane and Miranda Mugford, *Birth Counts: Statistics of Pregnancy and Childbirth*, i–ii (text/tables)(London: Stationery Office, 2000) is the standard reference work for Great Britain. Stillbirth statistics are discussed in volume i (pp. 46–7 and p. 50, fig. 3.5). Volume ii reports the tabulated data for years (tables in sections A3.3 and A3.9, and table A12.3.1). Late-fetal deaths were first notified in the Republic of Ireland in 1957, but stillbirths were not registered until 1995. Table 3.3.6 reports stillbirth data for Guernsey, where the SBR averaged 47 for the years 1911, 1916, 1921, 1926, and 1931 (197 stillbirths in 5 years).

22 in 100 of the children registered in France as still-born breathed, and such children in England would be registered among the births and deaths.

In France in 1875, the corrected proportion of still-born to every 100 live-born children was 3.6. In Belgium the proportion in the years 1860–65 was 3.7.[25]

During the early years of the twentieth century renewed attempts were made to have stillbirths brought into the registration system.[26] However, formal registration did not begin until 1 July 1927, although all stillbirths and live births should have been notified to local medical officers of health from 1918 onwards and the Notification of Births Act 1907 allowed notification to be adopted on a voluntary basis in sanitary districts. During the nine years of compulsory notification (1918–26) the average annual stillbirth rate was 31, substantially below the post-1927 rates, indicating that the notification system was deficient compared with registration. Stillbirths in Britain, as we noted in Chapter 2, were defined in terms of a gestational age of more than 28 weeks where the fetus, after being completely expelled from its mother, did not breathe or show any other signs of life. Little attempt was made to evaluate the quality of stillbirth registration during its early years, but it was noted that while the registration of a live birth could take a month or more, it was necessary for a stillbirth to be registered before burial could take place. Marked geographical variations, as well as those between legitimate and illegitimate births, also gave cause for concern.[27] Figure 4.9 shows the stillbirth rate for England and Wales from 1927, and for

[25] William Farr, *Vital Statistics*, ed. Noel A. Humphreys (London: Sanitary Institute of Great Britain, 1885), 107, taken from the *Thirty-Eighth Annual Report of the Registrar General* for 1874 (British Parliamentary Papers (BPP), 1877 XXV, pp. xxv–xxvi). Farr had made strenuous efforts to have stillbirths properly certified by the registration medical officer, but they were not to be registered as live births were. 'As still-born children are not registered at all, and are buried with little difficulty, there is a great temptation to inter the bodies of children living only a short time as still-born. This opens another gate to crime' (*Twenty-Seventh Annual Report of the Registrar General* for 1864 (BPP XIX, p. 182)). See Edward Higgs, *Life, Death and Statistics: Civil Registration and the Work of the General Register Office, 1836–1952, Local Population Studies Supplement* (Hatfield: Local Population Studies Society, 2004), 19. Graham Mooney, 'Still-births and the measurement of urban infant mortality rates *c.*1890–1930', *Local Population Studies*, 53 (1994), 42–52 has analysed the tabulation of stillbirth entries in cemetery registers for England and Wales in 1890. Some 26.3 per cent of stillbirths were buried without certificate (21.2 per cent in London). Mooney's estimate of the SBR is 43.6 for England and Wales, and 35.4 for London (p. 48, table 3). We will return to the case of France and the contribution of Dr Jacques Bertillon, Statistical Superintendent of Paris, in the following section.

[26] A committee of the Royal Statistical Society reported on the various systems for registering births, including stillbirths, in 1912 (Reginald Dudfield, 'Still-births in relation to infantile mortality', *Journal of the Royal Statistical Society*, 76 (1) (1912), 1–57). See also Reginald Dudfield, 'Stillbirths: the case for their compulsory registration and their definition', *Proceedings of the Royal Society of Medicine: Section of Epidemiology and State Medicine*, 17 (1914), 81–106, and J. W. Ballantyne, 'Still-births registration', *Journal of Obstetrics and Gynaecology of the British Empire* 25 (3) (1914), 132–49. The problems surrounding the definition of stillbirths, including the approaches of Dudfield and Ballantyne, were discussed in Chapter 2 (pp. 21–24).

[27] The Registrar General's *Statistical Review of England and Wales for the Year 1927* has a brief introduction to the registration of stillbirths. Subsequent *Reviews* added little to the account, apart from new annual statistics.

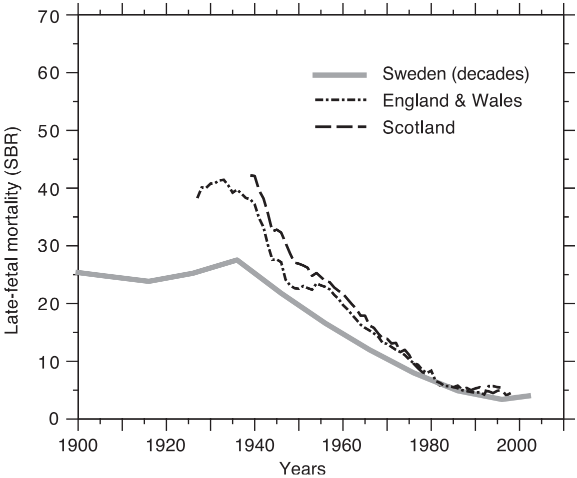

Fig. 4.9: Late-fetal mortality (SBR): England and Wales, and Scotland.

Source: Based on data supplied by the Office of National Statistics, London; Registrar General for Scotland, Edinburgh.

Scotland from 1939. In both cases the starting-points for the series indicate rates around 40, roughly where Farr and others suggested they lay in the nineteenth century.[28]

Some important geographical variations in late-fetal mortality are captured in Figure 4.10*a*, which shows variations in the stillbirth rate (SBR per 1000 total births) among the administrative units of England and Wales in 1931.

These are the 234 units used to report mortality statistics in the Registrar General's *Reviews*. They cover the boroughs of London, the county boroughs (large urban centres), and the counties divided into rural and urban districts. Figure 4.10*b* uses the same units to illustrate variations in the infant-mortality rate (IMR per 1000 live births), while Figure 4.10*c* considers infant deaths registered as due to congenital malformations (per 1000 live births), and Figure 4.10*d* shows the maternal-mortality rate (MMR per 10 000 live births). These four maps set side by side demonstrate how difficult it is to provide a simple yet convincing explanation of the causes of late-fetal mortality. Although there are important elements of correspondence with infant mortality, congenital malformations, and maternal mortality, the stillbirth rate

[28] Scotland uses the same definition of stillbirths as England and Wales, but has a separate registration system and Registrar General. Charlotte A. Douglas, *Infant and Perinatal Mortality in Scotland*, US National Center for Health Statistics, 3rd ser., 5 (Washington, DC: US Government Printing Office, 1966) outlines the early pattern of late-fetal mortality in Scotland, while Gayle Davis, 'Stillbirth registration and perceptions of infant death, 1900–1960: the Scottish case in national context', *Economic History Review*, 62 (2009) describes the long road to registration.

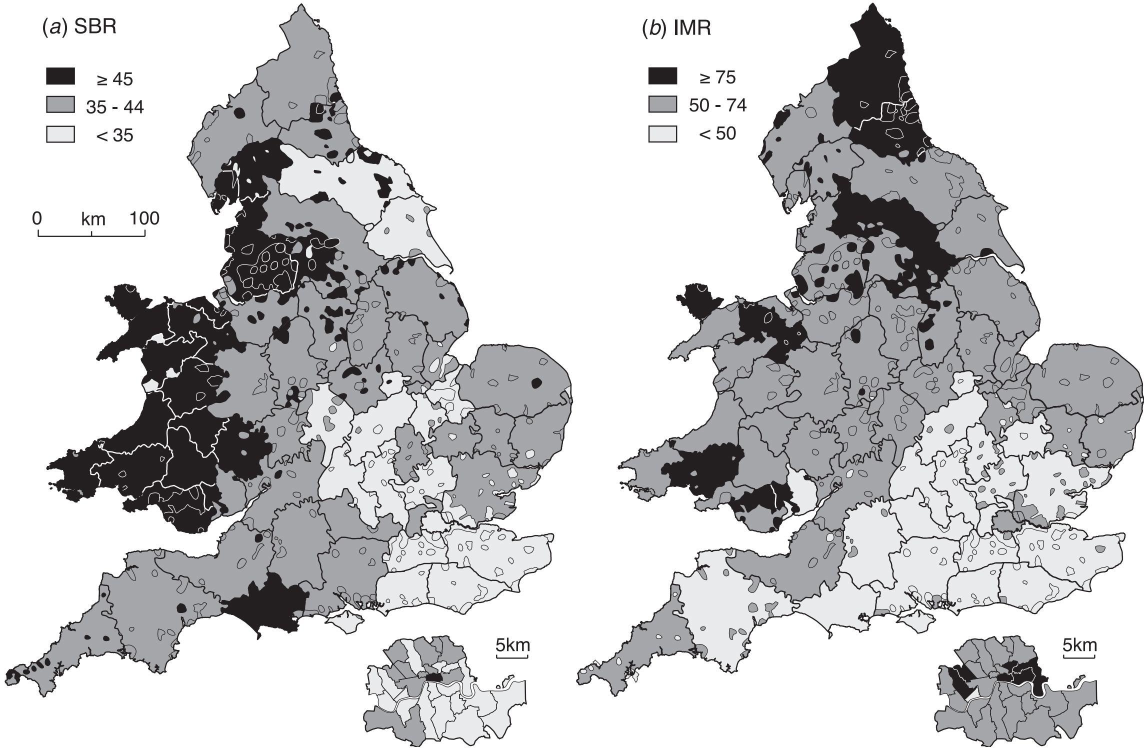

Fig. 4.10: Variations in selected mortality rates: England and Wales, administrative units, 1931. ((*a*) SBR: stillbirths per 1000 total births; (*b*) IMR: infant deaths per 1000 live births; (*c*) Congenital malformations: deaths from congenital malformations in infancy per 1000 live births; (*d*) MMR: maternal deaths per 10 000 deliveries. The administrative units include London boroughs, county boroughs, urban and rural districts in each county.)

Source: Derived from data in the Registrar General's *Statistical Review of England and Wales for the Year 1931* (London: HMSO, 1933).

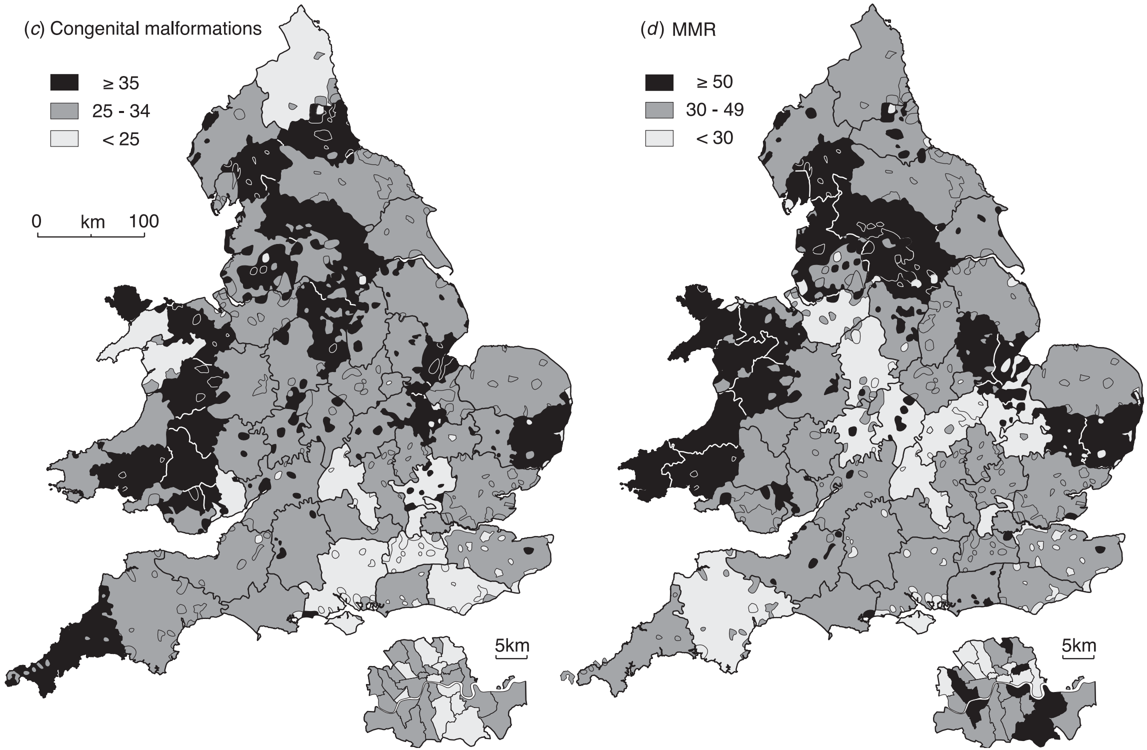

Fig. 4.10: Continued

shows some very distinctive characteristics. The mortality rate was high in Wales and the North West of England, but not in London and much of the south-east. Some rural districts had especially high stillbirth rates, as did certain towns. Infant mortality had a sharper urban concentration among the northern towns. Deaths in infancy due to congenital malformations (predominantly neonatal) should, in principle, have been closely tied to fetal deaths, and again there is some overlap. Maternal mortality was more important in Wales and some northern districts, as well as a few areas in the eastern counties.

Ian Sutherland's early study *Stillbirths* (1949) focused on these issues, especially as they were revealed during the 1930s.[29] He suggested that for Wales, where the stillbirth rate lay in the mid-fifties throughout the 1930s, it was likely that some neonatal deaths were being registered as stillbirths. Overall, Sutherland's study emphasized the importance of good-quality antenatal care, access to skilled birth attendants (particularly in specialist institutions, hence London's advantage), and the underlying effects of poverty (affecting maternal nutrition and physique, and reflected in paternal social class).

The registration of fetal deaths in the USA was, to say the least, even more chaotic in its early decades than it is today.[30] Although there is a long series of population censuses, the civil registration of vital events has a far shorter history. A birth-registration system was established for ten states, plus the District of Columbia, in 1915, and other states were added during the following decades. Fetal deaths came into registration in 1922, but each state followed its own conventions, many of which were specified in local legal codes. Gestational ages of 4, 5, and 6 months were regularly used, although Indiana specified 'seven months and over' and Connecticut used 'not less than 28 weeks'. From the start there was a clear recognition that race was an important factor, with fetal mortality apparently twice as high among the non-white compared to the white population. This difference was undoubtedly real enough, but it also had an important bearing on the process of registration and the way in which the entire USA could be represented, since the various subgroups that made up

[29] Sutherland, *Stillbirths: Their Epidemiology and Social Significance* (London: Oxford University Press, 1949) describes the early years of stillbirth registration in Britain and offers several interpretations of the causes of variations. Robert Woods, 'The measurement of historical trends in fetal mortality in England and Wales', *Population Studies*, 59 (2) (2005), 147–62 uses the 1931 data to derive SBR estimates for earlier decades.

[30] Herbert S. Klein, *A Population History of the United States* (Cambridge: Cambridge University Press, 2004) outlines the bigger demographic picture, while George Alter, 'Infant and child mortality in the United States and Canada', in Alain Bideau, Bertrand Desjardins, and Héctor Pérez Brignoli (eds.), *Infant and Child Mortality in the Past* (Oxford: Clarendon, 1997), 91–108 focuses on the years after birth, but not fetal mortality itself. Sam Shapiro, Edward R. Schlesinger, and Robert E. L. Nesbitt, *Infant and Perinatal Mortality in the United States*, US National Center for Health Statistics, 3rd ser., 4 (Washington, DC: US Government Printing Office, 1965) addresses the registration problem in some detail.

'non-white' were geographically concentrated in certain states, especially in the south or towns in the north and west.[31] The early published reports on US vital statistics also tended to combine the numbers of registered fetal deaths from states regardless of definition, to use the term 'stillbirth' to refer to fetal deaths regardless of gestational age, and to report fetal deaths per 100 live births as the stillbirth ratio. All 48 states of the continental USA had become part of the National Vital Statistics System by 1933. In 1942 the registration of fetal deaths was harmonized, to some extent, by tabulating two critical gestational ages: 20 and 28 weeks LMP. Therefore, it is possible to derive our standard measure of late-fetal mortality (SBR) for the USA from the mid-1940s and certainly from 1950, although the plethora of regulations adopted for the registration of fetal deaths by individual states (see Table 2.3, on p. 26) raises important questions concerning quality and consistency when data for registration areas are pooled. It has been suggested that during the early 1950s there was an underregistration of late-fetal deaths by about 10 per cent.[32] For earlier years we have the fetal-death ratio (FDR: registered fetal deaths of various gestational ages per 1000 live births). This ratio may provide an index of the burden of fetal wastage, even though its level cannot be compared directly with the conventional stillbirth rate.

Figure 4.11 shows the post-1950 trend in late-fetal mortality for the USA using the stillbirth rate (i.e. fetal deaths of 28 weeks LMP or more). It also plots the SBRs for Indiana and Connecticut, relying on the assumption that because these two states only registered late-fetal deaths their data may provide a proxy for the experience of other states, if not the USA in general. Finally, the fetal-death ratio (FDR) is illustrated. England and Wales, and Sweden are also shown for scale. Because these series are so short, and of unknown reliability, it is difficult to gauge the level of the stillbirth rate during the 1930s. A range of 30–40 would appear appropriate based on Connecticut and Indiana, but this may be too low. Certainly, it is difficult to believe that late-fetal mortality was lower in the USA during the 1940s and 1950s than it was in Sweden. It is also difficult to detect a clear turning-point at or about 1940, although it is clear that

[31] This disparity still persists. See, for example, H. M. Salihu, et al.,'Racial disparity in stillbirth among singleton, twin, and triplet gestations in the United States', *Obstetrics and Gynecology*, 104 (2004), 734–40.

[32] Helen C. Chase, *International Comparison of Perinatal and Infant Mortality*, US National Center for Health Statistics, 3rd ser., 6 (Washington, DC: US Government Printing Office, 1967), 14–17. This finding was based on two survey studies. There are no equivalent figures for European populations. The data used to construct Figure 4.11 come from Forrest E. Linder and Robert D. Grove, *Vital Statistics Rates in the United States, 1900–1940*, US National Office of Vital Statistics (Washington, DC: US Government Printing Office, 1947), Robert D. Grove and Alan M. Hetzel, *Vital Statistics Rates in the United States, 1940–1960*, US National Center for Health Statistics (Washington, DC: US Government Printing Office, 1968), D. L. Hoyert, *Perinatal Mortality in the United States, 1985–91*, US National Center for Health Statistics, *Vital Health Statistics* 20 (26) (1995), esp. p. 4, table A, and the NCHS website.

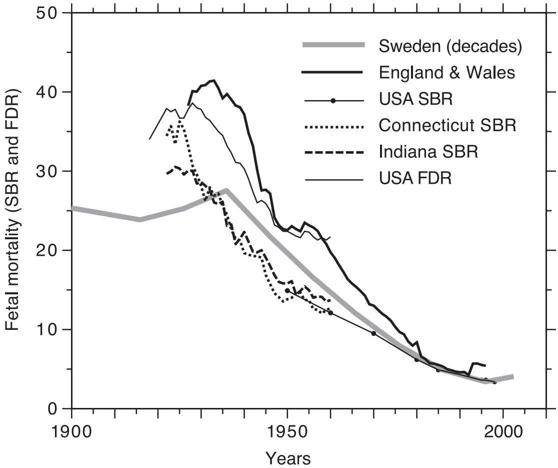

Fig. 4.11: Fetal mortality (SBR and FDR): USA, with Sweden and England and Wales for comparison.

Source: Based on data supplied by the US National Center for Health Statistics, Hyattsville, Md.

maternal mortality passed into a phase of steep decline during the late 1930s, as it did in Europe, and as illustrated by Figure 4.8 for Sweden.[33]

Few have ventured to examine fetal mortality in eighteenth- and nineteenth-century America. Laurel Thatcher Ulrich is one of the exceptions. Her work uses the diary of a Maine midwife, Martha Moore Ballard, which between 1785 and 1812 records 814 deliveries of which 14 were stillbirths. This gives a stillbirth rate of 17 per 1000. Ulrich has compared Mrs Ballard's performance with that of six other New England midwives about whom there is some information. Their average stillbirth rate was 30 with a range from 23 to 39.[34] Ballard appears to have been remarkably successful, therefore, although she may just have been fortunate in not having to deal with too many complicated cases, since only 5 maternal deaths were associated with the 814 deliveries. What evidence there is for late eighteenth- and nineteenth-century New England suggests that late-fetal mortality is likely to have fallen in the 2–4 per cent range.[35]

[33] Loudon, *Death in Childbirth*, p. 366, fig. 22.1, and Sam Shapiro, Edward R. Schlesinger, and Robert E. L. Nesbit, *Infant, Perinatal, Maternal, and Childhood Mortality in the United States* (Cambridge, Mass.: Harvard University Press, 1968), 145, fig. 7.1. Wanda D. Barfield, et al., 'Contribution of late fetal deaths to US perinatal mortality rates, 1995–1998', *Seminars in Perinatology*, 26 (1) (2002), 17–24 reviews recent trends.

[34] Ulrich, '"The living mother of a living child": midwifery and mortality in post-revolutionary New England', *William and Mary Quarterly*, 46 (1) (1989), 27–48, esp. tables I and II (pp. 33 and 39). See also Ulrich, *A Midwife's Tale: The Life of Martha Ballard Based on Her Diary, 1785–1812* (New York: Knopf, 1990).

[35] George Chandler Whipple, *Vital Statistics: An Introduction to the Science of Demography* (New York: Wiley, 1919), 340, table 96 reports stillbirth ratios for Boston. The average for 1891–1900

LES ONDOYÉS DÉCÉDÉS AND *LES FAUX MORT-NÉS*

Several European countries adopted and persisted well into the twentieth century with the practice of categorizing deaths during the first hours after live birth as stillborn and of including them with the registered stillbirths. In consequence, registered live births were those infants born with vital signs (respiration especially) and who survived for at least 1–3 days. We have already seen that the Netherlands, an advanced state, abandoned this practice in 1918, and, from William Farr's remark quoted on page 69, that the French statistician Dr Jacques Bertillon was concerned with the 'false stillbirths' problem and had made efforts to adjust his country's data accordingly. Bertillon contributed a substantial section on *les mort-nés* to the great *Dictionnaire encyclopédique des sciences médicales* (1876), in which he compared the available statistics from France, Belgium, and the Scandinavian countries in the 1860s.[36] His objective was to separate the false stillbirths (*les faux mort-nés*)—those infants born with vital signs that died within 3 days (the legally specified period for registration)—from the true stillbirths (*les vrais mort-nés*) that had survived at least 6 months from conception but had been born without having breathed. His estimates reduce the reported stillbirth rates for France and Belgium by 22 per cent, so placing them in the range occupied by the Scandinavian countries. Bertillon's method is unclear; indeed, it is difficult to see how such a correction could have been made without access to very detailed age-at-death data.[37] Recent work on French infant-mortality patterns has developed techniques for deriving the true number of live births between 1920 and 1974, but assumptions still have to be made for earlier years concerning the number of false stillbirths and their split between males

was 38.8 and that for 1901–10 was 37.9, suggesting an SBR of about 37. Unfortunately, Whipple was not specific about the definition used in Boston, but his comments suggest that only late-fetal deaths were involved. W. Peter Ward, *Birth Weight and Economic Growth: Women's Living Standards in the Industrializing West* (Chicago, Ill.: University of Chicago Press, 1993), 94, fig. 5.3 shows the percentage stillborn in Boston in the period 1871–1900 to lie between 4 and 5. These figures are also consistent with the 4.7 per cent reported for New York in 1912 and 1913 in L. Emmett Holt and Ellen C. Babbitt, 'Institutional mortality of the new-born: a report on ten thousand consecutive births at the Sloane Hospital for Women, New York', *Journal of the American Medical Association*, 64 (4) (1915), 287–90, esp. pp. 289–90 on stillbirths.

36 Jacques Bertillon, 'Mort-né', *Dictionnaire Encyclopédique des Sciences Médicales*, x (Paris: Masson/Libraire de l'Académie de Médecine, 1876), 2–28.

37 Jacques Dupâquier, 'For a history of prematurity', in Alain Bideau, Bertrand Desjardins, and Héctor Pérez Brignoli (eds.), *Infant and Child Mortality in the Past* (Oxford: Clarendon, 1997), 188–202 reports some additional data from Bertillon for Paris in 1901 (p. 200, table 11.6, no source given) which show that of 1972 registered stillbirths 17.7 per cent had breathed at birth. While the conventional SBR was 29.4, including false stillbirths made it 35.7. Table 11.5, on p. 199, has the SBR in France in 1853 as 38, with 34 in rural and 49 in urban areas. Michel Poulain and Dominique Tabutin, 'Mortalité aux jeunes âges en Belgique de 1840 à 1970', *Population et Famille*, 42 (3) (1977), 49–73, esp. p. 51, table 1 suggests that the percentage of false stillbirths in Belgium declined from around 24 in the 1850s to 15 in the 1920s.

and females.[38] There is, unfortunately, a further problem with the recording of births in France. The desire to avoid the deaths of unbaptized infants encouraged the practice of emergency baptism and thus the possibility that the unborn or stillborn could be prematurely baptized and registered as births. Louis Henry has argued that some 3 per cent of baptisms may have fallen into this emergency category (*les ondoyés décédés*) and that the practice affected French data before 1840.[39]

Bertillon's table (reproduced here as Table 4.1) has interest in its own right, since it emphasizes some of the broad similarities between countries in the nineteenth century, while illustrating, once again, the importance of legitimacy and the distortions that urban and rural birthplaces can create. However, the most important aspects of Table 4.1 must be the way it demonstrates the effects of registration practices and the long struggle that statisticians have conducted to make their data comparable.

Apart from France and Belgium, Italy and Spain also provide examples of countries in which the registration of fetal deaths followed rules that require special attention. Figure 4.12 shows the time-series for fetal mortality in Italy, France, and Spain, with Sweden and England and Wales. The French time-series is only drawn for the twentieth century, although figures are given for 1853 and the Bertillon estimate for the 1860s, as well as

[38] Jacques Vallin and France Meslé, *Tables de mortalité françaises pour les XIXe et XXe siècles et projections pour le XXIe siècle* (Paris: INED, 2001), 13. Etienne van de Walle, *The Female Population of France in the Nineteenth Century: A Reconstruction of 82 Départements* (Princeton, NJ: Princeton University Press, 1974), 47–51 discusses the stillbirth problem in French vital registration, especially before 1920. Using data for Belgium, Walle argued that 'false stillbirths' represented a declining proportion of live births (from 2 per cent in 1851–5 to 0.8 per cent in 1896–1900). He also suggested that SBR should lie between 20 and 60 and charted the number of departments that fell outside these bounds (88 per cent lay within by the mid-1850s). Raymond Pearl, *The Biology of Death* (Philadelphia, Pa.: Lippincott, 1922), 205, table 24 quotes an SBR for Paris in the period 1911–13 of 80 without any appreciation of the false-stillbirths problem. Catherine Rollet, 'La statistique des décès des enfants et des mort-nés dans la ville de Paris et le département de la Seine au XIXe siècle' (unpublished paper presented at the workshop on 'Fetal and neonatal mortality: historical perspectives on the borderline between life and death', Spanish Council for Scientific Research, Madrid, 10–11 June 2008) demonstrates the insecure nature of French stillbirth and live-birth statistics in the nineteenth century.

[39] Louis Henry, *Techniques d'analyse en démographie historique* (Paris: INED, 1980), 79. Alain Bideau, 'Accouchement "naturel" et accouchement à "haut risqué"', *Annales de Démographie Historique* (1981), 49–66 also suggests 2.8 per cent, although the proportion for women dying in childbirth was much higher (about 20 per cent). Hector Gutierrez and Jacques Houdaille, 'La mortalité maternelle en France au XVIIIe siècle', *Population*, 38 (1983), 974–94, esp. p. 991, table 17 indicates that in rural France in the eighteenth century the proportion of *ondoyés décédes* was 2 per cent, but that the regional figures varied from 3.1 to 0.6 per cent. Jacques Gélis, 'Miracle et médecine aux siècles classiques: le corps médical et le retour temporaire à la vie des mort-nés', *Historical Reflections*, 9 (1982), 85–101 and *Les enfants des limbes: mort-nés et parents dans l'Europe chrétienne* (Paris: Éditions Louis Audibert, 2006) discuss some of the cultural and medical issues that surrounded the recognition of signs of life in seventeenth- and eighteenth-century France.

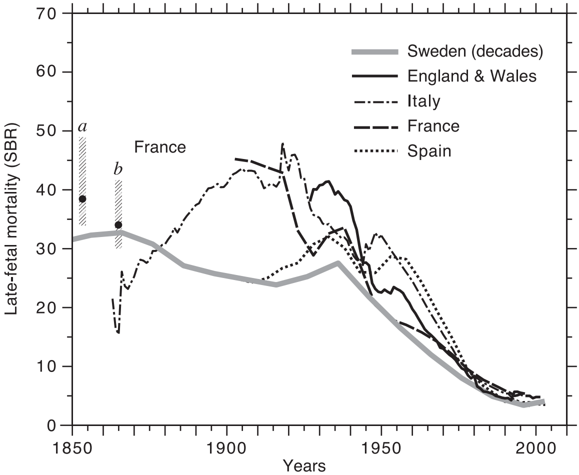

Fig. 4.12: Late-fetal mortality (SBR): Italy, France, and Spain, with Sweden and England and Wales for comparison. (See text for comments on data quality. The dots at *a* and *b* show estimates for France in 1853 and the 1860s, while the shaded bars illustrate the range between rural (low) and urban places.)

Source: Based on post-1900 data reported in Macfarlane and Mugford, *Birth Counts, ii. Tables* (2000), pp. 664–5, table A12.3.1; for France pre-1900: (*a*) Dupâquier, 'For a history of prematurity' (1997), p. 199, table 11.5, (*b*) Bertillon's estimates, Table 4.1 below for Italy pre-1900: ISTAT, *Tendenze evolutive della mortalità infantile in Italia* (1975).

Table 4.1. Bertillon's comparative stillbirth rates (SBR) for the 1860s

	France	Belgium	Sweden	Norway	Denmark
Total	44.3 *34.4*	46.2 *35.9*	32.7	36.7	38.9
Capital	69.7	—	—	56.5	42.9
Towns	52.5 *41.5*	52.7 *41.7*	40.7	42.5	32.2
Rural areas	38.7 *29.8*	45.7 *33.7*	31.6	34.7	39.6
Legitimate births	41.5 *32.2*	44.7 *34.7*	31.3	34.5	37.9
Capital	63.8	—	—	45.2	37.0
Towns	48.3 *38.2*	49.8 *39.3*	35.4	38.0	30.5
Rural areas	37.5 *28.4*	45.0 *33.1*	30.8	33.6	39.3
Illegitimate births	77.7 *62.0*	65.9 *51.0*	46.0	54.7	47.8
Capital	85.6	—	—	112.6	64.3
Towns	84.1 *67.5*	73.9 *59.4*	56.2	85.6	45.9
Rural areas	67.1 *53.1*	55.7 *44.1*	41.3	49.0	43.3

Note: The figures in italics for France and Belgium are Bertillon's estimates of the true stillbirth rate. The other figures are the reported SBRs.

Source: Bertillon, 'Mort-né' (1876), pp. 10–11, table II.

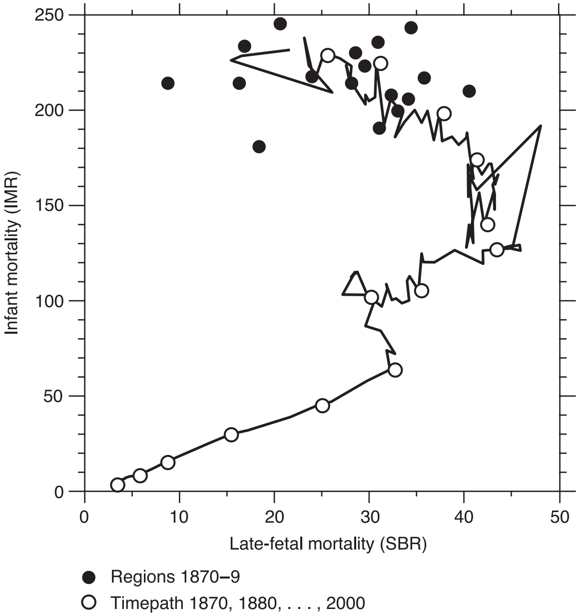

Fig. 4.13: Annual timepath for infant (IMR) and late-fetal mortality (SBR): Italy, 1863–2000. (The regions are shown in Figure 4.14.)

Source: Based on data in ISTAT, *Tendenze evolutive della mortalità infantile in Italia*, Annali di Statistica, 8th ser., 29 (1975).

the urban–rural ranges. The case of Italy will be examined in a little more detail here.

The registration of stillbirths began in Italy in 1863.[40] But the low level of national SBRs and the regional differentials indicate that the process was far from comprehensive. Figures 4.13 illustrates the scale of the problem. It shows the annual timepath for changes in infant and late-fetal mortality (IMR and SBR) from 1863 to 2000, as well as variations among the sixteen Italian regions in 1870–9, the first full decade after registration began. It is clear that while infant mortality declined through the nineteenth century, late-fetal mortality increased. In the 1870s only seven of the Italian regions had SBRs over 30 and in four (Abruzzi, Calabria, Sicily, Sardinia) it was less than 20. This is illustrated by Figure 4.14, which shows for the 1870s regional

[40] Lorenzo Del Panta, 'Infant and child mortality in Italy, eighteenth to twentieth century: long-term trends and territorial differences', in Alain Bideau, Bertrand Desjardins, and Héctor Pérez Brignoli (eds.), *Infant and Child Mortality in the Past* (Oxford: Clarendon, 1997), 7–21 compares the infant-mortality and stillbirth rates for Italy from 1863 (p. 8, fig. 1.1). Del Panta notes that the increase in the number of stillborn up to 1925 is probably due more to changes in the accuracy of live-birth and stillbirth definitions, and to changes in the data-collection process. The data used to

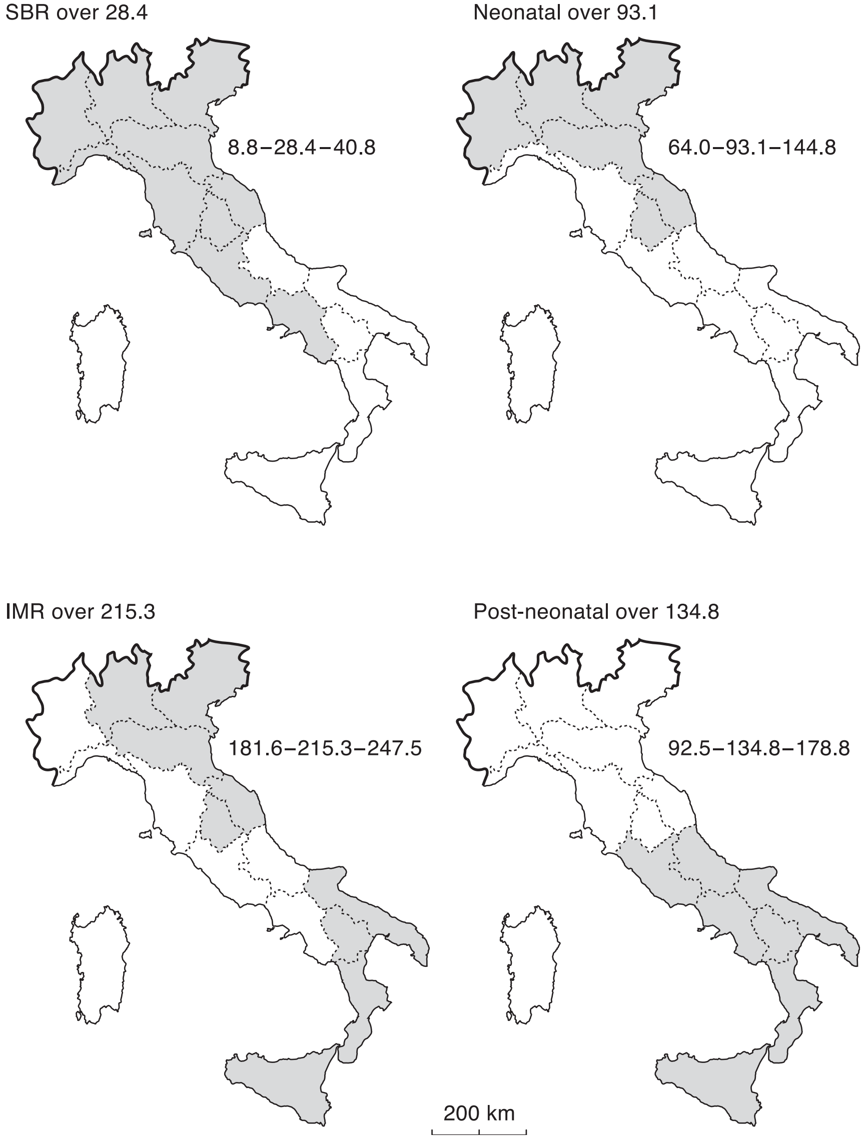

Fig. 4.14: Late-fetal (SBR) and infant-mortality rates: regions of Italy, 1870–79. (The regions shaded in grey are those above the national rates. The regional minima and maxima, and the national rates are also given. For example, in the case of SBR the lowest regional rate was 8.8 and the highest 40.8, while the national rate was 28.4)

Source: See Fig. 4.13.

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variations in the stillbirth, neonatal-, postneonatal-, and infant-mortality rates. Italy offers an excellent example of what we would expect to see in a country with improving registration coverage. National rates of late-fetal mortality only reached credible levels during the early decades of the twentieth century because regional differences in registration quality had narrowed by then. Rates in the south rose to match those in the north and then stayed at a higher level longer. After 1950 all regions shared in a sustained decline, so that Italy's stillbirth rate is now one of the lowest in the world. It is likely that this process of registration improvement, which may have been especially geographically differentiated in Italy, also occurred in other developed countries. The first decades of registration in Sweden, Denmark, Norway, and the Netherlands may also display this phenomenon.

SPECULATIONS ON THE CAUSES OF DECLINE AND CONVERGENCE SINCE 1930

Today there are only minor absolute differences in late-fetal mortality between the countries we have been considering. Their stillbirth rates lie in the range 3–6 per 1000 total births, perhaps one-tenth of what they were in the 1930s. All examples, regardless of registration conventions, have experienced dramatic decline, and in most cases there is some sign of a considerable turning-point in the late 1930s or during the 1940s. Decline and convergence are obvious, although there are differences of detail in terms of starting level and pace of change, especially in the 1940s and 1950s. A simple explanation would focus on medical knowledge and technology (blood transfusion, antibiotics, incubators, ultrasound), improved obstetric and paediatric practice enhanced by higher health expenditure (antenatal care, hospitalization of delivery), better living standards (nutritional status of women), and more effectively controlled fertility. The legalization of induced abortion in the 1960s and its increase in recent decades will also have had an impact on the broader pattern of fetal mortality. But such an explanation requires careful consideration both because it involves several elements and it is important to establish which are the most important, and because similar lists of factors have been proposed in studies of perinatal and maternal mortality. The causes of decline in late-fetal mortality are likely to be specific to the antepartum and intrapartum categories of deaths. However, it may prove useful to begin by considering examples of other approaches to the related problems of perinatal and maternal mortality.

construct Figures 4.13 and 4.14 come from ISTAT, *Tendenze evolutive della mortalità infantile in Italia*, Annali di Statistica, 8th ser., 29 (Rome, 1975). I am grateful to Professor Lucia Pozzi (University of Sassari, Sardinia, Italy) for allowing me to use her version of this material. John F. Osborn, Maria Sofia Cattaruzza, and Angela Spinelli, 'Risk of spontaneous abortion in Italy, 1978–1995, and the effect of maternal age, gravidity, marital status, and education', *American Journal of Epidemiology*, 151 (1) (2000), 98–105 discuss more recent Italian data on abortion.

Signild Vallgårda's account of recent trends in perinatal mortality in Denmark and Sweden provides a convenient starting-point.[41] She focuses on the 1940 turning-point and argues that birthweight, age, parity, health status of mothers, and obstetric care did not change at a time coincident with the start of the decline in perinatal mortality. 'It would seem, therefore, that factors associated with the distribution of perinatal deaths in a population at a given time (such as the proportion of low birthweight, maternal age and parity) cannot explain the change over time, nor the similarities or differences between countries.'[42] She favours the hypothesis that there was an association between women's and infants' improved health as a result of fertility decline from around 1900 and the fall in perinatal mortality among the offspring of women born after the fertility decline. Although she accepts that this mechanism could not account for all of the marked decline in perinatal mortality after 1940, it was nonetheless an important contributor. It is certainly possible to demonstrate that the proportion of low-birthweight babies (less than 2500g) hovered around 4–5 per cent in Sweden and 6 per cent in Denmark throughout the twentieth century and that hospitalization of deliveries followed different courses in the two countries (75 per cent by 1940 in Sweden and by 1970 in Denmark), but Vallgårda ignores other advances in medical technology as well as the lessons that can be learned from parallel research on maternal deaths.[43]

We have already noted and seen in Figure 4.8 that maternal and late-fetal mortality may not always follow the same course, although in the case of twentieth-century Sweden the two rates moved together and shared a common turning-point. Irvine Loudon's work on maternal-mortality trends and international variations in the twentieth century has stressed the importance of developments in the 1930s and 1940s, especially the new ability to control puerperal fever using the sulphonamide range of antibiotics, Prontosil especially, and then penicillin:

> As far as puerperal fever is concerned, the sulphonamides were responsible for the initial part of the steep and sustained fall in deaths from puerperal fever that has continued ever since. In 1935 there were about 200 deaths from puerperal fever in England and Wales for every 100,000 births; in Scotland the rate was 320 per 100,000. By 1940 the mortality from puerperal fever (in England and Wales) had fallen to 30 per 100,000 births. By 1944, when penicillin was becoming generally available, puerperal-fever deaths had fallen to about ten, by 1950 to four, and by 1960 to only one per 100,000 births. In the years 1967–78 inclusive there were six years in which the rate of death from puerperal fever in England and Wales was one, and six in which it was zero.[44]

[41] Vallgårda, 'Trends in perinatal death rates in Denmark and Sweden, 1915–1990', *Paediatric and Perinatal Epidemiology*, 9 (1995), 201–18.

[42] Ibid. 212.

[43] Signild Vallgårda, 'Hospitalization of deliveries: the change of place of birth in Denmark and Sweden from the late nineteenth century to 1970', *Medical History*, 40 (1996), 173–96 discusses the hospitalization issue in detail.

[44] Loudon, *The Tragedy of Childbed Fever* (Oxford: Oxford University Press, 2000), 186.

However, Loudon has also offered the following broad generalization:

> Levels of maternal mortality were determined most of all by standards of care provided by birth attendants. Poor obstetric care could either consist of ignorance of basic procedures (judged by the standards of the time), or it could consist of dangerous and unwarranted interference by trained personnel. Maternal mortality was relatively insensitive to social and economic determinants except in so far as these determined the type and quality of birth attendant. High maternal risk could be associated with cheap untrained midwives or expensive over-zealous and unskilled doctors. Sound obstetric practice by well-trained midwives could produce low levels of maternal mortality even in populations which were socially and economically deprived.[45]

Of course, these two statements are not incompatible. In order to achieve very low maternal mortality, access to drugs must be combined with the availability of effective, well-trained birth attendants. Today this can be managed among poor populations even where infant-survival chances are still rather low. In the late nineteenth century our advanced states invested in good-quality birth attendants, so achieving levels of maternal mortality towards the bottom of the international range. Other countries made such investments during the twentieth century, but their experience of maternal-mortality decline appears even more dramatic because the general availability of effective drug technology accentuated the decline from the late 1930s.

What are the implications of these accounts for work on fetal mortality? Highly skilled birth attendants would be instrumental in the reduction of intrapartum deaths, particularly if supported by specialist obstetricians and dedicated hospital facilities. Such developments are unlikely to have had rapid and dramatic effects on national-mortality series, however. Securing the health of women in the third trimester of pregnancy is crucial for the avoidance of antepartum deaths. Here, general antenatal screening, the targeting of those women with histories of fetal deaths, and the availability of antibiotics for the control of infections could have produced marked positive effects for fetal-survival chances in the short term. This would represent the equivalent of the 'sulphonamides effect' on maternal mortality. As for the cohort effects of reduced infant mortality and controlled fertility on maternal health, the beneficial consequences are likely to have been important and cumulative rather than dramatic and short-term. These lines of thinking, assisted by earlier studies focusing on perinatal and maternal mortality, lead to the following propositions that will require detailed discussion in subsequent chapters and will receive systematic evaluation in Chapter 7.

First, the risk of fetal death is inextricably linked to the quality of birth attendants available; it is impossible to explain the course especially of late-fetal mortality independent of the history of midwifery, broadly defined. Second, the diseases and physiological conditions that affected women in connection with pregnancy, both antenatal and postnatal, were only brought under some form

[45] Loudon, *Death in Childbirth*, p. 517.

of control during the twentieth century via the application of drug technology. Third, demographic factors, especially those relating to fertility and reproductive success, exposed women and their unborn fetuses to greater or lesser risks. Changes in the patterns of those risks had an important bearing on fetal mortality; they created the context for the survival struggle. Demography, epidemiology, and midwifery were bound together in determining fetal health in the late twentieth century.[46]

FETAL MORTALITY IN DEVELOPING COUNTRIES

During the 1940s and early 1950s the United Nations began to gather data on late-fetal in combination with infant and child mortality. When it was published in 1954, their compilation of statistical data and critical analysis of registration systems represented one of the first systematic attempts to draw international comparisons.[47] Table 4.2 illustrates some of the principal findings for the 1920s and 1930s. The study argued that stillbirth rates between 20 and 50 were credible, and that Canada, New Zealand, Sweden, Denmark, and Norway offered examples of good-quality registration systems.[48] It could find very few examples for countries with predominantly non-European populations. Only Mauritius, Trinidad and Tobago, Japan and Taiwan (in Japanese occupation) are listed here, although even more unreliable stillbirth data were available for a few other countries. It was also clear that there was a far from close relationship between late-fetal and infant mortality.

In recent decades the several rounds of Demographic and Health Surveys have, on occasions, made attempts to record stillbirths in specific countries. Thirty-six such surveys covering 20 countries are available for the 1990s. Of these, only 5 surveys indicate stillbirth rates in excess of twenty, and 3 of these are for Bangladesh.[49] The suspicion that stillbirths have been underrecorded in the

[46] The British case illustrates how each of these factors came into play, but also how they operated on different time-scales. The Midwives Act of 1902 was largely ineffective in improving the quality of birth attendants, but the 1936 Midwives Act led to the creation of a national service of salaried midwives. The development and adoption of Prontosil in the late 1930s had a substantial impact on infections among mothers, but it also reduced sepsis in abortion cases. Blood transfusion and increased hospitalization, especially for primiparae deliveries, also coincided (see Tania McIntosh, 'Profession, skill, or domestic duty? Midwifery in Sheffield, 1881–1936', *Social History of Medicine*, 11 (3) (1998), 403–20).

[47] UN, *Foetal, Infant and Early Childhood Mortality, i. The Statistics; ii, Biological, Social and Economic Factors*, United Nations, Department of Social Affairs, Population Division, Population Studies, 13 (New York: United Nations, 1954).

[48] Malcolm Fraser, 'New Zealand—infant mortality rates and stillbirths', *Journal of the Royal Statistical Society*, 92 (3) (1929), 428–44 discusses the early years (1913–27) of registration.

[49] Mary Mahy, *Childhood Mortality in the Developing World: A Review of Evidence from the Demographic and Health Surveys*, DHS Comparative Reports, 4 (Calverton, Md.: ORC Macro, 2003), p. 7, table 1. Other forms of data are available from community-based studies. See Elizabeth

Table 4.2. Late-fetal mortality (SBR) data compiled by the UN in the 1950s: selected countries, 1920–9 and 1930–9

	1920–9	1930–9
Mauritius	90 (138)	86 (158)
Trinidad and Tobago	72 (136)	63 (116)
Japan	59 (153)	51 (117)
Chile	—	43 (243)
Portugal	40 (148)	42 (142)
England and Wales	—	40 (59)
USA	38 (73)	34 (57)
Italy	40 (125)	33 (95)
France	37 (94)	34 (71)
Belgium	37 (105)	32 (87)
Taiwan	—	33 (149)
Canada	—	29 (73)
New Zealand	30 (43)	29 (32)
Germany	34 (111)	26 (72)
Spain	26 (144)	26 (122)
Sweden	25 (60)	27 (48)
Denmark	24 (83)	25 (69)
Netherlands	26 (66)	25 (42)
Norway	22 (52)	24 (43)
Iceland	26 (57)	21 (45)
Switzerland	27 (63)	22 (47)
South Africa (Europeans)	—	22 (60)

Note: The infant-mortality rate (IMR) is shown in brackets. These rates are of varying reliability and should be treated with caution.

Source: UN, *Foetal, Infant and Early Childhood Mortality*, i (1954), extracted from annex tables I and III.

DHSs has led the World Health Organization to derive national estimates of late-fetal mortality from early-neonatal mortality.[50] A WHO report of 2006 contains estimates of the stillbirth rate (SBR), the early-neonatal mortality rate (ENMR), the neonatal mortality rate, and the perinatal mortality rate for 21 United Nations and 14 WHO world regions and 201 countries for the year 2000. It is anticipated that these estimates will provide a basis for the monitoring of health-service provision by allowing governments and international agencies to compare performance during the twenty-first century. The report provides benchmarking

M. McClure et al., 'The global network: a prospective study of stillbirths in developing countries', *American Journal of Obstetrics and Gynecology*, 197 (2007), 247–51, which compares data from six developing countries. The highest SBRs found were for Pakistan (34), Democratic Republic of Congo (30), Zambia (29), and Orissa, India (27). The contribution of intrapartum stillbirths was stressed.

[50] WHO, *Neonatal and Perinatal Mortality: Country, Regional and Global Estimates* (Geneva: World Health Organization, 2006). See also Chapter 3, pp. 52–55.

material, therefore. It is acknowledged that although the methodology for deriving the mortality estimates is fairly simple (neonatal → early-neonatal → stillbirths), the assumptions required and the initial data demands are exacting. For example, in 87 countries data on neonatal deaths were derived from Demographic and Health Surveys. This represents 45 per cent of countries and 81 per cent of births. Only 37 per cent of countries (about 14 per cent of births) were covered by adequate civil-registration systems that attempted full counts of all live births and neonatal deaths.[51] The WHO also judged that although stillbirths were apparently underreported in some surveys in developing countries, such data should be taken at face value and not corrected. The method of estimation for SBR involved distinguishing between early- (first week: 0–6 days) and late-neonatal deaths and using the ratio of SBR to ENMR to derive the unknown former rate from the derived latter one (SBR from ENMR). Individual countries were allocated to development categories (five WHO mortality strata), each of which was judged to have a particular SBR/ENMR ratio that could then be applied to constituent countries lacking stillbirth data in order to derive SBRs.

Figure 4.15 shows for the year 2000 the association between the stillbirth rate and neonatal mortality among 201 countries and 21 UN world regions (plus 'World' with an SBR of 24; 'More developed regions', SBR of 6; 'Less developed regions', SBR of 26; 'Least developed regions', SBR of 31).The SBRs are either WHO estimates (96 countries) or they are derived from registration or survey data. Among the regions, late-fetal mortality is at its lowest in northern America (SBR of 3) and western Europe (4), and highest in middle and western Africa (41) and south-central Asia (34). Among countries, sixteen have rates of 40 or more (fifteen are African and the single exception is Afghanistan) with five having 50 or more. The highest national rates are for Mauritania (63), Liberia (58), Côte d'Ivoire (53), and Sierra Leone (50), but among the largest countries Nigeria has 48 and India 39. South Korea is credited with having the lowest SBR (2), but 10 countries have 3 (including Singapore and Malaysia; Australia and New Zealand; Italy, Switzerland, Sweden, and the Czech Republic). According to WHO estimates, the international range of late-fetal mortality in 2000 was 2–63, therefore. Among countries with a moderate to high stillbirth rate (20 and over) the association between SBR and ENMR was

$$\mathrm{SBR} = 1.1945\mathrm{ENMR} + 0.1524\ (\mathrm{R}^2 = 99.78\%,\ \mathrm{N} = 52)$$

This strong relationship is implied in Figure 4.15, although neonatal rather than early-neonatal mortality is shown because in many cases the latter has simply been derived from the former. The regression equation summarizes the outcome of the WHO's efforts to estimate national stillbirth rates for 2000.

Annex 6—'Estimating stillbirth rates when data were not available'—of the WHO report contains a section on 'Exploring SBR/ENMR ratios in retrospective

[51] WHO, *Neonatal and Perinatal Mortality*, p. 10, table 5.2.

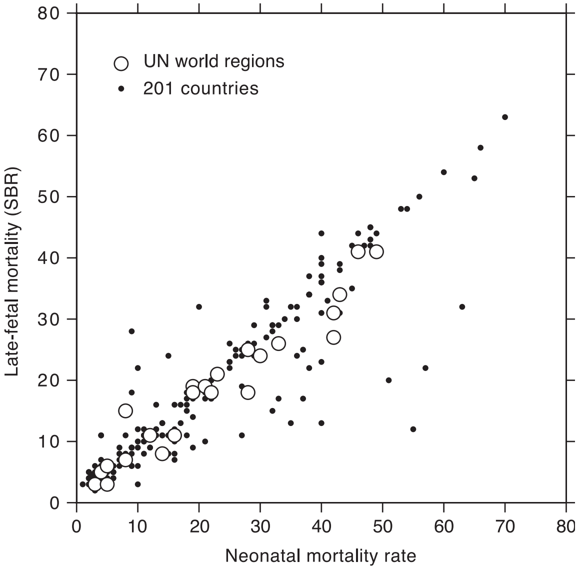


Fig. 4.15: Relationship between late-fetal (SBR) and neonatal mortality: international variations, 2000.

Source: Based on data in WHO, *Neonatal and Perinatal Mortality* (2006).

data'. It argues that '[t]he mortality rates in developed countries at the beginning of the last century were similar to those of developing countries around 1995', but that '[d]irect applicability to developing countries could not be demonstrated, although these relationships show that SBR/ENMR ratios well over 1 are indicated by historical evidence'.[52] A note to the first comment points out:

Since the longitudinal data included few datapoints where the ENMR was above 30/1000 births—values often still registered nowadays in D [high child, high adult mortality, e.g. India, Nigeria] and E [high child, very high adult mortality, e.g. 20 African countries] strata—it was not considered appropriate to use these historical data to estimate stillbirths in the high-mortality countries in strata D and E. Moreover, the relationship between early-neonatal mortality and stillbirth in countries with high mortality could be different from that observed in this historical dataset.[53]

The historical dataset constructed by WHO employed national statistics for various periods during the twentieth century. Only Denmark and Norway provided material for the entire century, so that the period before 1950, which 'better reflects the level of care and of maternal, early-neonatal and neonatal mortality now prevailing in countries of [mortality] strata D and E', is

[52] WHO, *Neonatal and Perinatal Mortality* (2006), pp. 54 and 55. [53] Ibid. 55 n. c.

dominated by their statistics.[54] None of the ENMR observations in this whole dataset exceeded 25, although the case of France in 1853 was found to provide a single counter example.[55] The WHO used this historical dataset to confirm the general level of the SBR/ENMR ratio at moderately high levels of ENMR, but there was clearly unease about taking the analogy too far. Estimates of SBR for countries in high-mortality strata D and E were derived by assuming an SBR/ENMR ratio of 1.2, not from strata-specific averages or historical precedents.

These three reports, from the UN, DHS and WHO, reflect the main problems in assessing the level of late-fetal mortality among a wide range of countries, especially developing ones. Those places where early-age mortality is at its highest are least likely to have an effective registration system, and even when population-based health surveys are conducted they are unlikely to take up the challenge of requesting details on fetal deaths. Estimation is essential in these circumstances. But the methodology for such estimation is far from robust, since either one has to rely on historical experience drawn exclusively from north-western Europe or one must make assumptions about the most likely level of mortality given some evidence for places that are believed to be equivalent. This is the challenge tackled in the WHO report on *Neonatal and Perinatal Mortality*. Although their findings must be treated with caution, their approach can offer a model for historical estimation.

HISTORICAL ESTIMATION

Our review of the available national data has established that for some countries the level of late-fetal mortality may be gauged even prior to 1900, but that definitions of stillbirths varied and changed both in principle and practice. With the findings of the UN and WHO reports in mind, and on the basis of the available models of fetal/infant survival proposed in Chapter 3 and the empirical evidence discussed in this chapter, it is likely that before 1940 from 2 to 6 per cent of viable fetuses that had reached 28 weeks' gestation (roughly seven months or the beginning of the third trimester) failed to survive to become live births. Although helpful, it is a broad band that conceals too much detail in terms of variation in level and trend. This final section of Chapter 4 considers the case of England before the registration of stillbirths began in 1927. It proposes estimates of late-fetal mortality as a demographic guide for subsequent chapters.

Apart from Farr's guess and some exploratory work conducted with late nineteenth-century stillbirth certificates and cemetery registers, there is very little direct evidence on late-fetal mortality for England before the 1920s.[56] During

[54] Ibid. 55 n. d.

[55] Ibid. 55, table A6.2. See Dupâquier, 'For a history of prematurity', p. 199, table 11.5 for the original source.

[56] See p. 69 and n. 25. An SBR in the low forties is the consensus.

the period between 1538 and 1837 Anglican parish registers provide virtually the only possible source of quantitative evidence, and they are normally silent on the unbaptized. The stillborn and those dying before baptism were not supposed to be buried in consecrated ground, but practice appears to have varied from parish to parish. Usually the midwife was left to dispose of a dead fetus, although it has been noted that the unbaptized were sometimes placed in the coffins of adults. When a woman died in childbirth it was usual to bury her dead fetus or infant with her. In these circumstances it is not surprising that deaths identified as stillbirths rarely entered the registers. The example of Hawkshead, Cumbria, illustrates some of the difficulties involved in interpreting the word 'abortives', which appears in the burial register more than 200 times between 1581 and 1710. If 'abortives' are stillbirths then the stillbirth rate would be 45 for the entire period, but for 1581–1660 it would be 34 and for 1661–1710, 70. It seems likely that after 1660 some neonatal deaths were being registered as 'abortives'. If half were, then the stillbirth rate for the second period would be 37.[57]

Apart from parish registers there are two other ways of identifying fetal deaths: the records of the lying-in hospitals and the London Bills of Mortality. Both pose new and interesting problems. Before the mid-twentieth century only a tiny minority of deliveries took place in institutions. Mothers giving birth in such places were a small and highly selected group. The new lying-in hospitals founded in the eighteenth and nineteenth centuries offered specialist obstetric care to poor, married women who were recommended by a trustee or a medical officer. They provided training for midwives and had the potential to develop new methods and encourage best practice.[58] They also became notorious as sources of puerperal fever and poor maternal survival. The lying-in wards attached to nineteenth-century workhouses dealt with destitute women, many of whom

[57] Roger Schofield, 'Perinatal mortality in Hawkshead, Lancashire, 1581–1710', *Local Population Studies*, 4 (1970), 11–16, esp. the table on p. 13. See also Roger Finlay, 'Distance to church and registration experience', *Local Population Studies*, 24 (1980), 26–40, which considers the effect of distance to church on the birth-baptism interval in a large parish like Hawkshead. Clearly Hawkshead was an unusual parish in registering the burial of 'abortives' at all, but it was also one rejected for further analysis, despite early promise, in E. A. Wrigley et al., *English Population History from Family Reconstitution, 1580–1837* (Cambridge: Cambridge University Press, 1997), 29, because it displayed a high degree of childlessness. Recent work by Chris Galley, 'On the stillbirth rate in early modern England', *Local Population Studies*, 81 (2008), 75–83, suggests an SBR of 45 (1618 stillbirths and 34 507 live births with a range 29–55 in 15 English parishes, 10 in London) covering various periods from 1578 to 1812. One of these parishes (Hackness, North Yorkshire), with an SBR of 50 (1631–60), reported stillbirths in remarkable detail. See Table 1.1 (on p. 6), and Donald Woodward, 'Some difficult confinements in seventeenth-century Yorkshire', *Medical History*, 18 (4) (1974), 349–53.

[58] Margaret Connor Versluysen, 'Midwives, medical men and "poor women labouring of child": lying-in hospitals in eighteenth-century London', in Helen Roberts (ed.), *Women, Health and Reproduction* (London: Routledge & Kegan Paul, 1981), 18–49, and Lisa Forman Cody, 'Living and dying in Georgian London's lying-in hospitals', *Bulletin of the History of Medicine*, 78 (2004), 309–48 discuss the work of the early lying-in hospitals in detail. Peter Razzell and Christine Spence, 'The history of infant, child and adult mortality in London, 1550–1850', *London Journal*, 32 (3) (2007), 271–92 reviews research on mortality in early modern London more broadly.

were both young and unmarried. There was, however, a third group: deliveries managed by the lying-in hospitals or associated charities that were domiciliary but assisted by midwives trained and employed by these organizations. The lying-in hospitals, and their domiciliary offshoots, were particularly good at recording the number of women delivered, stillbirths, infant deaths, and the deaths of mothers. Poor Law institutions were far more unreliable. Some of this evidence is summarized in Table 4.3. It must be read with particular caution.[59]

The scale of maternal mortality associated with the lying-in hospitals and the workhouses has been a matter of considerable debate among both contemporaries and medical historians. For example, Florence Nightingale's *Introductory Notes on Lying-in Institutions* (1871) discussed the statistics of lying-in hospitals and proposed some new recording conventions. Nightingale relied heavily on Léon Le Fort's great survey of international statistics, *Des maternités* (1866).[60] Loudon's modern interpretation of the data is clear. He concludes that 'no statistical tests are required to see that the differences in maternal mortality between the in-patient institutions and the out-patient charities (differences in MMR [per 10 000 live births or deliveries] between 100 or more and 30 or less) were highly significant', and, in general,

> [t]he evidence leaves little doubt that until the final ten or fifteen years of the nineteenth century, the safest way for a woman in London to be delivered, *regardless of social class*, was at home by a trained member of the staff of the Royal Maternity Charity or a trained midwife. The next safest was to be delivered at home by a private doctor and the next in the wards of a prestigious hospital such as Queen Charlotte's where the mortality was ten or more times as high as the Royal Maternity Charity.[61]

The substantial difference between in-patient and domiciliary deliveries in terms of maternal mortality is also suggested by Table 4.3, although it is possible that some of the subsequent maternal deaths of out-patients were not recorded by the charities, only those that occurred at or immediately following delivery.

However, none of these authorities gave much attention to the survival of the fetus. When one considers the evidence of Table 4.3 in relation to the stillbirth rate some unexpected points emerge. First, the workhouse rates are either far too low or remarkably high. Since most women giving birth in such institutions were young and unmarried, like Oliver Twist's mother, both they and their

[59] See F. Bisset Hawkins, *Elements of Medical Statistics*, ed. Richard Wall ([1829] London: Gregg, 1973), esp. ch. 7, pp. 120–5 on 'Statistics of lying-in hospitals, and of the still-born'.

[60] Florence Nightingale, *Introductory Notes on Lying-in Institutions* (London: Longmans, Green, 1871) and Léon Le Fort, *Des maternités*: *Étude sur les maternités et les institutions charitables d'accouchement à domicile, dans les principaux états de l'Europe: France, Autriche, Prusse, Russie, Angleterre, Belgique, Danemark, Hollande, Etats allemands* (Paris: Masson, 1866). Margaret DeLacy, 'Puerperal fever in eighteenth-century Britain', *Bulletin of the History of Medicine*, 63 (1989), 521–56 discusses the eighteenth-century hospital statistics.

[61] Loudon, *Death in Childbirth*, pp. 200–1, referring to tables 12.3–12.5, which summarize statistics on maternal mortality from the lying-in hospitals and charities.

Table 4.3. Mortality at the lying-in hospitals and charities: British Isles, eighteenth to twentieth centuries

	Women delivered	Total births	Stillbirths	Live births	Children dying	Women dying
British Lying-in Hospital, London						
1750–9	3 761	3 806	113 (30)	3 693	224 (61)	84 (223)
1760–9	4 862	4 919	132 (27)	4 787	238 (50)	95 (195)
1770–9	5 639	5 697	232 (41)	5 465	129 (24)	102 (181)
1780–9	5 549	5 620	293 (52)	5 327	129 (24)	89 (160)
1790–9	5 971	6 047	285 (47)	5 762	74 (13)	21 (35)
1750–99	25 782	26 089	1055 (40)	25 034	794 (32)	391 (152)
Dublin Lying-in Hospital						
1757–86	22 440	22 812	1131 (50)	21 681	3219 (148)	246 (110)
1787–93	10 787	10 874	580 (53)	10 294	421 (41)	124 (115)
1826–33	16 137	16 654	1121 (67)	15 533	284 (18)	164 (102)
1842–4	6 634	6 702	325 (49)	6 377	—	65 (98)
Westminster General Dispensary						
1774–81	1 897	1 923	84 (44)	1 839	—	—
1818	640	649	20 (31)	629	—	4 (63)
1818–28	12 478	12 762	302 (24)	12 460	—	25 (20)
Royal Maternity Charity, London, Eastern District						
1828–50	48 996	49 538	1823 (37)	47 715	—	220 (45)
1857–61	12 143	12 299	412 (34)	11 887	—	39 (31)
Liverpool Lying-in Hospital						
1842–5	339	341	18 (53)	323	—	1 (29)
University College Hospital, London						
1842–4	467	470	19 (40)	451	—	3 (64)
Liverpool Workhouse						
1868–70	1 416	1 445	195 (135)	1 250	—	6 (43)
Workhouses, 1871–80						
England and Wales	87 726	88 696	162 (2)	—	—	765 (87)
London	23 117	—	—	—	—	204 (88)
Liverpool	3 148	—	—	—	—	31 (98)
Manchester	2 265	—	—	—	—	39 (172)
Glasgow Maternity Hospital, 1897						
Hospital in-patients	—	447	67 (150)	—	—	—
Hospital domiciliary	—	1 502	125 (83)	—	—	—
West End Branch	—	394	17 (43)	—	—	
Edinburgh Royal Maternity Hospital, 1921						
Hospital in-patients		1 510	104 (69)	—	—	—
Hospital domiciliary	—	1 260	52 (41)	—	—	—
Hospital total	—	2 770	156 (56)	—	—	—
Edinburgh City total	—	9 028	432 (48)	—	—	—

Table 4.3. Continued

Note: The rates are given in brackets. The mortality rate for women (women dying/women delivered) is expressed per 10 000; the other rates for stillbirths (SBR) and children (children dying/live births) are per 1000.

Source: Derived from data in the following:
British Lying-in Hospital, London, 1750–99: William Heberden, *Observations on the Increase and Decrease of Different Diseases*, 39–41, table.
Dublin Lying-in Hospital (The Rotunda), 1757–86 and 1787–93: T. Percy C. Kirkpatrick, *The Book of the Rotunda Hospital: An Illustrated History of the Dublin Lying-in Hospital from its Foundation in 1745 to the Present Day*, ed. Henry Jellett (London: Allar, 1913), 114, table; see also for 1760–86: Ian Campbell Ross, 'Midwifery', in Ross (ed.), *Public Virtue, Public Love: The Early Years of the Dublin Lying-in Hospital, The Rotunda* (Dublin: O'Brien, 1986), 155, table; 1826–33: Robert Collins, *A Practical Treatise on Midwifery, Containing the Result of Sixteen Thousand Six Hundred and Fifty-four Births, Occurring in the Dublin Lying-in Hospital, During a Period of Seven Years Commencing November 1826* (London: Longman, Rees, Orme, Browne, Green and Longman, 1835), and Robert Collins, 'Observations on the periodicity of births, &c.', *Dublin Journal of Medical Science*, 10 (29) (1836), 197–204; 1842–4: Alfred H. McClintock and Samuel L. Hardy, *Practical Observations on Midwifery and the Diseases Incident to the Puerperal State* (Dublin: Hodges and Smith, 1848).
Westminster General Dispensary, 1774–81: Robert Bland, 'Some calculations of the number of accidents or deaths which happen in consequence of parturition; &c.', *Philosophical Transactions of the Royal Society*, 71 (1781), 355–71; 1818: Augustus Bozzi Granville, *A Report of the Practice of Midwifery, at the Westminster General Dispensary, During 1818* (London: Burgess and Hill, 1819), 20; 1818–28: Augustus Bozzi Granville, 'On certain phenomena, facts, and calculations, incidental to or connected with the power and act of propagation in females of the industrial classes in the metropolis; derived from the experience of two lying-in institutions, embracing a period of eleven years, during which upwards of 12,000 cases were carefully observed', *Transactions of the Obstetrical Society of London*, 2 (1860), 139–96 (Westminster General Dispensary, 1818–28, 7717 deliveries; Benevolent Institution, 1822–8, 4761 deliveries).
Royal Maternity Charity, London, Eastern District, 1828–50: Francis H. Ramsbotham, *The Principles and Practice of Obstetric Medicine and Surgery, in Reference to the Process of Parturition*, 5th edn. (London: Churchill, 1867), 734–5; 1857–61: Robert Barnes, unpublished casebook, 1857–68, Archives, Royal College of Obstetricians and Gynaecologists, London.
Liverpool Lying-in Hospital, 1842–5: Thomas H. Bickerton, *A Medical History of Liverpool from the Earliest Days to the Year 1920* (London: Murray, 1936), 217.
University College Hospital, London, 1824–44: Edward William Murphy, *A Report on the Obstetric Practice of University College Hospital, London* (Dublin: Hodges and Smith, 1844), 11.
Liverpool Workhouse, 1868–70: Florence Nightingale, *Introductory Notes on Lying-in Institutions*, p. 53. (Of the women delivered 67 per cent were unmarried and 20 per cent were aged 16–19.)
Workhouses (Poor Law Institution Infirmaries), 1871–80: F. J. Mouat, 'Note on the statistics of childbirth in the lying-in wards of the workhouse infirmaries of England and Wales for the ten years, 1871–80', *Transactions of the International Medical Congress, London, 1881* (London: 1881), 392–4. (There were 644 workhouses in England and Wales, with 30 in London, and 75 per cent of the women giving birth were unmarried.)
Glasgow Maternity Hospital, 1897: Robert Jardine, 'A year's work at the Glasgow Maternity Hospital', *Glasgow Medical Journal*, 50 (1898), 90–2. The West End Branch was an annex of the hospital in St Vincent Street.
Edinburgh Royal Maternity Hospital, 1921: J. W. Ballantyne, 'Ante-natal, intra-natal, and neo-natal death', p. 587.

babies would have been at especially high risk. Stillbirth rates in excess of 100 should not be surprising in this particular case. Second, as far as the lying-in hospitals and domiciliary charities are concerned the distribution of stillbirth rates matches reasonably well with the 20–60 guidelines, which is emerging as an informal rule. Certainly, the Dublin Lying-in Hospital (The Rotunda) appears towards the top of the range, but the other examples are not exceptional. Third, unlike the case of maternal mortality, it is far from obvious that there was a significant difference between the risk of having a stillbirth as an in-patient or an out-patient. There may be a tendency for the lying-in hospitals to fall towards the top of the range and the domiciliary charities towards the bottom, but there is not a clear and substantial gap between the two. On the basis of the evidence provided in Table 4.3, it appears likely that home delivery did not secure a distinct advantage as far as fetal survival was concerned and it is possible that stillbirth rates for the hospitals and charities may have reflected the experience of the 'normal' population.

Finally, an additional word of caution is required over the use of hospital statistics to reflect anything more general than the particular institutions themselves. The last example in Table 4.3 comes from the Edinburgh Royal Maternity Hospital for the year 1921.[62] The stillbirth rate of 48 given for the City of Edinburgh as a whole is based on the certification, rather than the registration, of stillbirths, but it is broadly in line with the rates available from 1939 onwards. The lowest stillbirth rate is for those delivered at home as part of a hospital-managed scheme (41); then come the deliveries at home or in private nursing homes that were independent of the hospital (44); and at the highest level we have the hospital in-patient deliveries (69). Sixty-nine per cent of deliveries were not associated with the maternity hospital and only 17 per cent of deliveries were to hospital in-patients. These 1050 deliveries were to particularly at-risk women, either because they were already being treated for other complaints, such as venereal disease, or because their circumstances made a home delivery unwise and they had been referred to the hospital by their doctor. These rates for 1921 cannot be compared directly with others in Table 4.3, even those for Glasgow in 1897, where mortality seems to have been especially high, although we lack a rate for the city as a whole. The selection process for in-patient delivery was very different from those operating in the nineteenth and eighteenth centuries.

The Bills of Mortality compiled for London provide information about the number of baptisms and burials, including age and sex, and the apparent cause of death.[63] The categories 'burials under 2 years', 'deaths in childbed'

[62] J. W. Ballantyne, 'Ante-natal, intra-natal, and neo-natal death: causes, pathology, and prevention, with special reference to ante-natal death', *British Medical Journal*, 2 (1922), 583–8. Alison Nuttall, 'Passive trust or active application: changes in the management of difficult childbirth and the Edinburgh Royal Maternity Hospital, 1850–1890', *Medical History*, 50 (2006), 351–72 analyses casebooks for 1850, 1870, and 1890, but, while illustrating the expansion of the in-patient service, does not separate stillbirths and neonatal deaths. J. M. Munro Kerr, 'The causes of stillbirth', *Glasgow Medical Journal*, 87 (1917), 283–91 reports that for the Indoor Department of the Glasgow Royal Maternity and Women's Hospital during the three months from December 1916 to February 1917 the SBR was 152 (312 deliveries, 56 dead-born) with about 60 per cent of stillbirths the 'result of diseases and complications of pregnancy' and the remainder due to 'complications of labour' (p. 284). See also Chapter 6, pp. 165–67. Edith L. Potter and Fred L. Adair, *Fetal and Neonatal Death* (Chicago, Ill.: University of Chicago Press, 1940, 2nd edn. 1949), 153–5 discuss some of their findings from the Chicago Lying-in Hospital in the 1930s and 1940s, but they were also not able to tell us anything about citywide rates. Ballantyne's study is particularly useful in this respect.

[63] William Heberden, *Observations on the Increase and Decrease of Different Diseases, and Particularly of the Plague* (London: Payne, 1801) and John Marshall, *Mortality of the Metropolis*

(broadly, maternal deaths directly associated with labour or occurring shortly after delivery), and 'abortions and stillbirths' are available from 1728, for infant deaths, and 1657. They offer the possibility of deriving estimates of the infant-mortality rate (burials under 2 years corrected to deaths under 1 year per 1000 baptisms inflated to births), maternal mortality (deaths in childbed per 10 000 baptisms inflated to births), and late-fetal mortality (abortions and stillbirths per 1000 baptisms inflated to births plus abortions and stillbirths, i.e. total births).[64] Columns 1, 3, and 5 of Table 4.4 illustrate what these rates might look like. The figures for London are set alongside equivalent rates for England based on family-reconstitution studies and, for 1825–49, partly on vital-registration data.

The infant-mortality rates for London based on the Bills are substantially higher than the England estimates. This is only to be expected, since post-neonatal mortality is liable to be excessive in urban as opposed to rural areas. What is surprising is that the London childbed-mortality estimates are broadly in step with the maternal-mortality rates for England. The stillbirth rates for London appear to be rather low, although each period falls within the 20–60 guidelines. For example, the SBR for 1750–99 was 35, while that for the British Lying-in Hospital was 40 (Table 4.3) for the same period, yet for 1775–99 the rates were 32 and 47. It seems quite likely that both the maternal and stillbirth series for London in Table 4.4 underrepresent the extent of mortality.

Table 4.4. Mortality estimates: London and England

	IMR London (1)	IMR England (2)	Childbed London (3)	MMR England (4)	SBR London (5)	SBR* England (6)
1700–24	—	195	137	134	35	56
1725–49	246	196	132	123	35	55
1750–74	238	170	120	95	37	50
1775–99	221	166	88	90	32	49
1800–24	171	144	73	63	23	44
1825–49	164	152	—	47	—	40

Note: The infant mortality (IMR) is per 1000 live births, the stillbirth rate (SBR) is per 1000 total births, the childbed-mortality and maternal-mortality rates (MMR) are per 10 000 deliveries or births. An asterisk is used to distinguish the best estimate of the stillbirth rate (SBR*).

Source: See Table 4.5 and Woods, 'Mortality in eighteenth-century London' (2006), p. 17, table 2, and p. 20, table 3. Columns 2, 4, and 6 are also shown in Table 4.5.

(London: Treuttel, Würtz, and Richter, 1832) provide contemporary guides and selections from the Bills. Andrea Rusnock, *Vital Accounts: Quantifying Health and Population in Eighteenth-century England and France* (Cambridge: Cambridge University Press, 2002) discusses the intellectual background to the quantitative movement of which the eighteenth-century Bills of Mortality were a part.

[64] The details of this estimation exercise can be found in Robert Woods, 'Mortality in eighteenth-century London: a new look at the Bills', *Local Population Studies*, 77 (2006), 12–23.

The final column of Table 4.4 requires special attention and explanation. It gives the best estimate of the stillbirth rate (SBR*) for England.[65] The other estimates and their base-mortality series are shown in Table 4.5. Earlier attempts to derive stillbirth rates employed either the early-neonatal-mortality rate (col. 2 in Table 4.5) or the endogenous-mortality rate (col. 3 in Table 4.5), to which

Table 4.5. Selected early-age-mortality, maternal-mortality, and estimated late-fetal-mortality (SBR) rates: England

	IMR (1)	ENMR (2)	Endo-genous (3)	MMR (4)	SBR1 (5)	SBR2 (6)	SBR3 (7)	SBR4 (8)	SBR5 (9)	SBR6 (10)	SBR* (11)
1580–99	177	64	78	123	115	116	67	55	55	77	55
1600–24	171	75	89	128	135	133	74	59	56	90	58
1625–49	157	69	80	140	123	120	70	57	58	83	58
1650–74	169	76	87	170	137	131	75	60	64	91	62
1675–99	189	78	88	156	141	132	76	61	61	93	61
1700–24	195	65	84	134	116	126	68	55	57	78	56
1725–49	196	63	81	123	113	121	67	55	55	75	55
1750–74	170	50	61	95	90	92	59	50	50	60	50
1775–99	166	47	53	90	85	79	57	48	50	56	49
1800–24	144	34	41	63	60	62	49	43	45	41	44
1825–37	152	23	33	47	41	50	42	39	42	28	40
1840–59	150	24	26	60	43	39	43	39	44	30	41
1930–9	62	22	23	39	40	35	41	38	41	26	40

Note: The infant-mortality (IMR), early-neonatal-mortality (ENMR, 0–6 days), and endogenous-mortality rates are per 1000 live births; the maternal-mortality rate (MMR) is per 10 000 birth events, and the stillbirth rate (SBR) is per 1000 total births. See text for an explanation of the methods used to estimate the SBRs.
SBR *estimates*
SBR1: ENMR × 1.8 (Hart's method)
SBR2: endogenous-mortality rate × 1.5 (Wrigley's implied method)
SBR3: ENMR × 0.6208 + 27.6889 (from 1931 cross-sectional relationship)
SBR4: ENMR × 0.3943 + 29.8160 (from 1931 cross-sectional relationship, English urban and rural districts only)
SBR5: MMR × 0.1740 + 33.9593 (from 1931 cross-sectional relationship)
SBR6: ENMR × 1.1945 + 0.1524 (WHO's method)
SBR*: 'best estimate' based on the average of SBR4 and SBR5, with the 1930s set at 40

Sources: *1580–1837*
IMR: Wrigley et al., *English Population History* (1997), p. 262, table 6.14.
ENMR and endogenous mortality: Ibid. 226, table 6.4.
MMR: Ibid. 313, table 6.29, col. 3.
1840–59, 1930–9
Based on Registrars General *Annual Reports* and *Annual Statistical Reviews* for England and Wales.

[65] Woods, 'Measurement of historical trends' (2005) discusses the estimation procedures in detail. It must be emphasized that arguing from a cross-sectional association to a longitudinal relationship is never ideal. The estimation results must be treated with caution and corroborated using rates from other sources.

they applied, respectively, the ratio of SBR to ENMR in 1931 (Hart's method) or the ratio of SBR to endogenous mortality also in 1931 (Wrigley's implied method).[66] The results, labelled SBR1 and SBR2, are shown in Table 4.5. Both of these series are remarkably high and fall outside our 20–60 guidelines. An alternative approach would be to allow the estimated SBR to vary with the selected base-mortality estimate and not to use a single, constant inflation factor (e.g. ENMR is simply multiplied by 1.8 in Hart's method). This is the approach adopted in the World Health Organization's report on *Neonatal and Perinatal Mortality* (2006), which is discussed above (pp. 86–89). The WHO estimates for countries in 2000 are based on judgements about the SBR/ENMR ratio and how it will vary as early-age mortality changes. Columns 7 and 9 in Table 4.5 show what results if one uses the cross-sectional relationship between the stillbirth rate and the early-neonatal-mortality rate (SBR3), and the stillbirth rate and maternal-mortality rate (SBR5) among the 234 administrative units of England and Wales in 1931 (see Figure 4.10, pp. 72–73).[67] Column 8 uses the relationship between SBR and ENMR found among 95 urban and rural districts of England in 1931 (i.e. excluding London, the county boroughs, and Wales). It could be anticipated that these geographical units will replicate more closely the associations between late-fetal and early-neonatal mortality to be found in earlier centuries. Column 10 in Table 4.5 shows the result of applying the WHO method to the early-neonatal-mortality rate in column 2.[68]

Before we consider the reliability of the estimates in Table 4.5 in more detail, it is necessary to look at the implicit assumptions that have permitted their derivation. For five of the series it has been assumed that 1931 provides a secure anchor point—that the structure of late-fetal and early-age mortality during the first census year after stillbirth registration began was consistent with the one operating in earlier centuries. Certainly, it is unrealistic to select a single-number inflation factor, but did the pattern of association between, say, late-fetal mortality and early-neonatal mortality persist over centuries? The evidence considered in Chapter 3 appeared to support the argument that there was a close link between the two components of perinatal mortality. Knowledge of one might be used to derive the other. This is also the position adopted by the WHO. The second difficulty relates to the reliability of the base-mortality series, and even the evidence

[66] Nicky Hart, 'Beyond infant mortality: gender and stillbirth in reproductive mortality before the twentieth century', *Population Studies*, 52 (2) (1998), 215–22, and E. A. Wrigley, 'Explaining the rise in marital fertility in England in the "long" eighteenth century', *Economic History Review*, 51 (3) (1998), 435–64. Wrigley does not give a precise figure for his inflation factor, but his hypothetical results suggest that it should be about 1.5. The derivation of endogenous-mortality estimates was discussed in Chapter 3, at pp. 35–41.

[67] The three regression equations for 1931 are: $SBR3 = 0.6208ENMR + 27.6889$ ($R^2 = 13.06\%$, $N = 234$), $SBR4 = 0.3943ENMR + 29.8160$ ($R^2 = 12.38\%$, $N = 95$), and $SBR5 = 0.1740MMR + 33.9593$ ($R^2 = 12.04\%$, $N = 234$).

[68] The regression equation for countries with SBRs of 20 and over in 2000 is $SBR = 1.1945ENMR + 0.1524$ ($R^2 = 99.78\%$, $N = 52$).

for 1931. While the broad outlines of past mortality patterns may be accepted, the detailed age components are still a matter for discussion, and maternal mortality has to be given special attention.[69] For example, Figure 4.16 illustrates the national time-series for maternal mortality (MMR) in conjunction with estimates for wives of members of the British peerage, for which there is believed to be especially good genealogical data. But since the number in observation at any one time is small, the two-standard-deviations range about the best estimate is shown as a shaded area. The peers' wives have been included because, like those delivered in the lying-in hospitals, they appear to have experienced higher levels of maternal mortality than the general population of pregnant women, and even the London population. The reasons for this remain a matter for debate.[70]

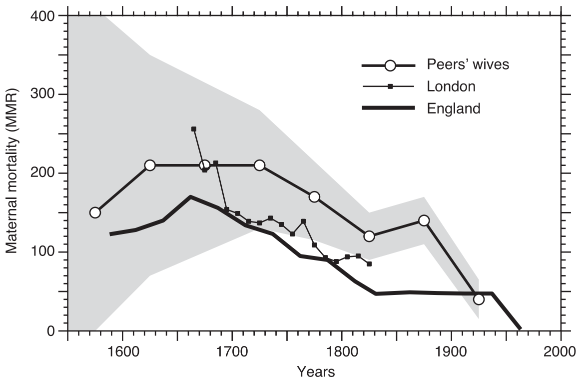


Fig. 4.16: Maternal-mortality (MMR) estimates: England, London, and British peers' wives.
Note: MMR: maternal deaths associated with childbirth per 10 000 deliveries or births. The range between +2 and −2 standard deviations round the best estimate for peers' wives' MMR is shown as a shaded area.

Source: Derived from: Wrigley et al., *English Population History* (1997), p. 313, table 6.29 (England); Loudon, *Death in Childbirth* (1992), p. 159, fig. 10.1 (London); Smith and Oeppen, 'Place and status' (2006), p. 73, fig. 4.7, (peers' wives).

[69] Wrigley et al., *English Population History*, ch. 6, pp. 198–353 is the most important summary, but see also E. A. Wrigley, 'British population during the "long" eighteenth century 1680–1840', in Roderick Floud and Paul Johnson (eds.), *The Cambridge Economic History of Modern Britain, i. Industrialisation, 1700–1860* (Cambridge: Cambridge University Press, 2004), 57–95, and Robert Woods, *The Demography of Victorian England and Wales* (Cambridge: Cambridge University Press, 2000), ch. 7, pp. 247–309. Maternal-mortality estimates are discussed in detail in Schofield, 'Did the mothers really die?', pp. 231–60, and revised in Wrigley et al., *English Population History*, pp. 307–22, where the problem of adjusting for stillbirths is considered. See also Table 1.1 (on p. 6).

[70] Richard M. Smith and Jim Oeppen, 'Place and status as determinants of infant mortality *c*.1550–1837', in Eilidh Garrett et al. (eds.), *Infant Mortality: A Continuing Social Problem* (London: Ashgate, 2006), 53–78 discusses these issues. T. H. Hollingsworth, *The Demography of the British Peerage*, supplement to *Population Studies*, 18 (2) (1964), esp. pp. 52–70 on mortality, outlines the

The simple conclusion is that although the base-mortality rates given in Table 4.5, columns 2–4 are not beyond criticism and may be subject to revision in the future, they are the best available national series for England.

The estimates presented in Table 4.5 show a range of possibilities. Which of the series is most likely to come closest to the true picture? All of the evidence that we have considered in this chapter points to the conclusion that we are unlikely to find stillbirth rates in excess of 60 in large populations during the nineteenth and twentieth centuries. What little we have from family-reconstitution studies and the statistics of lying-in hospitals for the seventeenth and eighteenth centuries does not contradict this view. This line of argument suggests that SBR4 and SBR5 provide the most realistic estimates.[71] Only these series capture plausible levels within, or generally close to, the 20–60 guidelines, and for this reason our 'best estimate' (SBR*), based on the average of SBR4 and SBR5, has been used in Table 4.4. In terms of trend, all the potential base series show increase through the seventeenth century to peak in the third or fourth quarters, followed by decline through the eighteenth century and stability in the nineteenth century. Only the infant-mortality rate peaks during the first half of the eighteenth century, but it too follows a hill-plateau-cliff sequence from the sixteenth to the twentieth centuries. SBR3, based on early-neonatal mortality, has the correct shape but is at too high a level. SBR6, which uses the WHO method, is too high in the late seventeenth century and too low in the 1930s.

However, a further problem is revealed when one adopts the WHO tactic of considering the ratio of SBR to ENMR and its distribution.[72] The WHO report considered unreliable ratios of less than 1 (i.e. SBR should be greater than ENMR) and used 1.2 as a minimum ratio for estimation purposes. Adopting such caution in this case would lead us to prefer SBR3 or to suspect that the ENMR series in Table 4.5 were too high. This problem will not be resolved until further direct evidence on late-fetal mortality can be gathered. As matters now stand, SBR* will be used to reflect the level and trend of stillbirth mortality in past centuries. It implies that late-fetal mortality in eighteenth-century England was at about the same level that it now is in several West African states, and close to the apparent position occupied by Wales in the 1930s. Figure 4.17 uses SBR* to illustrate the most likely pattern of long-term change in late-fetal mortality in England.

general pattern of life expectancy. Gutierrez and Houdaille, 'La mortalité maternelle', p. 980 shows that MMR was at about the same level in France during the eighteenth century, and that it declined there also. Wrigley et al., *English Population History*, p. 314, fig. 6.22 also emphasizes this point. The debate is taken up again in Chapter 7, at p. 198.

[71] It is worth recalling the case of Sweden, where SBR and MMR did not trend together between the 1750s and the late nineteenth century (Fig. 4.8, p. 68). Here maternal mortality would have provided a poor guide to late-fetal mortality. But then maternal mortality in England was rather different, as Loudon, *Death in Childbirth*, p. 159, fig. 10.1 has demonstrated.

[72] WHO, *Neonatal and Perinatal Mortality*, p. 95.

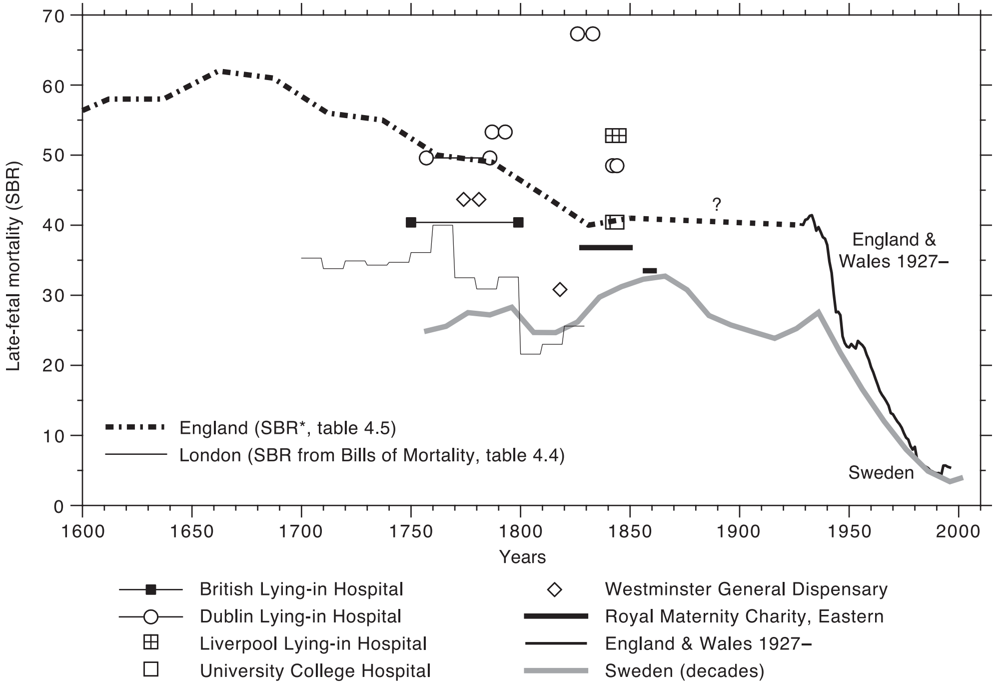


Fig. 4.17: Estimates of long-term trends in late-fetal mortality (SBR): England, 1600–2000.

Source: Tables 4.3, 4.4, and 4.5.

If, as seems likely, the stillbirth rate in England declined from 56 at the beginning of the eighteenth to 44 at the start of the nineteenth century, how might the split between antepartum and intrapartum deaths have been affected? Of course, we cannot be certain about an answer to this question, but, judging by the relationship sketched in Figure 3.7 (p. 54) for the UN world regions in 2000, we might expect intrapartum deaths to have declined from 41 to 38 per cent.[73] This would imply a 26 per cent fall in intrapartum stillbirths and an 18 per cent fall in antepartum stillbirths over the century. There is no indication that late-fetal mortality declined during the nineteenth century, although there could have been local and regional variations, just as there were in the 1930s.

[73] The percentage of stillbirths that are antepartum or intrapartum also depends on the critical gestational age that is used to define late-fetal deaths. For example, Ethel C. Dunham et al., 'Problem of the causes of stillbirth', *American Journal of Public Health*, 28 (4) (1938), 491–8 shows that for a large, hospital-based sample in the USA during 1936–7 the intrapartum percentage was 42 when 20 weeks LMP was used and 46 when 28 weeks LMP was adopted. They also indicate that the intrapartum percentage was 44 for whites and 33 for blacks. This study warns against making simple judgements about the proportion of intrapartum deaths one should expect.

Could direct obstetric deaths have declined by 26 per cent during the eighteenth century, and what would this tell us about the quality of midwifery available? Might late-fetal mortality have been lower in London, just as it was in the 1930s? These highly speculative questions cannot be tackled without exploring the history of midwifery from the eighteenth to the twentieth centuries—in particular, the ways in which birth attendants approached the risk of fetal death.

5

Midwifery and fetal death

Histories of midwifery have been written in many very different ways. The first studies focused on the people involved, their background and activities, and especially their publications. In most cases the result was more akin to a biographical dictionary than an account of changing practice.[1] In the twentieth century concerted efforts were made to write more analytical accounts containing judgemental observations on the state of practical knowledge and the skills of practitioners. For example, Herbert R. Spencer's 1927 history opens with the following: 'At that date [1650] British Midwifery was in an unsatisfactory condition and was conducted mainly by women, many of whom had not the education, knowledge or character requisite for its proper practice'.[2] Its sequel, which took the story to 1950, was a more carefully balanced committee effort dedicated to the celebration of success and progress.[3] Recent scholarship has moved in several different directions. First, there has been a particular concern with gender relations in midwifery; namely, the supposed conflict between women and men-midwives in the eighteenth century, with the former usurped by the attempts of physicians and surgeons to move into a potentially lucrative market. Second, interest in the history of women's bodies has had implications for work on pregnancy in the past by making it much more sensitive to the subject's perspective. Third, historians of morbidity and disease have given special prominence to maternal mortality, which has brought into closer scrutiny both antenatal and postnatal care. Fourth, the institutionalization of delivery during the second half of the twentieth century has exposed old tensions between obstetricians and midwives. Fifth, the changing contribution of medical science and technology still maintains a prominent position. In each of these examples differences of approach are also to be found between historians, sociologists, and

[1] James Hobson Aveling, *English Midwives, Their History and Prospects* (London: Churchill, 1872) and Heinrich Fasbender, *Geschichte der Geburtshülfe* (Jena: Fischer, 1906) are two important examples.

[2] Spencer, *The History of British Midwifery from 1650 to 1800*, Fitz-Patrick Lectures for 1927, delivered before the Royal College of Physicians of London (London: Bale, Sons, & Danielsson, 1927), 1.

[3] J. M. Munro Kerr, R. W. Johnstone, and Miles H. Phillips (eds.), *Historical Review of British Obstetrics and Gynaecology, 1800–1950* (Edinburgh: Livingstone, 1954).

members of the medical profession writing history. Conflict and achievement are not given equal space by all in each.[4]

Here we will take a different perspective, one that focuses on patient outcomes, with limited advances amid continuing failures for both fetus and mother. Of necessity, most of our knowledge of obstetric practice in the past comes from the accounts left by birth attendants, whether midwives, accoucheurs, or obstetricians. Many of these were published in the form of textbooks or case notes. They are, of course, not impartial accounts. Most authors in the eighteenth and early nineteenth centuries were male members of the medical profession who moved into midwifery as a full-time specialism, which they often combined with teaching courses, either in the universities or private schools. Many of the textbooks were derivative, lacking any obvious originality in either the scientific or literary spheres; but there were exceptions. These textbooks and case notes provide a wealth of information on the ways in which individual practitioners dealt with specific problems, and often they also mention the short-term outcome as far as the mother is concerned: died or survived. But here we will focus especially on the outcome for the fetus/infant. We need to establish how the midwives dealt with complicated cases, what high-risk deliveries they encountered, and what their failure rate might have been in terms of fetal death. This detailed evidence on individual cases may then be set alongside the other more generalized material considered in earlier chapters, but especially Chapter 4, where Table 4.5, illustrated by figures 4.16 and 4.17, established the best estimates of long-term change in English maternal-mortality and late-fetal rates. Although some specialists in the early nineteenth century did begin to tabulate their results, in this they followed the lead of a small number of pioneers in medical statistics reporting data from the Bills of Mortality or the lying-in hospitals; eighteenth-century accounts tend to be both descriptive and chronologically disjointed. They are also bound to be highly selective in that

[4] Just a few examples must suffice to illustrate these points. Arranged by date of publication, their emphasis is usually clear from the title: Jean Donnison, *Midwives and Medical Men: A History of the Struggle for the Control of Childbirth* (London: Heinemann, 1977); Adrian Wilson, *The Making of Man-midwifery: Childbirth in England, 1660–1770* (Cambridge, Mass.: Harvard University Press, 1995); Irvine Loudon, 'Review essay: The making of man-midwifery', *Bulletin of the History of Medicine*, 70 (3) (1996), 507–15; Karen Newman, *Fetal Positions: Individualism, Science, Visuality* (Stanford, Calif.: Stanford University Press, 1996); Bryan Hibbard, *The Obstetrician's Armamentarium: Historical Obstetric Instruments and their Inventors* (San Anselmo, Calif.: Norman, 2000); Mary E. Fissell, *Vernacular Bodies: The Politics of Reproduction in Early Modern England* (Oxford: Oxford University Press, 2004); Clare Hanson, *A Cultural History of Pregnancy: Pregnancy, Medicine and Culture, 1750–2000* (London: Palgrave, 2004), on literary theory; Helen King, *Midwifery, Obstetrics and the Rise of Gynaecology: The Uses of a Sixteenth-century Compendium* (London: Ashgate, 2007). Pam Lieske (ed.), *Eighteenth-century British Midwifery*, pt. I, vols. 1–4 (2007); pt. II, vols. 5–8 (2008); pt. III, vols. 9–12 (2009) (London: Pickering and Chatto, 2007–9) reprints in facsimile with editorial notes most of the literature on midwifery published in eighteenth-century England.

they cover the procedures and cases with which the author was most familiar or those that place him or her in a favourable light. The consulting midwife is often called in at the last minute when matters have obviously reached a crisis and the first-call midwife has not been able to cope. The resulting accounts incline to the heroic.

Clearly it is beyond the scope of this study to cover even a substantial minority of the midwifery texts published during the seventeenth, eighteenth, and nineteenth centuries. Instead, this chapter deals with some of the more important of those general works on midwifery, especially those that provided case notes, whether integrated in the text or as separate sections or even volumes, published in English. The case notes are especially important because they purport to give accounts of what the midwife actually did in specific cases and as such they differ from the standard textbooks, which offered advice to practitioners on what they should do. We are looking for examples of fetal death; of how miscarriages, abortions, and stillbirths were dealt with; how the dead fetus was recognized and removed; how potentially complicated cases (e.g. unnatural presentations, pre- or post-term labours, 'flooding', and multiple births) were dealt with. There is also a concern with the ways in which relationships were represented in the notes, especially among midwives, and between midwife and patient, midwife and fetus/infant. How were medical priorities defined and resolved? Finally, we would like to see how recommended practice and actual practice may have differed between midwives and how these might have changed over time. To this end the sections that follow take the 1750s as a defining point, dealing with midwifery accounts before and after those of Dr William Smellie (1697–1763). Smellie's *Theory and Practice of Midwifery* (1751) and his *Sett of Anatomical Tables* (1754) are so important that they demand to be treated separately and in more detail.

MIDWIFERY BEFORE 1750

Most midwifery textbooks had a chapter or two on fetal death. They did so for the obvious reason that the midwife would be required to extract the fetus or risk the death of the mother. However, it is surprising that even those books originally published in the sixteenth century also contained such instructions. For example, Eucharius Rösslin, who died in 1526, devoted two chapters of his *The Rose Garden for Pregnant Women and Midwives* to a discussion of miscarriage and of fetal death—with the latter including instructions on how to remove a dead fetus using hooks and tongs.[5] By the seventeenth century this convention

[5] Rösslin, *When Midwifery Became the Male Physician's Province: The Sixteenth Century Handbook* The Rose Garden for Pregnant Women and Midwives, *Newly Englished*, trans. with an introd. Wendy Arons ([1513] Jefferson, NC: McFarland, 1994), 80–93.

was all but routine. Percival Willughby (1596–1685) in his *Observations in Midwifery* states the following on abortion:

Pareus saith, that abortion, or untimely birth is one thing, and that effluxion is another. They call abortion the sudden exclusion of the child already formed, and alive, before the perfect maturity thereof. But that is called effluxion, which is the falling down of seeds mixed together, and coagulated but for the space of a few dayes, in the form of membranes, or tunicles, congealed blood, and of any unshapen, or deformed piece of flesh.[6]

And this on a case of fetal extraction:

I was sent for to Colton [near Derby, England] about the yeare 1654 to help a poor woman (Mercy Haywood) that had lien long in labour. The child was too great for the passage. I deferred the operation very long. And, when nothing prevailed to awaken the throwes, or to drive forth the child, (perceiving at the last, the child to bee dead) I drew it with the crotchet, and brought it away indifferent easily. Shee afterward recovered her health, and strength, and I saw her well in the yeare 1667; as also 1672, on 26 January.[7]

Although Nicholas Culpeper is best known as a herbalist—he styled himself 'Gent., Student in Physick and Astrology'—he also wrote *A Directory for Midwives*, which includes in its first part 'Book VI. Of Miscarriage in Women'.[8] Here there is an account of the signs of miscarriage, the causes of abortion, and their cure. Much of this is hopeless quackery, but there are some points of common sense. For example, here are some of the causes of abortion.

4. The Haemorrhoids or Piles many times cause Miscarriage.
5. Fat women, are subject to miscarry, by reason of the slipperiness of their wombs; and very lean women, for want of nourishment for the child in it.
6. Bleeding in the time she goes with Child.
7. Strong Purges are very bad, but Vomits wurse.

[6] Percival Willughby, *Observations in Midwifery* [c.1672], edited from the original MS by Henry Blenkinsop (1863), with a new introd. by John L. Thornton (Wakefield: S. R., 1972), 263. The manuscript was not published in English until 1863, although there had been a Dutch translation in 1754.

[7] Ibid. 88. Willughby's work has been discussed by Miles H. Phillips, *Percival Willughby, Gentleman: A Man-midwife of the Seventeenth Century*, Lloyd Roberts Memorial Lecture, delivered at St Mary's Hospital, Manchester, 14 November 1952 (Manchester: St Mary's Hospital, 1952), and 'Men-midwives of the past', *Bristol Medico-chirurgical Journal*, 52 (196) (1935), 83–102, as well as by Audrey Eccles, *Obstetrics and Gynaecology in Tudor and Stuart England* (London: Croom Helm, 1982). Willughby was educated at Eton and Oxford, and spent most of his life in practice in the Derby area. It is unfortunate that his manuscript was not published sooner, since, as Phillips and Eccles note, it contains much useful, practical information for midwives, including a set of 150 case notes.

[8] Culpeper, *A Directory for Midwives: or a Guide for Women, in their Conception, Bearing; and Suckling their Children* (London: Printed for H. Sawbridge at the Sign of the Bible on Ludgate Hill, 1675, 1684). Phillips, 'Men-midwives of the past' (1935), 87–8 is scathing about Culpeper's practical knowledge of midwifery. In the second part of his book Culpeper offered to cure all the diseases of women, doubtless the principal objective of this enterprise. See Fissell, *Vernacular Bodies* (2004), 135–56 on 'Culpeper's radical book'.

8. Great cold and heats, a Bath, and a hot house favour not the child in the womb; for they heat it so, that it labours to come out where 'tis cooler.
9. Hunger starves the child in the womb, surfeiting by much meat or drink strangles it.[9]

Two of the most influential midwifery texts to appear in late seventeenth- and early eighteenth-century England were translations from the French and Dutch. Dr Hugh Chamberlen translated François Mauriceau's 1660s text as *The Diseases of Women with Child, and in Child-bed*.[10] This is a serious and important textbook written by a famous surgeon/midwife and translated by a professional man-midwife. It lacks case notes, but it is thorough. After the introductory 'Anatomical Treatise' it is divided into three long sections: books I–III. 'Of Abortion, and its Causes' appears as chapter 24, the last in Book I, and 'Of delivering a dead Child' is chapter 31 of Book II. Mauriceau writes:

When a woman casts forth in the beginning what she had retained by conception in the Womb, 'tis called an Effluxion or sliding away of the Seeds, because they have not yet acquired any solid Substance; if they miscarry of a False-conception, which is ordinarily from the latter end of the first to the end of the second Month, it is called an Expulsion: but when the Infant is already formed, and begins to live, if it comes before the time ordained and prescribed by Nature, it is an Abortion; which may happen from the second to the beginning of the seventh Month, for afterwards it is accounted a Birth, because

[9] Culpeper, *A Directory for Midwives*, p. 113. Culpeper was not alone in having misguided views on abortion. *The Compleat Midwifes Practice* (London: Printed for Nathaniel Brooke at the Angell in Cornhill, 1656), by TC, ID, MS, TB, Practitioners, claimed that the south wind was 'a great enemy to women with childe, causing ofte times abortion in them' (p. 54). Immoderate laughing, crying, and anger were also dangerous. As for sexual intercourse while pregnant: 'In the first four moneths she ought not to lye with her husband, for that shakes and moves the fruite of the womb, and causes the flowers to descend; she must also abstain in the sixth and eight; but in the seventh and ninth it is not denyed, and is thought to facilitate the delivery' (p. 57).

[10] François Mauriceau, *The Diseases of Women with Child, and in Child-bed: As also best Means of helping them in Natural and Unnatural Labours. With fit Remedies for the several Indispositions of New-born Babes. To which is prefix'd an* Anatomical Treatise. *All illustrated with divers fair Figures, correctly engraven in Copper. A Work much more perfect than any now extant in* English; *and very necessary for Chirurgeons and Midwives practising this Art. Written by Francis Mauriceau, Translated by Hugh Chamberlen MD* (London: Printed for Andrew Bell at the Cross Keys and Bible in Cornhill, near Stocks Market, third corrected edition, 1697). Mauriceau (1637–1709) was the leading figure in French obstetrics during the seventeenth century. His *Traité des maladies des femmes grosses, et de celles qui sont nouvellement accouchées,* 2nd edn. (Paris: Chez l'Auteur, au milieu de la rue de Petits-Champs S. Honoré, à l'Enseigne du bon Medecin, 1675), *Observations sur la grossesse et l'accouchement des femmes, et sur leurs maladies et celles des enfants nouveau-nez* (Paris: Chez Jean Anisson, Directeur de l'Imprimerie Royale, rue S. Jacques, à la Fleur de Lis de Florence, 1694), and *Dernières observations sur les maladies des femmes grosses et accouchées* (Paris: Chez Laurent d'Houry, rue S. Severin; au Saint Esprit, vis-à-vis la rue Zacharie, 1708) are especially important. The *Observations* contains the case notes. *Aphorisms touchant la grossesse, l'accouchement, les maladies, et autres dispositions des femmes* (Paris: Chez Laurent d'Houry, rue Saint Jacques, devant la Fontaine S Severin, au Saint Esprit, 1694), and in English, *Aphorisms relating to the Pregnancy, Delivery, and Diseases of Women, Translated from the French by Thomas Jones, Surgeon* (London: Printed for the author [translator]; and sold by Mr Samuel Birt; and William Chase, in Norwich, 1739) is a pocket-sized book of dos and don'ts in midwifery.

the Infant being strong enough, and having all its Perfections, may then live, which is impossible, if he comes before. These things thus understood, we then say, that an Abortion is an issuing forth of a Child, yet imperfect, out of the Womb contrary to Nature before the Term limited; which is the Cause that for the most part it is dead, or if sometimes alive, it dies in a short time after.[11]

The causes of abortion are as follows: accidents; vomiting; 'reachings and endeavours' (constipation); 'cholicks and gripes'; flooding (e.g. 'separation of the afterbirth from the womb'); dropsy of the womb; 'the pox in the mother infects the child, and often kills it in her belly' (maternal syphilis); 'whatever very much agitates and shakes the big-bellied woman's body' such as 'great labour, strong contortions, violent motions of what manner soever, in falling, leaping, dancing, and running or riding, going in a coach or wagon, crying aloud, or laughing heartily, or any blow received on the belly'. Also 'if the woman be too straight-laced, or keeps in her belly with strong and stiff busks for to be well shaped' or if she engages in 'frequent copulation, especially towards the end of her reckoning' she may miscarry. Some causes relate to the fetuses themselves:

As when they are Monstrous, because they do not then follow the Rule of Nature; as likewise when they have an unnatural situation, which makes them torment themselves because of their troublesome or uneasy apartment; and they oblige the Womb to expel them, not being able to endure the Pains they cause which it also does when the *Foetus* is so great that it cannot contain it to full Time, nor the Mother furnish it with sufficient Nourishment.[12]

Mauriceau was also full of remedies and warnings. Of these, the most sensible recommends 'they that are subject to abortion, ought above all to take care, and keep in bed if they can, observing a good diet, and refraining copulation' while avoiding diuretics and 'violent passions of the mind'. Their dress should be kept loose, so they can breathe easily, and they should wear low-heeled shoes with large soles, to avoid falling over.

The chapter 'Of delivering a dead Child' offers advice on the operation required to deliver a dead fetus. A fetal death can be recognized by these signs:

[I]f the woman perceives it not to stir, nor hath a long time before; if she be very cold; much pain and heaviness in the bottom of her belly; if the child be not supported, but always falls like a mass of lead to that side on which the woman lies; if the burden or navel-string has been a long time in the world; and if no pulsation be there felt, and that dark and stinking matter comes away from the womb.[13]

All or most of these signs will confirm that the child 'is assuredly dead'. Once this has been established, the author advises that the fetus should be delivered feet first if possible (by rotation if necessary), but that if the head presents first

[11] Mauriceau, *Diseases of Women*, p. 104.
[12] Mauriceau, *Diseases of Women*, pp. 107–8.
[13] Ibid. 216.

(or it has become detached from the rest of the body—the subject of a separate chapter) then the surgeon should use the crotchet:

[H]e must . . . put it up as far as he can without violence, between the Womb and the Child's Head, observing to keep the point of it towards the Head, where he must fasten it, endeavouring to give it good hold upon one of the Bones of the Skull, that it may not slide, forcing in the point of it, which must be strong, that it may not turn; and after the Crotchet is well fixed in the Head, he may therewith draw it forth, keeping the ends of the Fingers of his left Hand flat upon the opposite side, the better to help disengage it, and by wagging it by little and little, to conduct it out of the Passage.[14]

Mauriceau knew full well that this was an extreme procedure to be used only when all other manual methods failed. He gave a clear warning:

Although the Chirurgeon be sure the Child is dead in the Womb, and that it is necessary to fetch it by Art, he must not therefore presently use his Crotchets, because they are never to be used but when Hands are not sufficient and that there is no other remedy to prevent the Woman's danger, or to bring the Child any other way; because very often, though he hath done all that Art directs, Persons present that understand not these things, will believe that the Child was killed with the Crotchets, although it had been dead three Days before, and without other Reasonings or better understanding of the matter, for recompense of his saving the Mother's Life, requite him with an Accusation, of which he is altogether innocent; and in case the Mother by misfortune should afterwards die, lay her Death also to his charge, and instead of Praise and Thanks, treat him like a Butcher or Hangman; to which divers Midwives are usually very ready to contribute, and are the first that make the poor Women, that have need of the Men, afraid of them. So much they are in fear of being blamed by them, for having themselves been the Cause (as some of them often are) of the Death of Infants, and many ill Accidents which after befall the poor Women, not causing them to be helped in due time, and from the very moment they perceive the difficulty of the Labour to pass their Understandings.[15]

Diseases of Women with Child contains many other interesting passages about the care of the mother and the newborn child, as well as the choice of a wet nurse.[16] But it is also important because of its illustrations and the role of its translator, who provided notes by way of commentary. Hugh Chamberlen was a member of the family responsible for introducing the obstetric forceps, although they were able to keep exact details of the instrument secret until the 1730s. The crotchet, as illustrated by Mauriceau, has a long blade with a hooked end. Chamberlen's notes are highly disparaging of the device, claiming that 'although this crotchet cannot hurt a dead child, yet it may endanger the woman by

[14] Mauriceau, *Diseases of Women*, pp. 218.

[15] Ibid. 219. See Lianne McTavish, 'Blame and vindication in the early modern birthing chamber', *Social History of Medicine*, 50 (2006), 447–64 on the blaming aspect of obstetrical treatises, especially the French examples.

[16] For example, Mauriceau recommended that the mother should not breast-feed for the first 8 days after birth (p. 295), and that wine and sugar were suitable for the first 4 days, but he also recognized that half of the infants died before they were two or three years old (p. 302).

slipping: wherefore the translator of this *Treatise* cannot approve of it, having an easier and safer way to do this operation', and 'those instruments are unsafe for the woman, and having a better way, cannot pass them without manifesting my dislike'. Controversy over the use of instruments continued through the eighteenth and nineteenth centuries, as we will see.

Mauriceau's *Treatise* also demonstrates several general points. It reflects the international aspect of obstetric knowledge and practice even in the seventeenth century, and it shows that the textbook writers were a disputatious group ever willing to seek advantage in their struggle with professional rivals. More specifically, it demonstrates that although there was a concern for the signs and causes of miscarriage, and a desire to find reasonable ways to deliver the dead fetus, the scientific basis of understanding was virtually non-existent and the practical surgical skills described were dangerously rudimentary. These observations apply equally well to the second example of a translated text: Hendrik van Deventer's *The Art of Midwifery Improv'd*.[17] This work also contained a chapter on delivering a dead child, entitled 'Of a difficult Birth, when the Child is dead', and made much of its new device, the extractor, which was said to be superior to Mauriceau's hooks and crotchets, including his *tire-tête* devise. However, Deventer was also highly critical of the excessive use of 'wounding' instruments, and the dangers inherent in not knowing whether the fetus was still alive. The illustrations in *The Art of Midwifery Improv'd* were, however, of a reasonably high standard, particularly their portrayal of fetal positions (pl. 4), although the English version lacked the clarity of the original Latin, or the French translation of 1739.

While both Mauriceau and Deventer had their admirers and were without doubt highly influential, two original English texts, which first appeared in the 1730s, made a distinctive impact on the development of midwifery. Both were books of case notes, one by a surgeon and the other by a woman-midwife.

William Giffard's *Cases in Midwifery* contains notes on 225 women attended during the late 1720s in London.[18] In most instances the labour had reached a crisis, the surgeon having been called in by a midwife, or a close relative, to complete the delivery. Flooding (haemorrhage), the fetus lodged in the birth canal, unnatural presentations (mainly breech (bottom first) and footling (feet first)), retention of the afterbirth, and multiple births were the most common problems. Often the intervention was successful—a combination of

[17] Deventer (1651–1724), *The Art of Midwifery Improv'd. . . . Written in Latin by Henry à Daventer. Made English. To which is added, a Preface giving some Account of this Work, by an Eminent Physician*, 1st edn. (London: Printed for E. Curll at the Dial and Bible, J. Pemberton at the Buck and Sun, both against St Dunstan's Church in Fleet Street, and W. Taylor at the Ship in Paternoster Row, 1716). Deventer and his contribution were introduced in Chapter 1.

[18] William Giffard, *Cases in Midwifery, Revised and published by Edward Hody, MD, FRS* (London: Printed for B. Motte, T. Wotton, and L. Gilliver, in Fleet Street; and J. Nourse, without Temple Bar, 1734). Giffard died in 1731; his case notes were arranged and published by Edward Hody (1698–1759).

skill, strength, and manual manipulation was required. But there were some mishaps:

Case LXIX

A Delivery of a Foetus *of about six Months; the Head was separated from the Body, and remained in the* Uterus.

May the 28th, 1729. The Mother of one Mrs C—h came to consult me for her daughter, who she told me was about six Months gone with Child, and that the Membranes were broke, and the Waters gone off some hours before: her Throws were gone off, and she had continual draining of blood. I thereupon told her she would miscarry, and the sooner all was brought away, the better. I went with the Mother, that I might by Touching make a better judgment than I could from hear-say. Upon my passing up two Fingers into the *Vagina*, I found one Foot of the *Foetus* slipped down beyond the *Os internum*, which I took hold of and drew gently towards me; but as it was rotten and very tender, it had like to have separated at the Ankle; but the flesh being ready to divide from the bone, I was almost afraid it would have separated at the Knee: and as I found some obstacle above, I immediately passed up two Fingers by the Leg already brought down, and found, as I before judged, that the *Os internum* was not enough dilated, that closely environed the Hips; wherefore I passed up one Finger between the Neck of the Womb and the *Foetus*, and dilated it so far as to make room for the Hips to pass, and by gently pulling that Leg which I had before brought down, drew it out to the Shoulders; but finding it stuck at the Head, I again passed up my Fingers, and found the *Os internum* closely environing the Head. I endeavoured with one Hand to dilate the Mouth of the Womb, and by pulling with my other at the Shoulders, I got out the Head beyond the *Labia Pudendi*; but as it was very tender and rotten, notwithstanding all my precaution and circumspection, the Head separated from the Body, and remained in the *Uterus*. I was now under some difficulty how to proceed; but having no Instruments with me, I immediately passed up my Hand into the *Vagina*, and the ends of my Fingers into the *Os internum*, which I gently dilated, and then thrusting them forwards in the *Uterus*, I tried to take hold of some part of the Head, and at length by pressing the end of a Finger against the upper part of the Head, I thrust it through the outer Teguments (they being very tender) into the Skull, and there bending it in the manner of a Hook, I drew the Head forwards, but with all caution imaginable; because the parts were so very tender, they were ready to separate upon the least pulling; but by this method I fetched the Head out of the *Uterus*. Afterwards I took hold of the *Funis Umbilicus* with one Hand, and passed the other through the *Vagina* into the Womb to the *Placenta*, which I found partly loose, and partly adhered, so that I was forced to separate it with the ends of my Fingers; and having drawn it out, the Flooding immediately stopped.[19]

We are not told the fate of the mother or why Giffard did not have his instruments with him. On another occasion they were available:

Case LXXVI

Two Births, where the Children presented their Heads, which stuck between the Bones of the Pelvis.

[19] Giffard, *Cases in Midwifery*, pp. 157–9.

About eight a'clock in the evening of the last-mentioned day [5 July 1729], upon my coming home from visiting a Patient at *Chelsea*, I was told a person was waiting for me, to carry me to his Wife, who was in Labour, and lived without *Bishopsgate*. For expedition sake I took Coach; and upon my coming the Midwife informed me that the Woman had been in Labour about 30 hours, and the Waters were run off several hours before I came, and that the top of the Head was sunk very low into the *Vagina*; but notwithstanding all the endeavours both of the Mother and Midwife, it could not be brought farther. Upon examination I found the top of the Head sunk so low, and the parts so stretched by it's bulk, that the *Labia* were kept at some distance from one another. At first I endeavoured with my Hands, by dilating the parts, and taking hold of the Head with my Fingers, to move it, and bring it forwards; but that not proving effectual, I had recourse to my *Extractor*. I passed up one side of it between the *Os Pubis* of the Woman, and the Head of the Child, and endeavoured to dislodge it from off the said bone, and bring it backwards towards the *Anus*. Not succeeding in that method, I passed and fixed my *Extractor* and immediately brought out the whole Head; the other parts readily followed, by my taking hold on both sides of the Head, and by gently pulling towards me. I then fetched the *Placenta* as usual. Upon examination of the Child's Head, I found a Tumour about the bigness of a Pigeon's egg, on it's upper part, arising, as I judged, from the Midwife's too rudely handling it, or it's lying so long locked between the bones. This Child was born alive, and well, but from the bruises from the pressure of the *Extractor*, had two or three small Impostumations in the Neck near to the Ears, and another upon one Check, all which in a few days after I opened with the point of a Lancet, and they were soon healed.[20]

Two other books written by surgeons and published in the 1730s are also worthy of note, because they illustrate rather different perspectives. Edmund Chapman's *A Treatise on the Improvement of Midwifery* was especially concerned with obstetric operations, ignoring anatomy and postnatal care.[21] It considered in detail the use of instruments in delivery: forceps, fillets, and crotchets. But it also gave advice on turning the fetus, on extraction, and on how to cope with haemorrhage. Thomas Dawkes, also a London-based surgeon, constructed his textbook, *The Midwife Rightly Instructed*, in the form of a dialogue between a surgeon and a woman-midwife.[22] These two examples indicate the versatility of authors in the early eighteenth century.

[20] Ibid. 179–80.

[21] Chapman, *A Treatise on the Improvement of Midwifery, Chiefly with regard to the Operation. To which are added Fifty-seven cases, selected from upwards of Twenty-seven years practice*, 2nd edn. (London: Printed for John Brindley, at the King's Arms in New Bond Street; John Clarke, under the Royal Exchange; and Charles Corbett, at Addison's Head against St Dunstan's Church in Fleet Street, 1735). Chapman practised as a surgeon in Orange Street, Red Lion Square, London. See Hibbard, *Obstetrician's Armamentarium*, esp. pp. 199–212, 219–33, on the development and popularity of these instruments. Chapman, Giffard, and Mauriceau were the subject of an attack over their use of instruments by the surgeon and Fellow of the Royal Society John Douglas. His *A Short Account of the State of Midwifery in London, Westminster, &c.* (London: Printed for and sold only by the Author in Lad Lane near Guildhall, 1736) was highly critical of the too-ready use of such devices, although while attacking the 'impudence and ignorance' of the 'Doctor midmen' it also advocated the proper training of 'midwomen'.

[22] Dawkes, *The Midwife Rightly Instructed: Or, The Way, Which all Women desirous to learn, should take, to acquire the True Knowledge and be Successful in the Practice of, the Art of Midwifery.*

However, Sarah Stone's *A Complete Practice of Midwifery* is even more interesting, because it provides instruction for midwives by a woman with considerable practical experience, and it is in the form of case notes.[23] Although the introduction mentions a course of anatomy derived from dissecting the dead, Stone learnt most of her midwifery from her mother, Mrs Holmes, with whom she trained for six years prior to practising in Bridgwater and Taunton, Somerset, then Bristol, before finally moving to London. She was especially critical of ignorant woman midwives 'for their want of knowledge when to assist a woman' as well as 'young-pretender man-midwives and their over-eager use of instruments'. She also blames the employment of women in the Taunton domestic woollen industry for 'many wrong births and bad labours'. Stone's purpose in writing her text is set out clearly in an address to the Queen:

> Your Majesty's tender regard to our Sex's modesty, makes a Treatise of Midwifery implore Your Royal Protection; the practice of which is generally so little understood by Women-Midwives, especially in the Country: where tho' the Women are commonly more robust, and pure Nature in great measure assists, the least difficulty has frequently baffled the Midwife's judgment, and she often forced to send for a Man; when the Labour has been no more than a common Case, as a Child's pitching wrong, and there's another misfortune, that 'tis rare to find in the Country, Gentlemen that are grave and old experienced Practitioners; which forces our Sex to submit to every boyish Pretender; by which our modesty is exposed, and the Midwife's reputation hurt: to prevent which (as far as in my power) I resolved to publish some Observations in my Practice; in hopes they'll prove instructive to some Women Midwives, especially those of the lower class.[24]

Although there is no indication as to how Mrs Stone selected her cases for publication, it is clear that in all but a handful the mother survived, even flourished, after her intervention. But in a substantial minority of cases the infant

Written principally for the Use of Women (London: Printed for J. Oswald, at the Rose and Crown in Poultry, near Stocks Market, 1736).

[23] Stone, *A Complete Practice of Midwifery. Consisting of Upwards of Forty Cases or Observations in the valuable Art, selected from Others, in the Course of a very Extensive Practice. And Interspersed with many necessary Cautions and useful Instructions, proper to be observed in the most Dangerous and Critical Exigencies, as well when the Delivery is difficult in its own Nature, as when it becomes so by the Rashness or Ignorance of Unexperienced Pretenders. Recommended to All Female Practitioners in an Art so important to the Lives and Well-Being of the Sex* (London: Printed for T. Cooper, at the Globe Paternoster Row, 1737). Isobel Grundy, 'Sarah Stone: enlightenment midwife', in Roy Porter (ed.), *Medicine in the Enlightenment* (Amsterdam: Rodopi, 1995), 128–44 provides an essentially literary commentary stressing 'Stone's contextualizing of birth practices' (p. 131). The same can be said of Ernelle Fife, 'Gender and professionalism in eighteenth-century midwifery', *Women's Writing*, 11 (2) (2004), 185–200, which compares the 'circular discourse' (emotional, concerned) of the women-midwives, Stone included, with the 'linear discourse' (scientific, objective) of the men, William Smellie included. Given the unique nature of her case notes it is surprising that medical historians have not paid them more attention. See also Isobel Grundy, 'Stone [née Holmes], Sarah (*fl.* 1701–1737), midwife', *Oxford Dictionary of National Biography* (Oxford: Oxford University Press, 2004).

[24] Stone, *Complete Practice of Midwifery*, p. vi.

was dead-born and Stone's task was to save the mother. In her 43 observations there were 4 maternal deaths, 49 births, including two sets of twins, with 19 fetal deaths, plus 8 neonatal deaths. The extent of fetal wastage should not be surprising, nor should the reasons. In many cases the presentation of the fetus was 'wrong' or unnatural. Ordinary midwives found it very difficult to deliver in situations where an arm came first. This inevitably led to delay, and often the infant was born dead, presumably caused by asphyxia. Stone was able to turn the fetus in several cases and certainly she prided herself on the speed with which she could deliver women whose lives were in danger. She criticized midwives for trying to hasten the onset of labour before due time and for being slow to deliver once it had begun. She examined her patients by touching, used her fingers to accelerate dilation, favoured giving birth in bed (rather than standing, crouching or sitting), and she was not afraid to request the additional services of a physician or surgeon. Where she could not deliver a fetus whole, she was careful to establish that death had occurred (by checking for a pulse in the umbilical cord, for example), and to dismember the body with the minimum of force. The only instrument mentioned as being used is a penknife, although the lack of an incision knife is noted. Stone often mentions the longer reproductive history of her women, particularly their experience of miscarrying. Her advice to keep quiet and to avoid straining if costive was all she could suggest to prevent the violent haemorrhaging that accompanied the loss. Table 5.1 summarizes the cases and their outcomes.

Table 5.1. Summary of the cases reported by Sarah Stone and published in 1737

Observations: 43
Women delivered: 47
Fetuses: 49 (including 2 sets of twins)
Live births: 30
Neonatal deaths: 8
Fetal deaths: 19 (2 miscarriages, 17 dead-born)
Maternal deaths: 4 (including 1 from smallpox)
Of the 19 live births in which the infant and mother survived, the following reasons were given for calling in Mrs Stone: infant stuck on the share-bone (pubic bone, anterior section of pelvis) 5; infant 'came wrong' 6 (of which 3 face, 1 breech, 1 knee, 1 arm); flooding (haemorrhage) 2; helped mother to pass water 1; administered glyster (enema) for constipation 1; warned against straight lacing of corset 1; warned not to advance labour 1; fallen mouth of womb 1; long labour 1
Of the 8 neonatal deaths: 2 sets of twins; tumour 1; flooding and premature 1; flooding and short navel-string 1; premature 1
Of the 19 fetal deaths: delivered arm first 5; shoulder 2; breech 2; 'wrong' 1; premature 2; flooding 2; dropsy 2; putrefied 2; long labour, dead sometime 1 (1 breech birth was strangled by long navel string)

Note: In several cases more than one reason or cause of death was mentioned.

Source: Stone, *Complete Practice of Midwifery* (1737).

Five of Stone's observations have been selected to illustrate the ways she dealt with problem cases, usually where the first-call midwife could not manage.

Observation III

The Delivery of a Woman in a violent Flooding, and her Child dead

I was soon after sent for to Petherton, two miles from Bridgwater [Somerset], to a Taylor's wife. When I came to her she was lying on the bed speechless; for she had flooded in so violent a manner, that she never stained a Cloth at, or after, her Delivery. When I had stated her dangerous Case, I touched her: the *Secundine*, I found, presented first; but Searching further, found the Waters not gone; wherefore having two beds in one room, I ordered the other to be ready to receive her; so breaking the Waters, the Child's head presented: but she being faint by prodigious loss of blood, I examined for the Feet; which in searching for, I found the Navel-string without the least Pulsation; a plain demonstration the Child was dead. However, I found the Feet with less Difficulty than I sometimes have, and delivered her in less than fifteen minutes of a large boy, who, by all circumstances, had been dead about eight hours; which, no doubt, happened through her great loss of blood. As soon as I had delivered her of the Child and After-Birth (assisted by the Women) we laid her in the other bed. It was a full hour before she spoke; when she recovered her spirits she declared, she remembered not anything of her being delivered. She lived and did well: for riding that way about five weeks after, I called to see her, and found her out of danger, but weak, and her legs inclined to swell, which is common in such cases: but this was soon removed, by taking a few doses of proper Physick, when capable of receiving it. It was 5 months before she recovered strength enough to stir abroad; though had the Midwife had judgment to have delivered her, as soon as she fell into such Floodings, the Child's life might have been saved, and the mother preserved from extreme danger; besides the expenses that such weak Lyings-in occasion, which are very chargeable to poor people.[25]

Observation X

The Delivery of a Woman, whose Child had been dead four Months, and not Putrified

In Taunton, a Smith's wife, being a washer-woman, desired my assistance when she should want it. She told me, she had not felt the child, since she quickened, for a month. For hanging some clothes on a line to dry, it being out of her reach, she felt a prodigious motion of her child, and never felt it afterwards. Her reckoning being almost out, she desired my assistance; (if she was with child?) I told her, I did not doubt but she was; but 'twas my opinion the child was dead from that time. She showed me her breasts, which were as full of milk, as if she had been a nurse. She was obliged to milk them twice a day; and never milked less than half a pint a day, out of each at a time . . . She went a month beyond her reckoning, and then she had several pains. That day she sent for me in the evening: I touched her, and found her water sunk without the neck of the womb: the skin that retained it was so very thin, that with the least touch it broke. I received some of the water in my hand, found it very clear, and without the least putrid smell; which I wondered at: it being usual when a child is dead to be offensive. Her pains being trifling, and the Matrix lying high, and out of my power to reach, I ordered her to bed,

[25] Stone, *Complete Practice of Midwifery*, p. 5.

and to continue there till her Pains grew stronger: which being done, about four in the morning, she sent for me. I then found her in stronger pains; she said they were not like the bearing pains she used to have with her former children. I found the child presented with its breech foremost, and brought it off in a little time: but the burden adhered so close to the Matrix, I was obliged to peel it off, in the manner you would the rind from a young tree. And, what is worth observation, the burden was at least two inches thick, but full as pale as the lungs of any animal. 'Tis, therefore, plain, that although the child was dead, yet that grew more than in a living child. The woman did exceeding well, and was capable of washing in three weeks time. When the child was born, the navel-string was seven times round the neck: which palpably shows, as the mother was throwing a sheet over a line, the sudden jerk occasioned the child being strangled with the navel-string, the child being whole and entire, without the least putrefaction; notwithstanding it had been dead at least four months: an instance I never met with in all my practice. I wish this may be a warning to all women with child, to take care not to over-reach themselves; that being often the loss of many infants, as well as mothers.[26]

Observation XXVII

The Delivery of a Woman whose Child was dead, being very sillily managed Six Weeks before her Time

In Paul's Street [Taunton], I was sent for to a woman that thought herself in labour; but I told her the pain she had was the cholick. I ordered her something to take, and advised her to go to bed. I went home, it being after ten at night. I sent the next morning to know how she did: her mother sent me word she had a good night, and was then asleep . . . I was sent for to a gentlewoman in the country on a miscarriage that morning, where I remained that day. In the afternoon the woman was seized with the cholick again: her husband came for me; but I being with the gentlewoman, they got another midwife. I came home about six in the evening, and went to see how the woman did. Her husband met me at the door, and told me that not being at home, he had got another midwife; and that his wife was like to be delivered in a little time. I said I was sure 'twas impossible. I went home without seeing the woman, but sent three times that night, to know how she was; the constant answer was, she was on the pinch of delivery. I heard nothing of her for three days after; and then I was told the poor woman was not delivered. The news did not surprise me, I being well assured her time was not expired; nor her pains, when I was with her, the least tending to labour. I immediately went to see her, and found her in a very low condition; her midwife and women with her. They told me they had been with her all that time: her eyes were swelled with weeping; her midwife having told her, she thought she could never be delivered. I asked the reason, why she kept the woman so long in hand? She said, because God's time was not come: I told her, I then thought she had no business with her. The reason she gave for trying to deliver her, was because she had pains. I touched the woman, but found not the least symptoms of labour, only the birth extended and swelled, through the ill usage and ignorance of the midwife. I ordered her to be put to bed, and gave her things to ease her pains, which had been much increased by ill management. I bid them keep her in bed three or four days, till all her pains were gone. I ordered fomentations for the parts swelled. She went six weeks after

[26] Stone, *Complete Practice of Midwifery*, p. 29.

this, in which time I often saw her: she continually complained of a constant motion of the child, which made her so weak from want of rest, that she was incapable of doing any business. At the six weeks end she sent for me, about eight of the clock at night, and told me she had pains; but had not felt the child for two days. I touched her, and told her it would be her labour; but I could be no ways serviceable to her till morning. I bid her keep in her bed till her pains come stronger, which she accordingly did; and about nine the next morning she sent for me again. About eleven o'clock I delivered her of a boy, which, I believe, had been dead the whole time that she had not felt it. It was like a skeleton, covered with a beautiful white skin; but the bones and ribs plainly appeared through the skin. It was exceeding tall. I doubt not but the child being disturbed before its time, was the cause of its continual stirring; and, consequently, of its extreme thinness and death . . . This Observation I have set down to caution those professing the art of midwifery, to be well assured of a true labour, before they begin their work.[27]

Observation XXIX

The Delivery of a Woman being seized with Smallpox, and brought in Labour before her Time

I was sent for to North Curry [Somerset], to a woman that had been in labour two days and one night; but in no more likelihood of being delivered, than when her midwife was first with her, as she told me; although she had been in strong pains ever since, and in a high fever. I touched her, and found it not a natural labour: but being kept so long in hand endeavouring to procure a delivery, the waters were gone, and part of the child's head bare. The child being dead, I thought it proper to use my utmost endeavour to deliver her, which I accordingly did, and in a short time brought off the secundine. It was very whole and sound; but after her delivery she complained of a violent pain in her back, and said she was almost as bad now as when in labour. I considered what might be the reason for her complaint, knowing she was safely delivered; I was satisfied her pangs could not proceed from her labour. I asked her, if she had ever had the smallpox? She told me no; and that she had been six miles from home, and in the house where she lay there was a person in the smallpox, who surprised her very much: 'twas three days before she fell ill: she said she had six weeks longer to reckon. I ordered her husband to send for a physician, for by her violent fever, and light-headedness, she was in great danger of life; and so it proved: for she did not live above eight and forty hours, but died delirious. Her daughter-in-law came to me after she was buried, and told me she was prodigiously full of the smallpox and purples; and that it was the opinion of the physician, had they sent for him at first, when she sent for the midwife, both she and the child might have been preserved: for her midwife, whilst with her, had given her strong waters, and her husband's water with the juice of leeks, and other things of the same nature, keeping her out of her bed; all which management increased her fever, and forced her labour; though all her pains at first were only symptoms of the smallpox.[28]

Observation XXXVI

The Delivery of a Woman who of her former Children had injured herself by too Strait Lacing

A farmer's wife that lived two miles in the country, came to speak with me, and told me, she had four months to reckon, though, by her bigness, I thought she could not have

[27] Stone, *Complete Practice of Midwifery*, p. 87. [28] Ibid. 94.

one; but she told me, she was sure it was so. I then told her, I feared she laced very tight; she said it was what she was advised to by her midwife, and acquaintances in the country. I answered, it was a great error, and that she ought to give herself all the liberty possible; she seemed very much rejoiced, for she said she was usually sick, and fainted three or four times a day. She begged I'd let her husband hear my opinion; for of her two former children she was in labour a week each child, and both dead born, which the women told her husband was owing to her not lacing straight enough. Her husband returning to my house in about half an hour, I told him the advice I had given his wife, but that she did not incline to follow it without his approbation. He immediately acquiesced to what I said, and desired her to lace moderately the rest of the time, he declared it was a great concern to him to see her in those fainting fits; but that his greatest desire being to have a child alive, made him persuade her to bear her lacing. I cannot imagine what advantage any woman can receive from severe lacing; but, on the contrary, have known it very injurious, especially to such short women as this was; for the Pelvis in such being much shorter, of consequence must be less than in tall women; and were they lace below the *Os Pubis*, they could not walk. So that all the room above the Share-bone being little enough to contain a child, certainly such people as do advise straight lacing, never saw a woman opened, undelivered; if they had, they could not be of that opinion, but advise them rather to wear no stays; for to see in what little room the bowels are confined, and especially when the child is very large, it is astonishing that women and children do well; what can be said for it is, the omniscient that formed us in the womb, hath ordered it so . . . According to the woman's reckoning, about four months after, I was sent for about ten at night, and finding her up, ordered her to bed; she asked me, what she should do there, for she never went to bed when in labour in her life? However, she agreed to be ruled by me, and went to bed. About eleven o'clock, I sat down by her, and found my assisting her, (in putting my two fingers just within the entrance of the *Uterus*) strengthened her pains, and with every pain brought it forward to the *Os Pubis*. Her child proceeded very fast, for by this method I am always capable of strengthening and lengthening a woman's pains, if in true labour. About twelve of the clock, she began to be very impatient, and desired to rise, but was no sooner up, than she begged to go to bed again. I told her, if she would go to bed again, there she must be delivered; and accordingly, about one o'clock I laid her in a proper posture for that purpose, and, (by the before-mentioned method of bringing the mouth of the Matrix, above the *Os Pubis*, with every pain, till the child's head was quite clear from it) I delivered her, in about an hour, of a son, a very stout child, and alive . . . have endeavoured to be very plain in this Observation, that if readers possessing the art of midwifery have the least genius, they may soon arrive to be great proficients in this art.[29]

Although Sarah Stone's account from the woman-midwife's perspective is not unique, it is certainly most unusual, and exceptionally valuable. Jane Sharp's *The Midwives Book* (1671) lacks the detailed case notes on deliveries made, and the outcomes for mother and baby, while Catharina Schrader's diary and memoirs were not published until 1984.[30] The style of Stone's account is far closer to

[29] Stone, *Complete Practice of Midwifery*, p. 126.

[30] Jane Sharp, *The Midwives Book. Or the whole Art of Midwifery Discovered* (London: Printed for Simon Miller, at the Star at the West End of St Pauls, 1671), ed. Elaine Hobby (New York: Oxford

Schrader's, since both comprise selected case notes where the emphasis is on the business of midwifery: how to have a labour that is safe for the mother and produces live-born infants. But the Dutch midwife deals with far more cases in much less detail, and she is writing a largely personal document for her own record, not to instruct the wider profession of midwives.

The last major text to appear before the start of Smellie's publishing enterprise was *An Essay Towards a Complete New System of Midwifery* by Dr John Burton.[31] Burton's account, addressed principally to male members of the medical profession, was based round 32 observations and 18 illustrations. The subject of fetal death was considered, as usual:

Observation VIII

A Lady at Some Distance from hence (*York*), who had been so subject to repeated Miscarriages, as never to go beyond the fifth Month, did, by proper Medicines and Fare, go on to her full Time, When she fell into Labour; and every thing promised very well, till the Midwife, eager to shew her Dexterity, and to bring an Heir (the Estate being entailed) forced the *Os Uteri* over the Head too soon, and the Child stuck at the Shoulders; it breathed, and made some faint Cryings or Noise as the Midwife was teizing it with her Hands: In this Situation the Child remained for some Hours, during which the Midwife frequently tormented the poor Lady, till at last she was forced to give over; when, with

University Press, 1999); Hilary Marland, *'Mother and Child Were Saved' The Memoirs (1693–1740) of the Frisian Midwife Catharina Schrader*, trans. and annot. Marland, with introductory essays by M. J. van Lieburg and G. J. Kloosterman (Amsterdam: Rodopi, 1987). The Dutch edition was first published in 1984; it has nearly 3000 cases, from which 122 have been selected for the English edition. The German midwife Justine Siegemund (1636–1706) produced a text (1690), which is written in the form of an instructional interview between two midwives (see Justine Siegemund, *The Court Midwife* [1690], trans. and ed. Lynne Tatlock (Chicago, Ill.: University of Chicago Press, 2005)). McTavish, 'Blame and vindication' discusses the work of three seventeenth-century French midwives: Louise Bourgeois, Marguerite de La Marche, and a Mlle Baudoin. Laurel Thatcher Ulrich, ' "The living mother of a living child": midwifery and mortality in post-revolutionary New England', *William and Mary Quarterly*, 46 (1) (1989), 27–48 analyses the work of a New England midwife from her diary, but like the others there is very little detail on her cases.

[31] Burton, *An Essay Towards a Complete New System of Midwifery, Theoretical and Practical. Together with the Descriptions, Causes, and Methods of Removing, or Relieving, the Disorders peculiar to Pregnant and Lying-in Women, and New-born Infants. Interspersed with Several New Improvements; Whereby Women may be delivered, in most dangerous Cases, with Ease, Safety, and Expedition, than by any other Method heretofore practiced: Part of which has been laid before the Royal Society at London, and the Medical Society, at Edinburgh; after having been perused by Many of the most Eminent of their Profession, both in Great Britain and Ireland; by whom they were greatly approved of. All Drawn up and Illustrated with Several Curious Observations, and Eighteen Copper-Plates* (London: Printed for James Hodges, at the Looking Glass, facing St Magnus' Church, London Bridge, 1751). John Burton (1710–71) was a well-known York physician and man-midwife, a Tory sympathetic to the Jacobite cause in the 1740s, and, most famously, the basis for Dr Slop in Laurence Sterne's *The Life and Opinions of Tristram Shandy, Gentleman* (1759–67). Here Dr Slop is satirized as a squat papist, an obstetric pioneer who promotes the use of forceps whenever possible. Sterne's wife, Elizabeth, had a long history of unsuccessful pregnancies and deaths in infancy (see W. H. Allport, 'Tristram Shandy and obstetrics', *American Journal of Obstetrics*, 65 (1912), 612–17, Alban Doran, 'Burton ("Dr Slop"): his forceps and his foes', *Journal of Obstetrics and Gynaecology of the British Empire*, 23 (1913), 3–24, 65–86, and R. W. Johnstone, *William Smellie: The Master of British Midwifery* (Edinburgh: Livingstone, 1952), 91–7).

proper Assistance, the mother was safely delivered of a dead Child, evidently strangled. Had this Midwife left the Whole to Nature, the Child's Head, by pressing against the *Os Uteri*, would have gradually dilated it, so as to have permitted the Shoulders to follow with Safety, for the Child was very well proportioned every Way. I speak this from repeated Instances, where I have been sent for to deliver Women with the Child's Head thus advanced; when, upon Strict Enquiry, I found the Midwife boasting how soon and dexterously she managed to get the Head out of the Womb, but was surprised what hindered the rest from following.[32]

In Observation XXIII Burton recounted how he had treated a woman who had miscarried seven times. He examined her four-month-old aborted fetus, established that it seemed healthy and concluded that the problem must lie with the woman herself. He prescribed mild opiates and 'gentle Corroborants with Stomachies, which agreed very well with her', and he reduced the amount of blood taken from the woman from 12 ounces in earlier pregnancies to four ounces, concluding that her 'pulse would not bear the loss of such a quantity'. The result was a live birth. But it was the midwives' lack of patience, their ignorance and incompetence, which provided his constant themes:

Observation XVII

A Lady not far from hence (*York*) is a remarkable Instance of a sad Piece of Cruelty and Ignorance in the Woman-Midwife: I was Sent for to her about the latter End of the great Frost in 1740, three Days after she was delivered; she complained of some Injury she had recurred from her Midwife, and that her Urine dropt from her constantly; upon Examination I found Part of the *Vagina* torn away, and along with it a Piece of the Bladder almost as big as a Crown-Piece; upon Enquiry, I found the Midwife had mistook the *Prolapsus Vaginae* for the Edge of the *Placenta*, and had with all her Force, tore it away.[33]

Many aspects of Burton's book are unremarkable, but this cannot be said of the illustrations, which are by the anatomical artist George Stubbs (1724–1806). In his twenties Stubbs is said to have dissected the body of a pregnant woman who had died before childbirth. His illustrations of fetal positions for Burton's text, some of which are rather imprecise, even crude and slightly absurd, relate to this experience. They are at least realistic, not hypothetical or stylized in the way that earlier anatomical drawings were.[34] Burton achieved some additional notoriety later in his career by his attack on William Smellie's first book.[35]

The history of obstetrics before Smellie is a curious one.

[32] Burton, *Essay Towards a Complete New System of Midwifery*, pp. 116–17.

[33] Burton, *Essay Towards a Complete New System of Midwifery*, pp. 170–1.

[34] See Newman, *Fetal Positions*.

[35] John Burton, *A Letter to William Smellie, MD, Containing Critical and Practical Remarks upon His* Treatise on the Theory and Practice of Midwifery (London: Printed for W. Owen, 1753). See John Glaister, *Dr William Smellie and His Contemporaries: A Contribution to the History of Midwifery in the Eighteenth Century* (Glasgow: Maclehose, 1894), esp. pp. 267–78, 'Burton on Smellie'.

MIDWIFERY PRACTICE ACCORDING TO DR WILLIAM SMELLIE

Several scholars have discussed Smellie's career in considerable detail.[36] The simple facts are these. Smellie was born (1697) and educated in Lanark, Scotland, where he practised between 1720 and 1739. He became a member of the Faculty of Physicians and Surgeons of Glasgow in 1733 and received the MD from the University of Glasgow in 1745. In 1739 he moved to London, where he not only practised as a man-midwife, but also began to teach midwifery from 1741. His teaching was of a theoretical and practical kind, the latter involving his pupils attending and assisting with the deliveries of poor women in their own homes. While it is not possible to be exact about the number of his pupils, several hundreds must have taken part in his short, intensive courses that catered separately for men- and women-midwives. Smellie returned to Lanark in 1759 and there he died in 1763. He married Eupham Borland in 1724; there were no children. He was a friend and literary associate of the novelist, sometime naval surgeon's mate, Tobias Smollett (1721–71), as well as being the teacher and friend of Dr William Hunter (1718–83), the great anatomist and man-midwife; they were fellow Scots.[37] Smellie's role in eighteenth-century obstetrics, his position as 'the master of British midwifery', is due to both his teaching (in terms of number of students and methods) and to his publications. Of the last-mentioned, the following are of most importance:

1. *A Treatise on the Theory and Practice of Midwifery* (London: Printed for D. Wilson, at Plato's Head, near Round Court, in the Strand, first edition 1751, dated 1752) (vol. i).
2. *A Collection of Cases and Observations in Midwifery. By William Smellie MD, To Illustrate His former Treatise, or First Volume, on that Subject* (London: Printed for D. Wilson and T. Durham, at Plato's Head, in the Strand, first edition 1754) (vol. ii).

[36] See, for example, Glaister, *Dr William Smellie* and Johnstone, *William Smellie*. Smellie is believed to have suffered from asthma, which, in combination with his physically demanding work as an instructor and man-midwife, may have contributed to his retirement through ill health.

[37] It is often claimed that Smollett edited and oversaw the publication of Smellie's works, that he may even have been their ghost-writer. He certainly reviewed the first volume in December 1751. See Lewis Mansfield Knapp, *Tobias Smollett: Doctor of Men and Manners* (Princeton, NJ: Princeton University Press, 1949); also George S. Rousseau, 'Pineapples, pregnancy, pica, and *Peregrine Pickle*', in G. S. Rousseau and P. G. Boucé (eds.), *Tobias Smollett: Bicentennial Essays Presented to Lewis M. Knapp* (New York: Oxford University Press, 1971), 79–109, on Smollett, Smellie, and maternal cravings during pregnancy. Philip J. Klukoff, 'Smollett's defence of Dr Smellie in *The Critical Review*', *Medical History*, 14 (1) (1970), 31–41 discusses the way in which Smollett defended Smellie against the attack from Mrs Elizabeth Nihell, 'professed midwife', in her *Treatise on the Art of Midwifery* (1760), especially his use of forceps, but men-midwives in general. William Hunter was certainly a professional colleague, but he was also critical of Smellie's overuse of instruments. Hunter's contribution will be considered later.

3. *A Collection of Preternatural Cases and Observations in Midwifery. By William Smellie MD, Completing the Design of Illustrating His First Volume, on that Subject* (London: Printed for D. Wilson and T. Durham, in the Strand, first edition 1764) (vol. iii).
4. *A Sett of Anatomical Tables, With Explanations, and an Abridgement of the Practice of Midwifery; with a view to illustrate a Treatise on that Subject, and Collection of Cases* (London: [no printer or bookseller named, but believed to have been printed by subscription, 100 copies printed], first large folio edition 1754, second, corrected, edition 1761) (vol. iv).

The first three went through at least eight editions during the eighteenth century, and were translated into French, Latin, German, and Dutch. They were combined into a three-volume set and republished by the New Sydenham Society under the editorship of Dr Alfred H. McClintock in 1876–8.[38] The fourth volume in the list, which was originally published in 1754, also went into a number of editions and revisions, especially by the inclusion of new illustrations.[39] In combination, these four volumes provide a comprehensive summary of the state of obstetric knowledge and practice in the 1750s—one based on Smellie's teaching and more than thirty years' experience. They need to be considered in some detail, since they shed considerable light on contemporary understanding of fetal development, as well as miscarriage, abortion, and fetal death.

Smellie writes thus in his *Treatise on Midwifery*:

Of Abortions

A miscarriage that happens before the tenth day was formerly called an *efflux*, because the embryo and secundines are not then formed, and nothing but the liquid conception or *genitura* is discharged. From the tenth day to the third month, it was known by the term *expulsion*, the embryo and secundines being still so small that the woman is in no great danger from violent flooding.

If she parted with her burden betwixt that period and the seventh month, she was said to suffer an abortion: in which case she underwent greater danger, and was delivered with more difficulty than before; because the uterus and vessels being more distended, a larger quantity of blood was lost in a shorter time, the foetus was increased in bulk, and the neck of the womb is not yet fully stretched: besides, should the child be born alive, it will be so small and tender that it will not suck, and scarce receive any sort of nourishment.

[38] *Smellie's Treatise on the Theory and Practice of Midwifery*, ed. and annot. with an introd. by Alfred H. McClintock, 3 vols. (London: New Sydenham Society, 1876–8). The 1788 edition published in Edinburgh is used. McClintock also numbered the cases (1–531) in volumes ii and iii, and made cross-references to them in volume i. McClintock's case numbers will also be used here.

[39] Most notably as *Anatomical Tables, With Explanations, and an Abridgment of the Practice of Midwifery; With a view to illustrate a Treatise on that Subject, and Collection of Cases* (Edinburgh: Printed for William Creech, 1787). This edition used the original copper plates from the 1754 and 1761 editions, and had additional notes by Professor Alexander Hamilton. Like the original, it was printed in an elephant-folio format. Other editions published by Charles Elliot in Edinburgh in the 1780s in a smaller format (8vo) had additional notes on the forceps by Dr Thomas Young of Edinburgh, as well as Dr Hamilton (see <http//:www.nlm.nih.gov/exhibition/historicalanatomies/smellie_home.html>, accessed Feb. 2009.)

When delivery happens between the seventh month and full time, the woman is said to be in labour. But, instead of these distinctions, if she loses her burden at any time from conception to the seventh or eighth, or even in the ninth month, we now say indiscriminately, she has miscarried.[40]

Of Miscarriages

Most of the complaints above described [stone in the kidneys and bladder, hernias or ruptures, dropsy, white fluid, venereal disease], if violent and neglected, may occasion a miscarriage; and it would be almost an endless task to enumerate every accident from which this misfortune may proceed: I shall therefore content myself with describing in what manner abortion happens; first, in the death of the child; secondly, in the separation of the *Placenta*; and lastly, in whatever may occasion too great extension of the neck, and of the *Os internum*.[41]

Of the Child's Death

This may proceed from diseases peculiar to itself, not to be accounted for, as well as from divers accidents that befall it in the womb. If, for example, the navel-string be long, and the quantity of surrounding waters great, the foetus, while young, may in swimming form a noose of the *funis*; through which if the head only passes, a circumvolution will happen round the neck or body; but should the whole foetus pass or thread this noose; a knot will be formed on the navel-string, which, if tight drawn, will absolutely obstruct the circulation. This may likewise be the case when the waters are in very small quantity, and the *funis umbilicalis* falls down before the head, by which it is violently compressed. In short, the death of the foetus will be effected by all circumvolutions, knots, or pressure upon the navel-string, which destroy the circulation betwixt the *placenta* and the child. [Cases 71–4.]

The foetus may suffer death from diseases and accidents that happen to the mother; from violent passions of joy, fear, or anger, suddenly raised to such transports as occasion tremors, fainting, or convulsions; and from a plethora, and all acute distempers in which the circulating force of the fluids is too violent. [Case 75]

The child being dead, and the circulation in the secundines consequently destroyed, the uterus is no longer stretched; the foetus, if large, is no longer felt to move or stir; all the contained parts run gradually into a state of putrefaction; the resistance of the membranes becomes weaker than the contracting force of the *uterus*, joined with the pressure of the contents and parietes of the abdomen; the containing waters of consequence burst through their mortified inclosure; and the *uterus* is contracted close to its contents, which are therefore pressed down lower and lower; the neck and mouth of the womb being gradually stretched, labour comes on, and a miscarriage ensues.

At other times, gripings, looseness, and labour pains, even before the membranes break, are occasioned by obstruction or resistance of the vessels of the *uterus*. In these cases, if no flooding happens, the woman is seldom in danger; and, though the child is known to be dead, the progress of nature is to be waited for with patience. If the woman is weak, exhausted, or timorous, she must be encouraged and fortified with nourishing diet: if plethoric, she must undergo evacuation by bleeding and laxative

40 *Smellie's Treatise*, ed. McClintock, i. 121.

41 Ibid. 162.

medicines; and when labour begins, be assisted according to the directions specified in the sequel.[42]

The Signs of a Dead Child

When the head presents, and cannot be delivered by the labour-pains; when all the common methods have been used without success, the woman being exhausted, and all her efforts vain; and when the child cannot be delivered without such force as will endanger the life of the mother, because the head is too large or the pelvis too narrow, it then becomes absolutely necessary to open the head and extract with the hand, forceps, or crotchet. Indeed, this last method formerly was the common practice when the child could not be easily turned, and is still in use by those who do not know how to save the child by delivering with the forceps: for this reason their chief care and study was to distinguish whether the foetus was dead or alive; and as the signs were uncertain, the operation was often delayed until the woman was in the most imminent danger; or, when it was performed sooner, the operator was frequently accused of rashness, on the supposition that the child might in time have been delivered alive by the labour-pains. Perhaps he was sometimes conscious to himself of the justice of this imputation, although what he had done was with upright intention.

The signs of a dead foetus were, first, the child's ceasing to move and stir in the uterus. Secondly, the evacuation of *meconium*, though the breech is not pressed into the pelvis. Thirdly, no perceivable pulsation at the fontanel and temporal arteries. Fourthly, a large swelling or tumour of the hairy scalp. Fifthly, an uncommon laxity of the bones of the cranium. Sixthly, the discharge of a foetid ichor from the *vagina*, the effluvia of such surrounding the woman, gave rise to the opinion that her breath conveyed a mortified smell. Seventhly, want of motion in the tongue when the face presents. Eighthly, no perceivable pulsation in the arteries of the *funis umbilicalis*, when it falls down below the head; nor at the wrist, when the arm presents; and no motion of the fingers. Ninthly, the pale and livid countenance of the woman. Tenthly, a collapsing and flaccidity of the breasts. Eleventhly, a coldness is felt in the abdomen, and weight, from the child's falling, like a heavy ball, to the side on which she lies. Twelfthly, a separation of the hairy scalp on the slightest touch, and a distinct perception of the bare bones.

All or most of these signs are dubious and uncertain, except the last, which can only be observed after the foetus hath been dead several days. One may also certainly pronounce the child's death, if no pulsation hath been felt in the navel-string for the space of twenty or thirty minutes; but the same certainty is not to be acquired from the arm, unless the skin can be stripped off with ease.[43]

When the Crotchet is to be used

Midwifery is now so much improved, that the necessity of destroying the child does not occur so often as formerly. Indeed it never should be done, except when it is impossible to turn or deliver with the forceps; and this is seldom the case but when the pelvis is too narrow, or the head too large to pass, and therefore rests above the brim. For this reason, it is not so necessary for the operator to puzzle himself about dubious signs; because, in these two cases there is no room for hesitation: for if the woman cannot possibly be delivered in any other way, and is in imminent danger of her life, the best

[42] *Smellie's Treatise*, ed. McClintock, i. 163. [43] Ibid. 288.

practice is undoubtedly to have recourse to that method which alone can be used for her preservation, namely, to diminish the bulk of the head.

In this case, instead of destroying you are really saving a life; for, if the operation be delayed, both mother and child are lost.[44]

The old Methods of extracting the Head

Various have been the contrivances intended for this purpose. Some practitioners, when the head did not advance in the pelvis, introduced the *speculum matrices*, in order to stretch the bones asunder, and thereby increase the capacity of the basin: if, after this operation, the woman could not be delivered with her pains, they fixed a large screw in the head, by which they pulled with great force. Others opened the head with a large bistory, or a short broad-bladed knife in the form of a myrtle leaf, or with a crooked bistory with a long handle: then a small pair of forceps with teeth were introduced; and one blade being insinuated into the opening, they laid hold on the skull, and pulled the head along: they likewise made use of different kinds of crotchets both sharp and blunt: and when the head was lower down, they practised the same expedient.

[Here Smellie mentions the instruments developed by Mauriceau, Ould, and Burton, among others.[45]]

The Method of using the Scissors, Blunt Hook, and Crotchet

The following method, if exactly followed according to the circumstances of the case, seems, of all others hitherto invented, the easiest, safest, and most certain, especially when it requires great force to extract the head.

When the head presents, and such is the case that the child can neither be delivered by turning nor extracted with the forceps, and it is absolutely necessary to deliver the woman to save her life, this operation must then be performed in the following manner.

The operator must be provided with a pair of curved crotchets, made according to the improvements upon those proposed by Mesnard, together with a pair of scissors, about nine inches long, with rests near the middle of the blades, and the blunt hook.

The patient ought to be laid on her back or side, in the same position directed in the use of the forceps; the operator must be seated on a low chair, and the instruments concealed and disposed in the same manner and for the same reason mentioned in treating of the forceps. The parts of the woman have already, in all likelihood, been sufficiently dilated by his endeavours to turn or deliver with the forceps: or if no efforts of that kind have been used, because by the touch he had learned that no such endeavours would succeed, as is the case of a large *hydrocephalus* [in this case the brain collapses when the water is evacuated], when the bones of the *cranium* are often separated at a great distance from each other, or upon perceiving that the *pelvis* was extremely narrow [extracted by use of the curved crotchet or, in extreme cases, the double-bladed curved crotchet which could be

[44] *Smellie's Treatise*, ed. McClintock, i. 292.

[45] Ibid. 293. We have already met Mauriceau and Burton. Sir Fielding Ould (1710–89) was an Irish surgeon and man-midwife, the author of *A Treatise of Midwifery. In Three Parts* (London: Printed for J. Buckland, at the Buck, in Paternoster-Row, 1748), which illustrated several new instruments (including a spring-loaded extractor blade) and boasted the ability to deliver dead fetuses footling. See Hibbard, *Obstetrician's Armamentariu*, p. 227, and Steven A. Brody, 'The life and times of Sir Fielding Ould: man-midwife and master physician', *Bulletin of the History of Medicine*, 52 (2) (1978), 228–50.

used like forceps]; if, upon these considerations, he hath made no trials in which the parts were opened, let him gradually dilate the *os externum* and *internum*, as formerly directed.

The head is commonly kept down pretty firm, by the strong contraction of the *uterus* round the child; but should it yield to one side, let it be kept steady by the hand of an assistant, pressing upon the belly of the woman: let him introduce his hand, and press two fingers against the sutures of the *cranium*; then take out his [perforating] scissors from the place in which they were deposited, and guiding them, by the hand and fingers till they reach the hairy scalp, push them gradually into it, until their progress is stopped by the rests.

If the head slips aside, in such a manner as that they cannot be pushed into the skull at the suture, they will make their way through the solid bones, if they are moved in a semicircular turn like the motion of boring, and this method continued till you find the point firmly fixed; for if this is not observed, the points slide along the bones.

The scissors ought to be so sharp at the points, as to penetrate the integuments of bones when pushed with a moderate force; but not so keen as to cut the operator's fingers, or the *vagina*, in introducing them.

The scissors being thus forced into the brain, as far as the rests at the middle of the blades, let them be kept firm in that situation; and the hand that was in the *vagina* being withdrawn, the operator must take hold of the handles with each hand, and pull them asunder, that the blades may dilate and make a large opening in the skull; then they must be shut, turned, and again pulled asunder, so as to make the incision crucial; by which means the opening will be enlarged, and sufficient room made for the introduction of the fingers; let them be afterwards closed and introduced even beyond the rests, when they must again be opened, and turned half round from side to side, until the structure of the brain is so effectively destroyed, that it can be evacuated with ease. This operation being performed, let the scissors be shut and withdrawn; but if this instrument will not answer the last purpose, the business may be done by introducing the crotchet within the opening of the skull. The brain being thus destroyed, and the instrument withdrawn, let him introduce his right hand into the *vagina*, and two fingers into the opening which hath been made, that if any sharp splinters of the bones remain, they may be broken off and taken out; lest they should injure the woman's *vagina*, or the operator's own fingers.[46]

In the second volume of his *Treatise* Smellie collected together several cases to illustrate the various complications associated with abortions and miscarriages, but there were other occasions on which a fetus was dead-born. There are also examples to show how a dead fetus might be delivered; how Smellie

[46] *Smellie's Treatise*, ed. McClintock, i. 294–7. McClintock provides a detailed commentary on this operation, which Smellie elaborates by describing how the hydrocephalous brain is to be dealt with and how the particularly narrow pelvis must be approached. Smellie mentioned Jacques Mesnard (1685–1746), the author of *Le guide des accoucheurs, ou, le maistre dans l'art d'accoucher les femmes* (Paris: Chez de Bure, Le Breton, Durand, 1743), which illustrated several new devices, including the curved crotchet blade. Smellie may also have had contact with André Levret (1703–80), whose *Observations sur les causes et les accidens de plusieurs accouchements laborieux* (Paris: Osmont, 1747) had case notes on difficult surgical procedures, especially using curved forceps, and which in later editions (e.g. 4th edn. 1770) had an article entitled 'Du forceps de M Smellie Anglois'. Smellie's *A Sett of Anatomical Tables* (1754) illustrates the curved forceps in plates 17, 21, 26, and 35; it also shows the straight-bladed forceps. See also Glaister, *Dr William Smellie*, pp. 205–57; Johnstone, *William Smellie,* pp. 98–106; and Hibbard, *Obstetrician's Armamentarium*, p. 211.

worked with his pupils, assistants, and other midwives; how he incorporated the published work of other specialists and the cases sent to him by correspondents; how he resuscitated the apparently stillborn; how he coped with smallpox and venereal disease; and how he managed the delivery of high-risk non-standard presentations. Collection XII groups together most of the miscarriage cases, while two resuscitation cases are placed in Collection XXII. The remaining cases that will be of interest here are scattered throughout the second and third volumes.

Collection XII

Of Miscarriage, or Delivery before the full time

Of what may occasion the Death of the Foetus in Utero

Number I. Four cases where the *Funises* were obstructed [Cases 71–4, also 172–3, 178]

Where women were frightened [75]
The bones of the *Foetus* discharged at the fundament and *Vagina* [76–7]
Other cases of the same kind from other authors

Number II. Miscarriages from different causes

A surprise [78]
From a fall [79]
An abortion in the fourth month due to overstraining [80]
Another in the fifth [81–2]
Miscarriages in the small-pox [83, also 170–1]
A miscarriage with flooding, in the seventh month [84]
Two abortions and a flooding [85–6]
A placenta delivered [87]
An abortion [88]
Cases from different authors

Number III. Marks and mutilations [89–90]

Case 180 from Collection XX will help to summarize Smellie's approach.

Case 180. *Tedious Labour from large size of Child's Head, and Mismanagement; Child dead born*

In the year 1742, I was called to a woman, whose friends told me she had been three days in labour, and that the midwife, who had lost her opportunity, was keeping her in hand. She, however, in her own vindication, gave me to understand that she had delivered the patient twice before; that the first labour was lingering, and the child, which was small, came before the time; that the second was also tedious, and the child, which was large, stillborn, because they had sent for her when it was too late to save it by making more room; that, in order to obviate the like misfortune upon this occasion, she had been called in good time, and considerably dilated the parts; but when the waters were discharged, the pains had not been strong enough to deliver the child. She likewise affirmed, that when she was called, there was no opening of the *os internum*, which did not begin until the preceding night; but that the woman laboured under a colic, attended by a looseness which had been stopped by something prescribed by the apothecary, upon which the pains grew stronger; and that she, the midwife, had lost no time, but tried all the different positions, and dilated the parts during every pain. Indeed, the looseness had exhausted the patient; and she was moreover fatigued by the unskilled management of the midwife, who was extremely ignorant, had never received the least instruction, and seemed incapable of profiting by her mistakes in practice.

When I first examined, I found the mouth of the womb pretty largely opened, but thick and swelled; the external parts were likewise tumefied and inflamed. I afterwards, during another pain, felt the head presenting, though very high up. Her pulse being low and quick, I directed the attendants to put her to bed, and keep her as quiet as possible. As she was troubled with a great drought, I desired her to drink barley-water, and take now and then a little weak broth, with toasted bread; lastly, in order to amuse herself and friends, I prescribed a draught of syrup and simple waters to be repeated every two hours. Then exhorting her to disregard the trifling pains she had, I assured her they would grow stronger, and assist the delivery with better effect, after she should have enjoyed a refreshing sleep. Having given these directions, I took my leave about eight in the morning; and returning in the evening, was informed that she had slept very sound for five or six hours, sweated plentifully, and undergone every now and then a smart pain.

Finding the parts much softer, the heat abated, and the pains gradually pushing down the head of the child into the pelvis, I encouraged the patient, telling her she was now in a good way, though, in consequence of her weakness, her delivery would require some time, and therefore she ought to exert her patience. I likewise privately directed the midwife to let her rest in bed, and sleep as much as possible, without fatiguing her by a repetition of her former conduct. But notwithstanding this express admonition, when I was called early next morning, I understood she had acted diametrically opposite to my advice, by raising her out of bed, and harassing her in the manner already described; so that she was quite sunk and dispirited, and the external parts were inflamed and swelled as before. She was immediately replaced in bed, and a poultice of bread and milk being applied to the parts, I waited to see the event. She slept and sweated a good deal; and when waked with a pain, took some broth, warm wine and water, and caudle alternately, at different times, so as to be much recruited and refreshed; the inflammation also abated; upon which the poultice was removed, and the part cleaned; and the pains growing stronger, she was delivered about noon, of a dead child, whose head was squeezed to a great length.

I afterwards delivered this woman three times, and the children were all uncommonly large; but by giving her time, and keeping up her strength, she was safely brought to bed and they were all alive.[47]

The two resuscitation cases (203 and 204, like 363) describe Smellie's procedure and the key vital signs he focused on:

Case 204. *Arm and Funis Presentation; Version; Child stillborn, but resuscitated*

In the year 1749, I attended a woman in labour, and the navel-string presented with the arm, I delivered the child by the feet. From the pulsation in the arteries of the *funis*, I knew it was alive; but I found great difficulty in delivering the head, and was obliged to rest

[47] *Smellie's Treatise*, ed. McClintock, ii. 242–4. Case 186 relates to the same theme, but here Smellie was not allowed to examine the patient; he had to 'wait in another apartment, in case of accidents'. Cases 182 and 183 also deal with the stillborn—the former natural, the latter footling.

several times before I could effect it; so that the pulsation ceased, and the child seemed to be dead, after all the common efforts were used for its recovery [i.e. from Case 203: rubbing the temples and breast with brandy, whipping and holding onion in the mouth and nose].

Nevertheless I inflated the lungs, by blowing into the mouth through a female catheter, and the child gave one gasp; upon which I repeated the inflation at several intervals, until the child began to breathe; and it actually recovered.[48]

Smellie was also required to dismember the dead fetus, on less fortunate occasions:

Case 386. *One Arm presented; Legs brought down and pulled off; the Child delivered piece-meal; the Pelvis small, and the Child large.*

1730.—One of the arms had descended, and been so pulled by the midwife, that the shoulder was torn to the *os externum*.

I tried to raise the shoulder by passing up along the arm, which was excessively swelled and livid, it having been down in that position above twenty-four hours; but I could not introduce my hand. Considering that the child was probably dead from its being so long in that situation, and its not being felt to move by the mother for many hours, I thought it was expedient to separate the arm from the shoulder. This last being low down, I guided the point of the scissors to it, and easily separated the arm; partly by cutting the skin and ligaments, and partly by pulling and twisting.

In pushing up the shoulder into the uterus, I found that the pelvis was small and the child large. I brought down only one of the legs, which was pulled off; and then with great labour I brought down the other, which gave way also by the force of pulling.

I was afterwards obliged to tear down the body with the crotchet, and even to fix the same instrument on the head.

Being the straight kind, it slipped several times, and hurt the inside of my left hand in two places, while I guided the point from hurting the *vagina* of the patient. At last, gaining a firmer hold above the ear, I fixed the fingers of my left hand over the shoulders, and pulled with great force, both at the body and the crotchet. Finding it did not move, I wrapped a cloth round the shoulders, and pulled at them with so great force, as almost to separate the head. By these means the head was brought a little lower; yet not daring to exact again such violence at the body, I pulled by the crotchet, which brought the head down to the *os externum*; and in raising the body and pulling it upwards, it at last separated.

The head, however, being brought low, I took hold of the under jaw; and pulling at that, while I exerted more force at the crotchet, the head was also delivered.

The woman behaved with great courage, although she had been much fatigued, and weakened by a flooding brought on by the great force that I was obliged to exert in turning the foetus. This woman also recovered, contrary to everybody's expectation.[49]

Twenty years later in London, Smellie was more skilful, and he had acquired pupils and forceps—what he called 'artificial hands':

Case 226. *Primipara; tedious Labour from Mismanagement; Forceps*

[48] *Smellie's Treatise*, 276. See Fig. 5.2*c*.

[49] Ibid. iii. 150–1. This is one of Smellie's Lanark cases in which he presumably lacked access to forceps.

On 3 July 1750, I received a message from a midwife, desiring me to prescribe some medicines to quicken the labour-pains in a woman whom she attended. As I was then engaged, and would not prescribe without being fully informed of the patient's condition, I sent one of my elder pupils to receive a more perfect account from the midwife herself; who told him, that the poor woman had been three days in labour; but would not allow him to examine, though she earnestly requested my assistance.

As soon as I was disengaged, I accompanied him to the place, where I found this loquacious midwife extremely ignorant, without the least tincture of knowledge in her profession. When called to the patient, whose pains were just beginning in this her first labour, she had walked her about and fatigued her so much, that she was quite exhausted, and the pains had entirely ceased. She said that she had done all that lay in her power to make room for the child, and that her fingers were swelled and painful from stretching the birth; but she could not inform me how long the waters had been discharged. Finding, upon examination, the head at the lower part of the pelvis, and the hairy scalp of the child, as well as the *os externum* of the mother, very much swollen, I ordered her to be put to bed, prescribed an anodyne mixture of *Aq. Fontan*. ℥v. *Tinct. Thebaic*. gut. xx. sweetened with sugar, directed her to take two spoonfuls every hour, in order to procure sleep, and applied to the *os externum* a large poultice of loaf-bread and milk, with hog's lard. These steps were taken in the evening; and I was again called at three o'clock in the morning, when I went attended by my pupils, who were permitted to be present.

The woman had enjoyed tolerable rest, and the poultice being removed and the parts washed, we perceived the swelling was much abated. We therefore waited several hours, in expectation that the pains would increase, so as to dilate the *os externum* slowly, and effect the delivery. In this hope, however, we were disappointed; then I resolved to assist with the forceps, as the head was so low down; though it was so swelled, that I could not distinguish its position; for I could feel neither suture, ear, or back part of the neck. Nevertheless, I concluded, that as it was so low down, the ears would be to the side of the pelvis, especially as the soft parts below were protruded by the head, yet not so much as to allow me to reach to the forehead, if backward, by introducing a finger in the rectum. However, I thought it highly probable that the forehead was backward towards the *sacrum*, rather than forward to the pubes; and in this position I directed the woman to be laid on her back across the bed, with her breech a little over the side, her head being supported by the bolster and pillows, and two assistants holding asunder and supporting her legs. Then I introduced a blade of the forceps on one side of the head, and gradually assisting as in the foregoing case, delivered the woman without lacerating her parts, or even marking the child's head.[50]

The effects of smallpox are discussed in three cases (83, 170, and 171), and of venereal disease in at least one (70):

Case 83. *Abortion at Four Months during Smallpox; Death*

[50] *Smellie's Treatise*, ed. McClintock, ii. 298–9. The pregnant woman was given a dose of laudanum (20 drops of tincture of Egyptian opium in 5 fluid ounces of spring water). This would give about 16 spoonfuls. There are at least fifty detailed prescriptions in Smellie's case notes, many of which involve opiates. Since Smellie was also trained as an apothecary, these prescriptions deserve careful attention (see Robert Woods, 'Dr Smellie's prescriptions for pregnant women', *Medical History*, 52 (2) (2008), 257–76.

In the year 1749, I was called to a woman four months gone with child, on the eleventh day after the eruption of the smallpox. She was then taken with pains, but being delirious, her case was not known until the nurse observed blood upon the cloths. I found the os uteri considerably opened; and the discharge being great, and attended with frequent strainings, I broke the membranes that were pushed down with the waters. This expedient stayed the flooding; the foetus was soon delivered, and had no mark of the smallpox; and the secundines came away in two hours. But the discharge had sunk the pustules, which were of the confluent kind, and could not be raised again. She died in a few hours after the miscarriage.[51]

Case 70. *Syphilis in Pregnancy; Delivery; Infection of Child*

In the year 1741, one of the poor women attended by my pupils, being near the full time, had a bubo in the groin, and her throat began to be affected with a venereal inflammation. Poultices were applied, in order to bring the tumour to suppuration; and small doses of calomel were given internally, to restrain the infection, until she should be delivered. These methods seemed to succeed; she was safely delivered of a male child, which at first had no appearance of infection; but in about eight days, the scrotum and penis began to swell, inflame, and break out in ulcers; the whole body was soon covered with venereal blotches; and it was attacked by a cough, which destroyed it in three weeks after it was born. As for the mother, the bubo was brought to suppuration, and the matter discharged; and I designed to have sent her to an hospital for the cure of the *lues*, as soon as she should be in a condition to be removed; but the ulcers in her throat grew worse and worse: in about a fortnight after delivery, her lungs were affected, a consumption ensued, and death was the consequence.[52]

A Sett of Anatomical Tables has received less critical attention than the textbook or the two books of cases, but its illustrations are of a particularly high standard—one that was not to be surpassed until the publication of William Hunter's *The Anatomy of the Human Gravid Uterus* in 1774. *A Sett* contains more than thirty anatomical drawings and illustrations of obstetric instruments, with introductory notes from the *Treatise* cross-referenced to the illustrations. Three of the plates are shown in Fig. 5.1, while Fig. 5.2 demonstrates how the long curved forceps were to be used.

Most of the drawings were by Jan van Rymsdyk (*fl.* 1750–88), who also illustrated for William and John Hunter and for Thomas Denman, but a further eleven were by Dr Pieter Camper (1722–89), sometime Professor of Anatomy and Surgery at the University of Amsterdam and a former student of Smellie. For example, plate V '[g]ives a front view of the *Uterus* in the beginning of

[51] *Smellie's Treatise*, ed. McClintock, ii. 128–9. McClintock notes that '[s]mallpox is one of those diseases which are very apt to interrupt the process of utero-gestation and to induce miscarriage'. Case 170, also from 1749, involved a stillbirth, as did Case 171, contributed by Mr Cook, one of Smellie's students in 1752.

[52] *Smellie's Treatise*, ed. McClintock, ii. 109–10. Syphilis, or *Lues venerea*, was treated with mercury, which produced an excessive flow of saliva, hence salivation. Smellie also notes the dangers of undergoing treatment for venereal disease by salivation during the later stages of pregnancy, and summarizes several cases from Mauriceau to illustrate the effects of the disease.

Fig. 5.1: Three fetal positions: (a) twins, one natural and one footling, (b) breech presentation, and (c) arm presentation.
Source: William Smellie, *A Sett of Anatomical Tables* (1754), plates X, XXX, and XXXII (Wellcome Library, London).

Fig. 5.2: Delivery of infant head using long curved forceps. Note that at this time Smellie bound the blades of his forceps with thin leather strips, 'which may easily be renewed when there is the least suspicion of venereal infection in a former case', in order to improve their grip.

Source: William Smellie, *A Sett of Anatomical Tables* (1754), plate XXXV (Wellcome Library, London).

the first month of pregnancy; the anterior part being removed, that the *Embryo* might appear through the *amnios*, the *chorion* being dissected off', while plates VI–IX show fetal development from 2 to 9 months. The positions of twins at the beginning of labour appear in plate X (Fig. 5.1*a*). A fetus with the umbilical cord round its neck and body is shown (e.g. plates XXIII, XXIX), as are the forceps delivery of the head (e.g. plates XVI, XVIII, XXI, XXXV (Fig. 5.2)), a breech delivery (plates XXIX, XXX (Fig. 5.1*b*)), and 'the delivery of a head by crotchet, foetus long dead' (plate XXXVI). The instruments illustrated include a blunt hook or crotchet used to extract an aborted fetus at 4–5 months (plate XXXVIIc), a whalebone fillet (plate XXXVIIIa), a female catheter (plate XXXVIIId), and perforator scissors for use on the cranium (plate XXXIXd). Smellie noted that '[t]he above instruments ought only to be used in the most extra ordinary cases, where it is not possible to save the woman without their assistance'.[53]

MIDWIFERY AFTER SMELLIE

Many other general midwifery textbooks were published after the appearance of Smellie's *Treatise*, and most contained sections on miscarriage, the causes of abortion, and how to recognize and deal with a dead fetus, but there were few startlingly original contributions before the issue was taken up in specialist studies during the nineteenth century. The publications of Alexander Hamilton (1739–1802) and Thomas Denman (1733–1815) provide typical examples. Hamilton was Professor of Midwifery at the University of Edinburgh and a significant textbook writer. His *Outlines of the Theory and Practice of Midwifery* (1784), which summarized his approach to obstetrics via chapters on anatomy and physiology, pathology, and different kinds of labour (natural, difficult, preternatural, and multiple), dealt at some length with abortion and the management of pregnant women:[54]

[53] Smellie, *Anatomical Tables*, quotations from p. 13 and the notes on pp.103–4. The later editions of *A Sett of Anatomical Tables* tended to add illustrations. For example, the 1787 edition had a plate XL showing Dr Denman's perforator 'implemented since Dr Smellie'. Thomas Young also provided notes and a new plate on developments in the forceps since the 1750s (see Johnstone, *William Smellie*, pp. 98–106, and Hibbard, *Obstetrician's Armamentarium*, p. 221). K. B. Roberts and J. D. W. Tomlinson, *The Fabric of the Body: European Traditions of Anatomical Illustration* (Oxford: Clarendon, 1992), esp. pp. 447–73—'British obstetrical atlases of the eighteenth century'—and Benjamin A. Rifkin, Michael J. Ackerman, and Judith Folkenberg, *Human Anatomy: Depicting the Body from the Renaissance to Today* (London: Thames & Hudson, 2006), 194–217 reproduce a selection of illustrations from *A Set* and William Hunter's, *The Anatomy of the Human Gravid Uterus Exhibited in Figures* (Birmingham: Printed by John Baskerville, 1774) (see n. 58).

[54] Hamilton, *Outlines of the Theory and Practice of Midwifery* (Edinburgh: Printed for C. Elliot, Edinburgh; and G. Robinson, London, 1784). This is an updated version of his earlier text, *Elements of the Practice of Midwifery* (London: Printed for J. Murray, No. 32, Opposite St Dunstan's Church, Fleet-Street, 1775). Although it cannot be claimed that Hamilton's textbooks broke new ground, they did show an ordered approach to obstetric problems. For example, the section on 'Instrumental

ABORTION is the 'premature delivery of the foetus'; which comprehends every period before the evolution of its system be sufficiently complete to enable the child to exit after the connection with the parent is dissolved.

Some authors still make the following distinction. When the ovum is expelled in the early months, they call it an *abortion*; and, if the foetus be delivered at any period between the fifth month and the full time, a *miscarriage*.

Abortion is commonly preceded by some of the following symptoms: flooding, pains in the back or belly, uterine bearing-down pains with regular intermissions, the discharge of a watery fluid.

If, along with flooding, any portion of a vascular skinny substance, which is the *membrana deciduas*, should be discharged, abortion for certain will ensue. None of the other symptoms are infallible; even the evacuation of a watery fluid is not necessarily followed with delivery, since it may proceed from a collection on the outside of the ovum, between the lamellae of the membranes. In the early months excessive floodings sometimes occur; and yet, by proper management, the woman is often enabled to retain the child.

There is less fear of abortion while the blood evacuated is pure and without clots, unattended with uterine pain and pressure. But, in forming a judgement, the constitution, occasional cause, and term of gestation, must be regarded.

Abortions happen more frequently from the beginning of the second to the end of the third month, than at any other period.

The immediate cause of abortion is the same with that of real labour.

The more remote causes are,

I. Whatever interrupts the regular circulation between the uterus and placenta; as,
   1. Diseases of the uterus.
   2. Imperviousness, or spasmodic constriction, of the extremities of the uterine blood-vessels.
   3. The separation of any portion of the cake, or deciduas, from the uterus.
   4. Determination of the fluids to other parts.

II. Every cause which prevents the distension of the uterus, or excites spasmodic contraction of its muscular fibres; as,
   1. Extreme irritability, preventing the extension of that organ.
   2. Violent exertions, as coughing, sneezing, vomiting, straining at stool; mechanical injuries, as strains, falls, &c.
   3. Irritation from the confined motion of the foetus, its kicking or strugglings.
   4. A habitual disposition to abortion.

III. The death of the foetus; which may be occasioned from,
   1. Diseases peculiar to itself.
   2. An original defect transmitted from the parents.
   3. External accidents affecting the mother.

deliveries' was divided into four parts, including: 'Cases where the child is intended to be extracted without injuring it or the mother' and 'Cases where the child must be destroyed by diminishing its bulk, with a view to preserve the mother's life'. Both Hamilton and Denman have become associated with a reaction in the late eighteenth century against the use of instruments, forceps in particular.

4. Diseases of the placenta, membranes, or cord.
5. Too slight adhesion of the cake or membranes to the uterus.
6. Weakness, or want of resistance, in the texture of the membranes; or an excessive quantity of the liquor amnii.
7. Knotty circumvolutions of the umbilical cord.

The size of the abortive ovum in early gestation is as follows: six weeks after conception, its bulk is nearly equal to a pigeon's egg; in eight weeks, to that of a hen; and in twelve, to that of a goose.

Where there is a reason to dread abortion, every probable mean ought to be employed to relieve painful symptoms by rest and opiates, to check haemorrhage by the means already directed, and to obviate occasional causes as much as possible; and the woman should be encouraged to hope as long as there is ground for it.

As abortion, in many instances, is preceded by no alarming symptom, till a discharge of watery fluid, or an excessive flooding with clots and portions of the deciduas, announce the approaching event; either to remove immediate symptoms, or prevent the accident that is dreaded, often baffles our boasted skill; for the circulation in the ovum perhaps had ceased a considerable time previous to any threatening symptom of its expulsion.

Little, therefore, can or ought to be done by way of treatment, besides obviating plethora, advising rest of body and tranquillity of mind, and guarding against every cause of irritation. Though the mother may suffer a considerable shock from miscarriage, and it may be some time before her constitution be sufficiently restored for any future fortunate pregnancy, women are rarely known to suffer fatally, but from mismanagement in the early months. Any manual operation to assist delivery is seldom necessary at an earlier period than the sixth month of gestation, unless the mother's life should be in danger from flooding. When this happens, the bag may be broken by thrusting the finger against it in time of pain, or endeavouring to assist its expulsion when within reach of the finger; but otherwise the delivery should be *wholly* trusted to nature. It is even hazardous to destroy the structure of the ovum in the early months: for when it breaks, the small foetus is first expelled; and the bag or placenta may be afterwards retained for a week or more, during which time the flooding often continues to be excessive; whereas, if the conception comes off entire, the effusion generally ceases immediately.

From long retention, the placenta, without circulation, is liable to become putrid: it is then expelled in different portions; and inflammation, excoriation, or gangrene of the uterus and vagina, often ensues. In these circumstances there is a necessity for keeping the parts clean, by frequent bathing, or by injections thrown into the vagina; and bark, with elixir of vitriol, should be given freely. Gently stimulating glisters, to promote the contraction of the uterus, in cases of retention of the placenta, where there is no great flooding, are often useful.

As women who have once aborted are liable to a repetition of that accident from a similar or very trifling occasional cause, it ought to be guarded against by every possible means. With this view, the management during pregnancy should be properly regulated.[55]

[55] Hamilton, *Outlines of the Theory and Practice of Midwifery*, pp. 181–8.

As far as the management of pregnancy and the dangers of abortion were concerned, Hamilton had the following advice:

On the first appearance of threatening symptoms, the woman should be confined to bed, and kept quiet till every alarming symptom be removed; her diet should be light and cooling; the state of the belly should be attended to. When she is hot and feverish, much fluttered, or pained, a little blood may be taken from the arm, and an opiate occasionally given at bed-time. She ought to be kept very cool and quiet; but, excepting so far as it depends on these and such like precautions, little good is to be expected in the way of treatment.[56]

Thomas Denman's two-volume *An Introduction to the Practice of Midwifery* (1794, 1795) took the standard account of abortion a little further:

The death of the child in the *uterus* may be occasioned by various causes independent of the mother, as by local inflammation or other disease of some part essentially necessary to its life; by some original imperfection in its structure which may prevent its acquiring more than a certain size, or existing beyond a certain time; by the smallness or morbid state of the *placenta*, hindering the proper communication between the child and the *uterus*; by a partial or total separation of the *placenta*; or, by the rupture of some of the large vessels of the *funis umbilicalis* becoming impervious; by the circulation through them being obstructed by the casual tying of the knot; by untoward pressure of the body of the child upon the *funis*, or by this becoming dropsical or otherwise diseased.

The child may also be destroyed by affections or diseases of the mother, as by the sudden and violent impression of fear, joy, or other tumultuous passion; by the irregularity of the parent's life; by fever; by improper or unwholesome diet; by any cause capable of depriving the child of a proper quantity of nutriment, or depraving the quality of that with which it may be supplied; or by accidents which produce some positive injury upon the body of the child, through the integuments and parts with which it is invested and naturally descended. Some of these are beyond the power of art to prevent or remedy, though others might by proper care and management be obviated or relieved; but at present we want only to discover those causes, of the death of a child, which may occur in the time of labour.[57]

If Hamilton and Denman did not exactly break new ground, the same cannot be said of William Hunter's contribution. *The Anatomy of the Human Gravid*

[56] Alexander Hamilton, *A Treatise of Midwifery, Comprehending the Management of Female Complaints, and the Treatment of Children in Early Infancy. To which are added Prescriptions for Women and Children, and Directions for Preparing a Variety of Food and Drinks, Adapted to the Circumstances of Lying-in Women. Divested of Technical Terms and Abstruse Theories* (London: Printed for J. Murray, No. 32, Opposite St Dunstan's Church, Fleet Street; J. Dickson, W. Creech, and C. Elliot, at Edinburgh 1781), 155–6—from the section on the treatment of cases of miscarriage (pp. 154–62), which follows that on abortion (pp. 148–54). There were less conventional suggestions also: 'Small doses of rhubarb should be given to keep the body moderately open: the patient should also be put on a course of light, aromatic, and strengthening bitters; and her diet, air, exercise, and amusement should be properly regulated' (*Outlines*, p. 149).

[57] Denman, *An Introduction to the Practice of Midwifery, in Two Volumes* (London: Printed for J. Johnson, No. 72, St Paul's Churchyard, 1794–5), quoted from ii. 190–1. Denman did make some interesting observations on the effects of venereal disease and of smallpox in pregnancy. On the latter, he was unsure whether the disease was passed to the fetus by its mother, arguing the need for 'more well-attested facts' on the problem (i. 313–19).

Uterus Exhibited in Figures (1774) is an atlas of quite remarkable beauty, a work of art and science combined.[58] The preface notes that in 1750 Hunter procured the body of a dead woman who was near to term and that she and her unborn fetus became the subjects of the first ten plates. There is an implication that perhaps a further twelve subjects were also used during the next couple of decades, although this is uncertain. Hunter worked on the dissections with his brother, John, and Robert Strange, the engraver; while Jan van Rymsdyk, who also supplied most of the illustrations for *A Sett of Anatomical Tables*, executed all but three of the plate drawings. The printer John Baskerville did the book design, using his own distinctive typeface, and the atlas sold for six guineas in boards. The anatomical plates show the development of the fetus at various stages. For example, plate XXV has the fifth month with 'Woman fully opened and foetus taken out; to show the exact dimensions and proportions of the child, and the state of the cervix uteri at this period of utero-gestation'; plate XXXIII shows three different abortions: two at 8 weeks and one at 9; while plate XXXIV, the last, has nine figures purporting to represent conceptions at very early stages of development: 3, 4, and 9 weeks. Some of these figures can be dated to 1769, 1770, and 1772.[59]

[58] Hunter, *Anatomy of the Human Gravid Uterus* (consult <http//:www.nlm.nih.gov/exhibition/historicalanatomies/hunterw_home.html>), accessed Feb. 2009. See W. F. Bynum and Roy Porter (eds.), *William Hunter and the Eighteenth-century Medical World* (Cambridge: Cambridge University Press, 1985), esp. chapter 12, by Adrian Wilson, on 'William Hunter and the varieties of man-midwifery' (pp. 343–69) and chapter 14, by Ludmilla J. Jordanova, on 'Gender, generation and science: William Hunter's obstetrical atlas' (pp. 385–412). The large-folio formats (43 × 65 cm) of Smellie's original limited edition, *A Sett of Anatomical Tables* (1754), the second, corrected, edition (1761), and William Creech's edition (1778) bear interesting comparison with Hunter's even more magnificent atlas. These large folios were probably used for teaching purposes, to illustrate lectures. Lyle Massey, 'Pregnancy and pathology: picturing childbirth in eighteenth-century obstetric atlases', *Art Bulletin*, 87 (1) (2005), 73–91 does make such a comparison between Smellie's and Hunter's atlases—one that is strongly influenced by Michel Foucault. Here the emergence of obstetric atlases is seen as part of the process of medicalizing childbirth, of privileging the pathological over the normative view of pregnancy. See also Lisa Forman Cody, 'The politics of reproduction: from midwives' alternative public sphere to the public spectacle of man-midwifery', *Eighteenth-century Studies*, 32 (4) (1999), 477–95, as well as her *Birthing the Nation: Sex, Science, and the Conception of Eighteenth-century Britons* (Oxford: Oxford University Press, 2005), and Londa Schiebinger, 'Skeletons in the closet: the first illustrations of the female skeleton in eighteenth-century anatomy', *Representations*, 14 (1986), 42–81.

[59] John Hunter, then a young surgeon, still in training, probably carried out most of the early dissection work for the atlas. Alistair L. Gunn, 'The inevitable William and the accidental John', *Transactions of the Hunterian Society* (1968), 87–103 illustrates the relationship between the Hunter brothers and their contemporaries. John L. Thornton and Patricia C. Want, 'William Hunter (1718–1783) and his contributions to obstetrics', *British Journal of Obstetrics and Gynaecology*, 90 (1983), 787–94 discusses William Hunter's legacy and the significance of his atlas. John L. Thornton, *Jan van Rymsdyk: Medical Artist of the Eighteenth Century* (Cambridge: Oleander, 1982), esp. pp. 38–9, considers the work of the anatomical artist. Apart from his atlas, William Hunter published very little. Some of his correspondence has been published recently, but the diary he kept while attending the pregnancy of Queen Charlotte is of more interest (see J. Nigel Stark (ed.), 'An obstetric diary of William Hunter, 1762–65', *Glasgow Medical Journal*, 70 (1908), 167–77, 241–56, and 338–56).

Although Hunter's was a purely anatomical atlas—no deliveries or instruments were shown—the value for the practising midwife was obvious. It made visible in striking and accurate detail what could not be seen during pregnancy, and it did so in a way that surpassed what had previously been available to physicians.[60] It also set new standards for the illustration of anatomical texts.

During the nineteenth century there were at least three important developments in work on fetal deaths: operative techniques were refined and more specialized; comparative statistical analysis became routine; and retrospective surveys of patients started to be conducted. In terms of our hypothetical rising curve of slowly expanding knowledge the last-mentioned was probably of most lasting significance, but the first two also reflected positive advances, the consequence of enhanced surgical technique and the development of what we might now call a social-science research methodology. However, it is also clear that these three strands were sometimes combined to create specialized, multi-perspective studies on the causes of fetal death. Reports by James Whitehead and William O. Priestley are of special significance in this regard.

David D. Davis's *Elements of Operative Midwifery* (1825) provides an example of a specialist text focusing almost exclusively on operative procedures and instruments.[61] It outlined rules and precautions for undertaking operations, described the use of various forms of forceps, and provided twenty detailed plates illustrating techniques of craniotomy using the crotchet and Denman's perforator. But no attempt was made to review failure rates or to give an evaluation of operative methods and patient outcomes. Rather, fetal death was treated with a surprising degree of resignation: 'Dead children, like dead men,

[60] Several illustrated reports on the dissection of pregnant women or fetuses existed prior to the publication of the 1774 atlas, but none was of the quality or detail achieved in Hunter's. For example William Cowper, *The Anatomy of Humane Bodies* (Oxford: Printed at the Theater, Samuel Smith and Benjamin Walford, Printers to the Royal Society, at the Prince's Arms in St Paul's Churchyard, London, 1698) showed the dissection of a seven-month-old female fetus in tables 62 and 63. Bernard Siegfried Albini, *Icones Ossium Foetus Humani* (Leiden: Johan and Herman Verbeek, 1737) showed only the disconnected bones, and Wilhelm Noortwyk, *Uteri Humani Gravidi Anatomi et Historia* (Leiden: Johan and Herman Verbeek, 1743) was rather poorly illustrated. Donald Monro, 'The dissection of a woman with child; and remarks on the *gravid uteri*', *Essays and Observations, Physical and Literary, Volume 1, Article XVII* (Edinburgh, 1754), 403–25 reports the dissection of a woman six months pregnant and compares results with those of Albini and Noortwyk. Monro's illustrations are also crude.

[61] Davis, *Elements of Operative Midwifery; Comprising a description of Certain New and Improved Powers for assisting Difficult and Dangerous Labour; Illustrated by Plates: with Cautionary Strictures on Improper use of Instruments* (London: Printed for Hurst, Robinson, 1825). Davis was not a surgeon but a physician, a member of the Royal College of Physicians of London and Edinburgh; formerly a physician to the Sheffield General Infirmary; late obstetric physician to HRH, the Duchess of Kent; one of the physicians to the Royal Maternity Charity for Delivering Poor Married Women at their own Habitations etc.; and a lecturer in midwifery. Some apparently specialist texts were published in the eighteenth century, such as Nathaneal Torriano, *Compendium Obstetricii: or, A Small Tract on the Formation of the Foetus, and the Practice of Midwifery* (London: Printed for E. Comyns, under the Royal Exchange; and J. Robinson, in Ludgate Street, 1753), but, as in this case, they usually lack either detail or scientific rigour.

can tell no tales; and at any event, still-births are occasional and unavoidable occurrences in the practice of the most consummate professors of the art'.[62] Robert Lee's *Lectures on the Theory and Practice of Midwifery* (1844) and his *Clinical Midwifery* (1842, 1848) provide further examples of slow progress in midwifery practice.[63] Lee looks back repeatedly to the masters of earlier centuries, especially Smellie and the Hunter brothers, while maintaining the tradition of publishing anthologies of case notes.

While the texts of Smellie, Hamilton, and Denman contain no use of comparative statistical data, some of those written in the early nineteenth century did begin to use medical statistics in their accounts of the frequency of different presentations (natural, breech, footling, etc.) and in their discussion of instrumental deliveries. Here are a few examples from the 1830s, 1840s, and 1850s. James Reid's pocket *Manual of Practical Midwifery* (1836) claims that in breech deliveries 1 in 7 die, whereas for vertex deliveries it is 1 in 30, and that in his practice forceps were used in 1 out of 207 cases, but among other authorities the range was 1 in 93 to 1 in 215.[64] The physicians and men-midwives Edward Rigby and Fleetwood Churchill, whose midwifery textbooks were first published in 1841 and 1842, also used statistical material derived from other authorities, some of which was tabulated for ease of comparison.[65] Churchill, in particular, proved himself very adept at pooling results from a large number of studies. This he used to show the typical distribution of presentation positions and the relative dangers experienced. For example, in 38 per cent of footling presentations the child died (537 cases); in 697 cases of twins 30 per cent died; in 12 cases of triplets 31 per cent died; and in 251 deliveries where the crotchet was used

[62] Davis, *Elements of Operative Midwifery*, p. 11.

[63] Lee, MD, FRS (1793–1877), *Lectures on the Theory and Practice of Midwifery* (London: Longman, Brown, Green, and Longman, 1844). *Clinical Midwifery: Five Hundred and Forty-Five Cases of Difficult, Preternatural and Complicated Labour* (London: Churchill, 1st edn. (400 cases) 1842, 2nd edn. 1848) and *Three Hundred Consultancies in Midwifery* (London: Churchill, 1864) continue into the nineteenth century the tradition of collecting midwifery case notes.

[64] Reid, *Manual of Practical Midwifery: Containing a Description of Natural and Difficult Labours, with their Management. Intended Chiefly as a Book of Reference for Students and Junior Practitioners* (London: Churchill, 1836), figs. from pp. 140 and 103, respectively. Reid, a surgeon, follows the convention of the time in giving chances in the form $1/x$, and not as probabilities or percentages. He also has some more elaborate suggestions for resuscitating apparently stillborn infants: apart from the ingestion of brandy and water, the spine should be rubbed, the infant may be bathed in warm water, artificial respiration attempted, and a tracheal pipe used to inflate the lungs. See also Hibbard, *Obstetrician's Armamentarium*, pp. 56–7, tables 4.2, 4.3, and 4.4, which summarize the frequency of forceps use by several European authorities during the eighteenth and early nineteenth centuries (e.g. London and Dublin, 0.18 per cent, or 1 in 550; France, 0.41 per cent, or 1 in 246; Germany, 1.38 per cent, or 1 in 72).

[65] Edward Rigby, *A System of Midwifery* (London: Whittaker, 1841) and Fleetwood Churchill, *On the Theory and Practice of Midwifery* (London: Henry Renshaw, 1st edn. 1842, 6th edn. 1872). Rigby was physician to the General Lying-in Hospital and Lecturer in Midwifery at St Bartholomew's Hospital, London, while Churchill held equivalent positions at the Western Lying-in Hospital and the Richmond Hospital School of Medicine.

21 per cent of mothers also died.[66] However, in both of these cases Rigby and Churchill were incorporating statistical evidence into general textbooks. Others began to write specialist studies and to use statistical materials either to illustrate their points or as analytical devices in their own right.

Although John Soper Streeter's *Practical Observations on Abortion* (1840) did use comparative data, its real contribution lay in its exclusive focus in a specialist text on the causes of abortion.[67] The following passages illustrate the new level of understanding that had been acquired:

> Abortion in the earlier periods of pregnancy is in most instances owing to imperfection or morbid conditions of the embryo, or its ovarian envelopes, on the one hand; or to morbid action of the interior of the uterus leading to abnormal states of the uterine coverings or connecting structures, incompatible with the development of life of the foetus, on the other.[68]

> Abortion may occur from the ovum not forming its normal attachment to the uterus after entering that organ. This failure of attachment is owing to a defective or imperfect formation of the decidual lining, but it far more commonly happens that miscarriage does not take place till after the ovum has become fixed to the uterus. The usual process of abortion, therefore consists,
>
> 1st, In the destruction of that membranous and vascular attachment which the ovum normally forms, by means of the uterine envelopes and the placenta, to the interior of the uterus.
>
> 2nd, In the dilation and opening of the neck and mouth of that organ, and,
>
> Lastly, In the extrusion of the unaffixed or detached ovum.[69]

> The causes of abortion fall into three great classes.
>
> 1st. An imperfect or abnormal formation of the ovum. This may take place either in the foetus or in its membranes; or in the deciduas and placenta, those structures which fasten the ovum to the uterus and finally connect the embryonic and maternal systems.

[66] Churchill, *On the Theory and Practice of Midwifery*, esp. chs.10–11, on 'Pathology of the foetus—signs of its death' (pp. 130–4) and 'Abortion—premature labour' (pp. 134–44). Churchill combined his own results with those from a wide range of French, German, and British sources, principally for the lying-in hospitals. His *Researches on Operative midwifery, etc.* (Dublin: Keene, 1841) reprints several of his earlier studies, especially those based on statistical data. For example, p. 173, table II has maternal deaths resulting from the use of the crotchet, in which Smellie is credited with 9 per cent out of 44. Among British practitioners, forceps were used 120 times in 42 196 labours (p. 131).

[67] Streeter, *Practical Observations on Abortion* (London: Sherwood, Gilbert and Piper, 1840). Augustus Bozzi Granville (1783–1872) had also concerned himself with the study of abortion. His *Graphic Illustrations of Abortion and the Diseases of Menstruation* (London: Woodfall, 1833) used colour printing, the illustrations of the artist Joseph Perry, and Sir Charles Clarke's collection of fetuses from St George's Hospital, London. This work provided the starting-point for several subsequent analyses of fetal collections, for example, Franklin Paine Mall and Arthur William Meyer, *Studies on Abortuses: A Survey of Pathologic Ova in the Carnegie Embryological Collection*, Contributions to Embryology, 56 (Washington DC: Carnegie Institution of Washington (publication 275), 1921), 41.

[68] Streeter, *Practical Observations on Abortion*, p. 7. [69] Ibid. 29.

2nd. Morbid states, functional or organic, of the uterus and its appendages.

3rd. Morbid states generally of the constitution of the mother.[70]

But Streeter was not alone. Richard King and Henry Madge devoted book-length studies to the causes of death among the stillborn and the diseases of the fetus, respectively, while W. Tyler Smith gave considerable attention to the treatment of repeated miscarriage in his published lectures of 1856.[71] King's book is important because it was probably the first to attempt a systematic review of the evidence on stillbirth mortality. Although, as we know, he was not able to do this for Britain, he did collect data for France, Switzerland, Denmark, Sweden, and, most importantly, the Prussian states. His finding that in 1838 Prussia had a stillbirth rate of 36 per 1000 total births and that in most places he surveyed it lay between 25 and 52 seems entirely appropriate. Madge's study was probably the first in English to deal specifically with the diseases particular to the fetus. In the chapter on 'Pathology, diagnosis, and treatment of foetal diseases' he also assembled a table to illustrate the extent of stillbirth mortality, although he was obliged to combine, in a way that could only lead to confusion, data on the ratio of stillbirths to total deaths at all ages (e.g. 1 to 10 in Glasgow) with those for stillbirths to live births (e.g. 1 to 12.6 in Paris). Madge made two further decisive, summary statements that reflect his thinking: 'Abortion is a frequent occurrence in the early months of pregnancy, particularly among women of the lower classes, who are exposed to much bodily fatigue and mental anxiety'; and

Diseases of the foetus are divisible into three classes.

1. Those received from parents.
2. Those peculiar to itself or to the appendages.
3. Those arising from accidents or other causes.[72]

Smith's contribution, although less significant than the others, is nonetheless indicative of contemporary thinking and the uses of diverse sources. Taking his cue from William Farr's surmise that there were in England and Wales 3 dead infants to every 100 born alive, he estimated that there were 22 122 stillbirths in 1852—a shocking waste of life. His recommendations for the treatment of abortion had a similar air of spurious precision. They included the following: large doses of quinine; cold and tepid bathing; a daily enema of cold water;

[70] Streeter, *Practical Observations on Abortion*, p. 33. However, Streeter was still happy to recommend 'bleeding followed by an opiate' after a miscarriage had occurred, together with 'bodily quietude' and 'gentle walking in the air' (p. 63).

[71] King, *The Preservation of Infants in Delivery; being an exposition of the Chief Cause of Mortality in Still-born Children*, (London: Churchill, 1847); also, *The Cause of Death in the Still-born*, 2nd edn. (London: Churchill, 1858); Henry Madge, *The Diseases of the Foetus in Utero (Not Including Malformations): With an Outline of Foetal Development* (London: Renshaw, 1854); and W. Tyler Smith, *A Manual of Obstetrics: Theoretical and Practical* (London: Churchill, 1858)—a course of lectures from *The Lancet* of 1856.

[72] Madge, *Diseases of the Foetus*, pp. 159 and 179.

but 'nothing is so likely to prolong gestation to the full term as absolute rest in the horizontal position'; and when all other means failed 'an attempt should be made to eradicate the abortive diathesis by a year's marital separation, and a tonic treatment in the meantime'.[73]

SPECIALIST STUDIES OF FETAL DEVELOPMENT AND ABORTION: WHITEHEAD'S SURVEYS AND PRIESTLEY'S *PATHOLOGY*

James Whitehead (1812–85) was surgeon to the Manchester and Salford Lying-in Hospital. His study *On the Causes and Treatment of Abortion and Sterility* (1847) was perhaps the first full-length account of the subject that collected retrospective data from pregnant women themselves.[74] 'Two thousand married women in a state of pregnancy, admitted for treatment at the Manchester Lying-in Hospital during parts of the years 1845 and 1846, were interrogated in rotation respecting their existing condition and previous history.'[75] These 2000 represented about two-thirds of the total number of pregnant women treated at the hospital. The excluded third 'appeared to remember so very imperfectly the events of their previous life, that their accounts were judged altogether inadmissible in a record of this character'. Whitehead used the term 'abortion' to refer to all fetal deaths after the seventh week of uterine life; they are, therefore, predominantly miscarriages or spontaneous abortions, with some stillbirths. He argued that when birth 'takes place before the end of the sixth month [24 weeks LMP], it is invariably fatal to the offspring'. Of the 2000 selected, 747 reported having experienced at least one abortion (4777 pregnancies, 1222 abortions), while the remaining 1253 had had none (3906 pregnancies). More than 37 per cent of women had experienced at least one abortion before the age of thirty, and some 87 per cent of those who had reached the end of their reproductive period (64 women) reported having had an abortion. Whitehead found that it was the

[73] Smith, *Manual of Obstetrics*, pp. 555 and 159. The author was Physician Accoucheur to, and Lecturer on Midwifery at, St Mary's Hospital, London.

[74] Whitehead, *On the Causes and Treatment of Abortion and Sterility: Being the Result of an Extended Practical Inquiry into the Physiological and Morbid Conditions of the Uterus, with reference especially to Leucorrhoeal Affections and the Diseases of Menstruation* (London: Churchill, 1847). It had over 400 pages with 13 tables and 56 detailed case notes, but no illustrations, apart from one device, few references, and no index. Whitehead's other publications include *On the Transmission, from Parent to Offspring, of some forms of Disease, and of Morbid Taints and Tendencies* (London: Churchill, 1851), *The Rate of Mortality in Manchester and Other Manufacturing Towns, Compared with that of Cathedral and County Towns*, 3rd, enlarged, edn. (London: Churchill, 1864), and, with A. Schoepf Merei, *First Report of the Clinical Hospital for Diseases of Children, Stevenson Square, Manchester: Containing an Account of the Results of the First 530 Patients there Treated* (Manchester: Bradshaw & Blacklock, 1856).

[75] Whitehead, *On the Causes and Treatment of Abortion*, p. 245. See also Malcolm Potts, Peter Diggory, and John Peel, *Abortion* (Cambridge: Cambridge University Press, 1977), 157–60.

third, fourth, and subsequent pregnancies and those of women at older ages that were most likely to end prematurely and not the first pregnancies as popularly believed. Of the 2000, 226 were pregnant for the second time, with 20 having aborted the first pregnancy, while of 230 who were pregnant for the third time, 58 had previously aborted.

Table 5.2 is based on Whitehead's table IX. It shows the gestational ages relating to 602 'abortions', which occurred under his 'own immediate observation'. He gives the gestational ages in months, but says that they relate to periods of two weeks either side of the month specified; so, for example, two months approximates to 8–11 weeks LMP. Although Whitehead noted that the fetus of six months' growth was generally considered viable, most born at that age were stillborn and all but one died within six hours after birth. The deaths of three women were associated with these pregnancies.

Whitehead prefaced his discussion of the causes of abortion among the 747 women with some general observations:

The causes of abortion are, according to authors, exceedingly numerous; including almost every circumstance in life, however trivial, which happens in deviation from the ordinary quiet course of nature. They have been divided into *predisposing*, and *occasional* or *exciting* causes; and the French writers add another, which they call the *immediate* or *determining* cause; referring merely to the physiological agency of the uterus and parts associated with it, engaged in the separation and expulsion of its contents.

By *predisposing causes*, are meant certain morbid conditions, local or constitutional, already in the system; or a particular susceptibility to morbid action during pregnancy, by the operation of which the process is likely to be prematurely arrested. They have been subdivided into two more orders: those, namely, which originate entirely in the maternal system; and those which appear to depend upon some defect in the product of gestation.

Table 5.2. The period of pregnancy at which abortion or birth occurred in 602 cases reported by Whitehead and published in 1847

Gestational age in weeks LMP (months)	Number of cases	Number of stillbirths	Number of live births	Number dying during first month after live birth
8–11 (2)	35	—	—	—
12–15 (3)	275	—	—	—
16–19 (4)	147	—	—	—
20–3 (5)	30	—	—	—
24–7 (6)	32	24	8	8
28–31 (7)	55	38	17	14
32–5 (8)	28	23	5	4
Total	602	85	30	26

Note: Whitehead called the 602 cases 'abortions', but clearly they include miscarriages (487), stillbirths (85), and early-neonatal deaths (26).

Source: Whitehead, *On the Causes and Treatment of Abortion* (1847), p. 249, table IX.

Of the first kind are, diseased states of the uterus, including all the morbid conditions of which the organ is susceptible, as tubercular formations; polypous and fibrous growths; hydatids; dropsy; rigidity of the uterine fibres; abundant leucorrhoeal discharges; dropsy of the amnion; accumulation of fluid between this membrane and the chorion; plurality of *ova*; and disease of the uterine appendages: also, certain constitutional conditions, as plethora; cachexy; morbid irritability; the haemorrhagic, scorbutic, or scrofulus diathesis; and certain transmitted peculiarities.

Among accidental causes of abortion, the most common are, violent mental emotion, as excessive grief, joy, fear, anxiety, anger, and the like; falls, blows, bruises, severe efforts, sudden movements of the body, as running, dancing, jumping; hysteric convulsions, epileptic fits, or severe pain; immoderate laughter, crying, coughing, vomiting, dysentery, diarrhoea; the use of strong purgative, emmenagogue, or mercurial medicines; the shock of the shower-bath, the hot foot-bath, copious bleeding; tight lacing, or any other inconvenience arising from dress; and whatever has a tendency to disturb the equilibrium of the circulation, or derange the balance of the nervous system.[76]

In terms of the 1222 abortions reported by the 747 women, Whitehead gave the following breakdown.

'Inward weakness', impaired state of the health generally, and acute disease [also known as 'waste', that is 'a light-coloured vaginal discharge unconnected with menstruation' or *leucorrhoea, fluor albus*, 'the whites'] 911

Accidents, mental perturbation, &c. 222

No assignable cause 90

But he also provided in his table X a breakdown of the causes of 378 abortions about which he appears to have had greater confidence, since it had been compiled 'with a view to obtain a correct statistical average of the prevailing

Table 5.3. Causes of, and conditions associated with, abortion in 378 cases reported by Whitehead and published in 1847

Causes	Cases	Percentage
Accidental agencies	44	11.64
Placenta praevia	8	2.13
Constipation of the bowels	3	0.79
Retroversion of the uterus	3	0.79
Incurable disease	1	0.27
Vascular congestion	15	3.96
Disease of the lower part of the uterus	275	72.75
Obscure causes	29	7.67
Total	378	100.00

Source: Whitehead, *On the Causes and Treatment of Abortion* (1847), p. 256, table X.

76 Whitehead, *Causes and Treatment of Abortion*, pp. 251–2.

causes thereof, occurring in immediate succession; a careful investigation having been instituted in each instance'. This is shown here as Table 5.3. Whitehead proceeded to consider each of these causes and to offer some detailed case notes to illustrate his points.

For example, the following case is one of three used to illustrate the treatment of women with a history of abortion, but who were probably not suffering from any major illness (like constipation and an ulcer) and could, therefore, be treated easily and effectively.

Case XXIX

Local uterine phlebitis with haemorrhage, in the fourth month of pregnancy. Threatened abortion. Issue, successful.

Ellen Dillon, aged twenty-six, requested my assistance on 9 May 1844, being in the fourth month of her third pregnancy. Her previous pregnancy terminated at the end of the sixth month, under circumstances similar to the present. It was stated that she had been suddenly seized, whilst in pursuance of her household avocations, with pain of the loins and abdomen, of an intermitting and forcing down character, similar to that of labour, accompanied with discharge of blood from the vagina, which, on my arrival, was considerable in quantity. For some weeks past, she had suffered from piles, with occasional escape of blood from the anus. The veins of the lower extremities, and the external pudic veins, were greatly distended, being, in some places, inflamed and painful. The abdomen was distended and tender, but no uterine tumour could be detected. No sound was elicited on inquiry with the stethoscope. The mammae exhibited the usual indications of pregnancy. She had not felt the fetal movements, but believed herself to have arrived near the end of the fourth month. The vaginal membrane was hot, turgid, and communicated a pulsatory impression on every side; the lower extremity of the uterus was tumid; the *os uteri* slightly dilated, its boundaries soft and irregular. On specular examination, the anterior labium occupied entirely the upper aperture of the instrument, being of a dark-red colour, and visibly congested. At its most dependent part was a depressed orifice the size of a split pea, whence a stream of blood issued freely into the speculum. This depression had a smooth but not well-defined margin, and presented no appearance of granulation. No fluid of any kind escaped from the *os uteri*. It was now accidentally mentioned that the bleeding was first noticed during the preceding night, and that it supervened immediately upon the act of sexual intercourse, which was attended with severe, deep-seated pain.

The patient was a strong person, of the bilious temperament, full habit of body, and subject to obstinate constipation of the bowels, and to attacks of crysipelas. The treatment consisted of free abstraction of blood from the arm, the exhibition of an active saline aperient at intervals, of an anodyne at bed-time, and complete repose in the recumbent posture. The uterine haemorrhage ceased soon after the operation of vensection, but returned, to a slight extent, during the ensuing night. On the following day, a feeling of distension and tenderness of the abdomen still remained, eight more leeches were applied to the hypogastrium, and the anodyne ordered to be repeated at bedtime. On the third day, the haemorrhage had completely ceased, and the patient expressed herself quite comfortable, but weak. On introducing the speculum at this period, the parts were found greatly reduced in size, both labia falling freely within the orifice of the instrument.

They were covered by a quantity of muco-purulent secretion, on removal of which, the orifice before noticed appeared as a shallow ulcer with uneven surface. A small quantity of blood escaped during examination, caused, doubtless, by pressure of the instrument. The sore was treated with the solid nitrate of silver. From this period the patient had no recurrence either of haemorrhage or pain; nor was the speculum afterwards used, as no symptoms indicating the existence of local disturbance were developed. She was delivered of a plump, healthy child, at the full term of utero-gestation, on 11 October, five months after the occurrence of the haemorrhage.[77]

However, Whitehead gave most attention to that category of causes which appears in Table 5.3 as '[d]isease of the lower part of the uterus'. Commonly referred to as 'inward weakness', also known as 'waste', or *leucorrhoea, fluor albus*, 'the whites'; these vaginal discharges were linked to ulcerative disease. Whitehead distinguished between *mucous leucorrhoea* and *purulent leucorrhoea*. Of the 2000 women questioned and examined, 1116 had some form of *leucorrhoea* symptoms (180 mucous, 936 purulent). A connection was made to venereal infections imperfectly cured or improperly treated. Venereal infections became a preoccupation of Whitehead's. His next study, *On the Transmission, from Parent to Offspring, of some forms of Disease, and of Morbid Taints and Tendencies* (1851), was almost entirely concerned with syphilis. It dealt in more detail with thirty-three cases as a follow-up to the earlier survey in which the mother suffered from venereal disease—for example, Case XIII of KM married at 18 in 1834 who had contracted syphilis from her husband:

The wife's first pregnancy ended at six months in the birth of a stillborn half putrid foetus; the second, fifth, sixth, eighth, tenth, and eleventh, were abortions at about three months; the twelfth terminated at eight months, the child was stillborn and decayed; the third, fourth, seventh, and ninth were born at full term but were meagrely grown; each of these became affected with secondary syphilis a few days after birth, in form of scaly blotches, occupying the skin in most parts of the body, and having sore mouth, inflamed eyes, obstructed respiration, and wasting, under which they died, one at the age of four weeks, one at six weeks, one at eleven weeks, and one aged fifteen weeks.

The thirteenth, born in 1847, died at eleven weeks, but the fourteenth, delivered in September 1848, survived because both parents had undergone a successful course of mercurial treatment. Whitehead noted the need for 'patience and perseverance in treatment of this most subtle and disastrous complaint'.[78]

Clearly Whitehead's various surveys represent an important development in work on the causes of fetal death. Substantial numbers of women were asked about their birth histories, including miscarriages and stillbirths; they were clinically examined and at least some of the symptoms observed were recorded; the results were tabulated and illustrated using detailed case notes. However, it

[77] Whitehead, *Causes and Treatment of Abortion*, pp. 274–5. Cases XXVII and XXVIII both had histories of multiple abortions that Whitehead was able to rectify.

[78] Whitehead, *Transmission, from Parent to Offspring*, pp. 114 and 117.

will be obvious to modern readers familiar with survey methods that the data collected must have been seriously flawed and that they were analysed in a far from rigorous fashion. Whitehead was aware of some of these problems. For example, he noted:

In interviewing poor, uneducated women, respecting their personal history, great caution must necessarily be exercised to avoid being led into error. They are so regardless of essential particulars, so liable to forget events as they really occurred, and have such an irresistible propensity to amplify upon any topic relating to their own sufferings, that their statements must, at all times, be received with a degree of limitation.[79]

But, even so, it might have been possible to extract a little more meaning if the women's reported ages, previous pregnancies, and live births had been employed systematically to give an approximation of the frequency of miscarriages by age and parity. The evidence was collected, but not used in a consistent form. Further, Whitehead was inclined to discuss the characteristics of women drawn from different survey populations as though they were of equal consequence. He was often selective rather than comprehensive in his approach. All of this makes it difficult for us to take his findings at face value. That he was an important pioneer of fetal epidemiology cannot be denied, and this especially in the circumstances of Manchester in the 1840s. He asked some entirely pertinent questions which he attempted to answer by interviewing patients, not just examining them.

In his *The Pathology of Intra-uterine Death* (1887) William O. Priestley (1829–1900) took a similar approach, but was, nonetheless, highly critical of Whitehead's figures:[80]

These figures, however, do not accurately represent the frequency of abortion throughout the whole childbearing period, and a considerable proportion of the women were pregnant for the first time. In any case, they only afford a calculation of the average number of abortions in the first half of the reproductive period; and inasmuch as abortion is alleged to be more frequent in the latter half of the childbearing period, it is probably much below the average of the whole [i.e. 1 in 7 pregnancies terminated in abortion].[81]

[79] Whitehead, *Causes and Treatment of Abortion*, pp. 254–5.

[80] Sir William Overend Priestley, *The Pathology of Intra-uterine Death*, Lumleian Lectures, delivered at the Royal College of Physicians of London, March 1887 (London: Churchill, 1887). There are three lectures here, all of which were also published in the *British Medical Journal* for 1887. Lecture II, 'Diseases of the foetal appendages', and Lecture III, 'Diseases and anomalies of the placenta', are important discussions of technical pathological problems. Only Lecture I will be considered in any detail here. Priestley's other publications include *Lectures on the Development of the Gravid Uterus* (London: Churchill, 1860), a rather poorly illustrated sequel to Hunter's atlas, and 'On the treatment of cases of abortion in which the placenta and membrane are retained', *Transactions of the Obstetrical Society of London*, 3 (1861), 146–71. Charles Bell, 'Remarks on abortion in the early months of pregnancy', *Edinburgh Medical Journal*, 11 (2) (1865), 120–33 also illustrates the 'incidental case history' approach that was still common in the 1860s, although obviously influenced by Whitehead's work.

[81] Priestley, *Pathology of Intra-uterine Death*, p. 7.

Priestley took 1000 women from among his private patients, but found that 'so far as many of the cases were concerned, the accounts of miscarriage were so untrustworthy or so indistinct as to be valueless'.[82] He therefore reduced the number to 400 for whom the evidence was 'distinct and unequivocal'. All of the 400 women were aged forty or more and had completed, or all but completed, their childbearing. The results were tabulated and compared with those from Whitehead's study of 2000 women. Here, they are shown as Table 5.4.

Priestley's interpretation of these findings stressed the differences in age composition between his and Whitehead's populations: 23 per cent of pregnancies ending in fetal death as against 14 per cent, and 62 per cent of women having experienced at least one abortion against 37 per cent. But he was also concerned with the general age profile of risk, believing that 'women of the better classes incur much more risk of aborting in their first pregnancies than their poorer sisters, from the prevailing fashion of taking long journeys immediately after marriage'. Among the poor, abortion was probably 'very frequent' yet practically impossible to estimate accurately, since 'it may produce so little disturbance in a woman's health as to be scarcely noticed'. Here Priestley refers to and reproduces Whitehead's table IX (Table 5.2 above) in support of his argument that the risk of abortion may increase after 14 weeks. He also draws on Robert

Table 5.4. Comparison of Whitehead's and Priestley's findings on the frequency of abortion

	Whitehead (average age about 30)		Priestley (all aged at least 40)	
Table I. Women and abortions	Number	Per cent	Number	Per cent
Women who had not aborted	1253	62.65	152	38.00
Women who had aborted	747	37.35	248	62.00
Total number of women under observation	2000	100.00	400	100.00
Women who had borne no live births	—	—	27	6.75
Table II. Pregnancies and abortions	Number	Per woman	Number	Per woman
Live births	7459	3.73	1783	4.46
Abortions	1222	0.61	542	1.35
Total pregnancies	8681	4.34	2325	5.81
Table III. Ratio of abortions	Per cent	1 in	Per cent	1 in
Ratio of abortions to pregnancies	14.08	7	23.32	4.33
Ratio of abortions to live births	16.39	6	30.40	3.33

Source: Priestley, *Pathology of Intra-uterine Death* (1887), p. 9, tables I, II, and III.

[82] Allen J. Wilcox and Louise F. Horney, 'Accuracy of spontaneous abortion recall', *American Journal of Epidemiology*, 120 (5) (1984), 727–33 shows in a more systematic fashion how right Priestley was to doubt patient recall.

Collins's statistics for the Dublin Lying-in Hospital to suggest that most stillborn fetuses (71 per cent in this instance) were either premature or putrid (i.e. antepartum), and that their deaths were not, therefore, due to injuries during delivery (i.e. intrapartum).[83] The significance of Whitehead's table IX cannot be overemphasized, therefore.

When Priestley came to the causes of intrauterine death, he considered, then turned away from, the classifications developed by other authorities. Instead, he simply distinguished those causes that could be linked to the father, the mother, or were related to the fetus itself. As far as the father was concerned, the following effects were mentioned: lack of potency in the 'spermatic fluid' associated with age or ill health and this independent of the health of the mother; certain specific diseases such as diabetes, lead-poisoning, and syphilis. On the last-mentioned, Priestley was inclined to accept 'the idea that syphilis could be transmitted directly from the father to the fetus without visibly affecting the mother' and cited a number of French authorities in support.

His treatment of causes associated with the mother was far more detailed. He distinguished between, first, general conditions and, second, specific diseases and local pathological causes. Among the first group, Priestley listed the following: 'constitutional conditions, external agencies which depress the general health, unhealthy habits and occupations, extremes of heat and cold, climate, locality, under-feeding and over-feeding, prematurity or old age; in fact, anything in the mother which tends to deteriorate strength and vigour, must be counted productive of embryonic death'.[84] The perils of tight-lacing came in for comment, again, as did the benefits of healthy exercise in the open air. On climate, we have the intriguing statement that 'English women going to reside in India are prone to abort'. And on diet: 'So far as I know, we have no data by way of enabling us to determine the relative effect of over- or under-feeding on intra-uterine life', but 'that both have an effect is undoubted'. Priestley recognized the effects of anaemia, high altitudes, interbreeding, plural births, too many or too rapidly succeeding pregnancies, of pregnancies at early and late ages, and of temperament, all of which he dealt with at some length, but especially the importance of anaemia. Mention was also made of so-called 'epidemics of abortion' which could be associated with famines, warfare, and the like—with the siege of Paris (1870–1) producing children with very weak constitutions who were known as 'enfants du siège'.

Priestley's list of direct and specific causes of abortion in the mother reads like a lecture on epidemiology. Smallpox, scarlet fever, measles, erysipelas,

[83] Robert Collins, *A Practical Treatise on Midwifery, Containing the Result of Sixteen Thousand Six Hundred and Fifty-four Births, Occurring in the Dublin Lying-in Hospital, During a Period of Seven Years Commencing November 1826* (London: Longman, Rees, Orme, Browne, Green and Longman, 1835), ch. 4, esp. p. 92, table 4.3. These data show a stillbirth rate of 67.3 per 1000 total births. Priestley fails to make his point sufficiently clear. Presumably his intention is to demonstrate that most deaths in the late-fetal period of gestation are due to natural causes.

[84] Priestley, *Pathology of Intra-uterine Death*, p. 22.

diphtheria, typhoid fever, pneumonia, pleurisy, eclampsia, phthisis or pulmonary tuberculosis, diabetes, jaundice, heart disease, malignant cholera, and, of course, syphilis, were all included as potential causes of fetal as well as maternal death. The consequences for the fetus of raised maternal body temperature connected with fever (termed pyrexia) were of special significance. Priestley, and others, believed that the fetal temperature was higher, and increased faster, than that of the mother, so that the fetus was likely to reach a critical state before the mother, with abortion or premature labour linked to 'forcible uterine contraction' the consequence. This temperature-induced response could be produced by most of the specific diseases mentioned. Of the diseases listed, some were obviously more prevalent, and more dangerous, to pregnant women and fetuses than others. Smallpox and syphilis are the most frequently considered examples, to which *The Pathology of Intra-uterine Death* is no exception, but Priestley made more interesting observations on some of the less obvious candidates. Of the common infectious diseases of childhood (scarlet fever, measles, diphtheria, for example), tuberculosis and eclampsia are worthy of particular consideration. Although the childhood infectious diseases do not target pregnant women with special force, once contracted they can produce eruptive fevers which provoke miscarriage or premature birth and early death soon after. These diseases are also epidemic in form, and non-immune mothers are especially susceptible via contact with their infected offspring. As for pulmonary tuberculosis, Priestley drew the following inference:

> In the early stages of phthisis the disease seems to be arrested by the occurrence of pregnancy. An impulse is given to nutrition generally,—but later when the growing foetus makes more demand on the resources of the mother, the disease advances more rapidly. It has been remarked also that when phthisis comes on during gestation or is developed in those predisposed to it as the result of exhaustion by childrearing—a renewed pregnancy rarely goes to full term.[85]

If pregnancy hastened the development of latent tuberculosis, the effects of the disease were often exacerbated by anaemia, which not only led to fetal death, but also the production of 'feeble progeny'. Eclampsia or 'puerperal convulsions', the consequence of heightened blood pressure, was associated with fetal asphyxia by some, with uraemia by others, and by most with a rise in the mother's body temperature to a level that was 'incompatible with the safety of the child'.

There can be no doubt that Priestley's lectures were a tour de force. They provided a detailed survey of current knowledge drawn from direct experience and the most authoritative British, French, and German medical literature.[86]

[85] Priestley, 53.

[86] Priestley's use of the latest international literature set new standards for critical review, although his referencing system was rather haphazard. Among the most important influences were the following texts: Pierre Cazeaux, *Traité théoretique et pratique de l'art des accouchements. Comprenant l'histoire des maladies qui peuvent se manifester pendant la grossesse et le travail et l'indication des soins à donner à l'enfant nouveau-né* (Paris: Méquignon-Marvis, 1841), esp. pp. 225–52, which

His check-list of the causes of abortion, especially those with a strong maternal influence, was remarkably full, and his appreciation of the means by which certain specific diseases could produce a heightened risk of miscarriage, stillbirth, and premature labour with likely neonatal death was exceptional. His treatment of the childhood infectious diseases and tuberculosis was both novel and sophisticated. Priestley was critical of Whitehead's contribution, but appreciative of some of his findings. In particular, it was obvious to Priestley that women found it very difficult to recall their past reproductive histories, and especially the miscarriages, and that such evidence must be treated with the utmost scepticism. But it also seemed clear that one should focus on women who had completed their child-bearing, or that experience should be distinguished by maternal age. These were important advances for statistical enquiries.

This account of practice and causes will lead in Chapter 7 to an evaluation of the contribution of advancing obstetric knowledge to changes in, especially, late-fetal mortality during the eighteenth and nineteenth centuries. What we have so far is a rather uneven picture in which practical experience was set down, and communicated in textbooks and case notes; translation and the expanding book trade facilitated the spread of information; specialist training courses were offered to both men and women; obstetric instruments, particularly the curved forceps, were developed and refined; anatomical drawing from dissection enhanced physiological understanding; and large, systematic retrospective surveys of birth histories assisted the identification of what was 'normal'—the average experience. There are many positive signs here; it should not be surprising that there was some decline in both late-fetal and maternal mortality in eighteenth-century England, although rates were still high at the start of the twentieth century. There were, of course, many important areas in which medical practice did not change radically enough, and it is very difficult to argue a case for significant advances in the nineteenth century. Antiseptic practices were non-existent to rudimentary even after the 1870s; opium and alcohol were the only anaesthetics before the use of chloroform in the 1840s, for example; and blood-letting was still popular. No miracles, then, but some signs of improvement.[87]

has an extensive discussion on abortion; James Y. Simpson, *Contributions to Obstetric Pathology and Practice* (Edinburgh: Sutherland and Knox, 1853); and Louis Arthur Alphonse Carpentier, *Traité practique des accouchements* (Paris: Baillière, 1880). Charpentier (1836–99) was especially influential. His thesis, *De l'influence des divers traitements sur les accès éclamptiques* (Paris: Parent, 1872), was one of the first pieces of published work on eclampsia. Two studies published in England during the 1880s made substantial use of both Whitehead and Priestley, illustrating their influence on contemporaries: Leslie Phillips, *Pathology and Treatment of Abortion* (Birmingham: Cornish, 1887), and Robert Reid Rentoul, *The Causes and Treatment of Abortion* (Edinburgh: Pentland, 1889).

[87] Robert Woods, 'Lying-in and laying-out: fetal health and the contribution of midwifery', *Bulletin of the History of Medicine*, 81 (4) (2007), 730–59 argues for a positive contribution in the eighteenth century, but not the nineteenth.

6

Fetal pathology and social obstetrics

Chapter 5 closed with a list of some potentially important advances in midwifery practice in England during the eighteenth and nineteenth centuries. In the twentieth century, as we began to establish in Chapter 4 (pages 82–85), there were many significant developments in medicine and social policy that had a bearing on survival chances—ante- and postnatal care, blood transfusion, antibiotics, the incubator, ultrasound, and fetal surgery included. Underpinning these advances were two parallel and ultimately mutually supporting sets of arguments about how to understand the causes of fetal death. In one group there were the pathologists, the successors of Sir William Priestley, who believed that fetal pathology could provide the answers and that morbid anatomy held the key. In the other group, patient surveys, population statistics, and the monitoring of high-risk individuals were seen as the way forward, with James Whitehead the pioneer. The pathologists were championed by John William Ballantyne (1861–1923) and the epidemiologists by Sir Dugald Baird (1899–1986), the promoter of 'social obstetrics'. Both were Scots: Ballantyne from Edinburgh and Baird based for most of his career in Aberdeen. Both, in their different ways, showed deep commitment to fetal medicine, and the care of infants and pregnant women. Comparing their approaches to intrauterine death, their research methods, their findings, and the way these influenced practice will provide an insight into fetal medicine in the late nineteenth and twentieth centuries. It will also help us to see how difficult and troubled such work has proved to be. While the risk of fetal mortality has been greatly reduced, much uncertainty still remains over the causes, both proximate and background, of many of those late-fetal deaths that do still occur.

DISEASES OF THE FETUS AND INFANT

Ballantyne was a brilliant pathologist, a distinguished scientist, a prolific author, an influential campaigner, a committed Christian, and a pillar of the Edinburgh medical establishment. However, he was not fashionable and he went largely unrecognized—'a library and laboratory man'.[1] His greatest contributions are to be found in his research monographs and papers and his textbooks, the most important of which are listed in the Bibliography.

The twin bases of Ballantyne's work were anatomy and physiology, and these he applied first to infants and then to fetuses. His first book-length publication, which was based on his Edinburgh MD thesis, dealt specifically with paediatrics. It was aimed at a professional audience—what a medical practitioner should know in order to become a specialist in infant care with a solid grounding in anatomy and physiology. There was much sound advice on the sterilization of feeding bottles, as well as the normal weight- and length-gain patterns during the average infant's first year (i.e. birthweight: male 3200g, female 2900g; length: 50 cm, with 1 or 2 cm variation). But arguably his greatest work, in terms of both detail and the new ideas it contained, was subtitled *An Attempt Towards a System of Ante-natal Pathology* and directed specifically at the fetus. *The Diseases and Deformities of the Foetus* was published in two volumes in 1892 and 1895. Its claim to be the first book to 'discuss together and at length in one work the diseases and the deformities of the foetus' was probably justified. Its originality lay chiefly in its scale—its attempt to cover all aspects of the problem and to discuss them in a systematic and ordered fashion.

Ballantyne began by outlining the difficulties his study was going to face. These related especially to 'symptomatological nomenclature' and the absence of reliable evidence on the level of fetal mortality:

> It is impossible to say exactly what is the foetal death-rate, for accurate statistics are wanting; but it must be very high, for the frequency with which abortion occurs is well known. Indeed, it would seem that there are few women who complete their childbearing life without having on one or more occasions had a miscarriage.
>
> The absence of a compulsory system of registration of stillbirths prevents us from arriving at any exact estimate of their frequency, but every medical man must admit that they are far from uncommon.
>
> Many of the deaths which occur during the first year of life cannot, of course, be ascribed directly to the foetal morbid states; but few will be prepared to assert that a great number of them are not due to conditions which are the result of intrauterine disease or malnutrition. This contention is strengthened by the fact that the nearer foetal life the infant is the more likely is it to succumb. It may, however, be argued that a high foetal and infantile death-rate is not an absolute proof of a want of knowledge of ante-natal pathology and aetiology, for the reason that a great part of the mortality is immediately due to neglect and ignorance on the part of parents. But whilst parental carelessness is

[1] See Helen Russell, *J. W. Ballantyne, MD, FRCPEdin, FRSE, 1861–1923*, Royal College of Physicians of Edinburgh, publication 39 (Edinburgh: Royal College of Physicians, 1971) for a highly informative biographical sketch, and H. E. Reiss, 'Historical insights: John William Ballantyne 1861–1923', *Human Reproduction Update*, 5 (4) (1999), 386–9 for a more recent appreciation.

truly responsible for many deaths amongst infants, and whilst maternal ignorance is the cause of many miscarriages, yet there is, underlying this carelessness and ignorance in the laity, a real absence of knowledge in the medical profession. The practice of the people always reflects more or less accurately the teaching of the profession.[2]

As to method, Ballantyne proposed the following approach via morbid pathology:

In the first place, specimens illustrating foetal disease or malformation ought to be looked for, and, when found, ought to be thoroughly dissected. The post-mortem examination of foetuses, or stillborn infants, and of newborn infants who succumb within the first weeks of life, is a means of observation to which the attention of the medical profession has not yet been sufficiently directed.[3]

Information from such dissections was to be combined with that derived from interviews with parents to create a full picture of the health and circumstances of fetus, mother, and father.

Ballantyne's scheme of data ran as follows:

I. Clinical history and symptomatology
- A. Maternal
  - 1. General
    - a. Age, development, weight etc.
    - b. Habits and environment
    - c. Constitution
    - d. Diseases
    - e. Deformities
  - 2. Sexual
    - a. Menstruation: type, habit etc.
    - b. Marriage: early or late etc.
    - c. Morbid states of uterus and annexa
    - d. Pregnancies
      - (1) Past: number and character of
      - (2) Present: character, twin or single etc.
      - Symptoms in pregnancy—
        - a. Maternal: gastric, renal, nervous and other derangements
        - b. Foetal: movements, heartbeat etc.
    - e. Labours and puerperia
      - (1) Past
      - (2) Present
    - f. Later sexual history (after birth of diseased foetus)
- B. Paternal: history of father's health, constitution, habits etc.
- C. Infantile (when the infant is born alive and survives for a longer or shorter time, or when there are twins of which one lives) Symptoms of disease in the various systems, especially in that obviously affected.

[2] J. W. Ballantyne, *The Diseases and Deformities of the Foetus: An Attempt Towards a System of Ante-natal Pathology*, i (Edinburgh: Oliver & Boyd, 1892), 8, 9, and 10. Ballantyne quoted from the studies by Whitehead and Priestley summarized in Table 5.4, on p. 148.

[3] Ibid. 14.

D. Family history—heredity

II. Morbid Anatomy

A. Of foetus

1. External appearances
2. Internal appearances—dissection
3. External and internal appearances—sectional method
4. Microscopic appearances
5. Bacteriological investigation of tissues
6. Chemical characters of fluids etc.

B. Of foetal annexa

Macroscopic and microscopic characters of:

1. Placenta
2. Umbilical chord
3. Membranes (1) Chorion (2) Amnion
4. Liquor amnii

C. Of mother (if the birth of diseased infant be followed by the death of mother)[4]

After a lengthy review of existing schemes, Ballantyne also developed his own classification of fetal diseases:

I. Idiopathic diseases (developed in foetus itself)
II. Transmitted
III. Traumatic morbid states
IV. Toxicological conditions
V. Death of foetus, and post-mortem appearances in:
A. Dissolution B. Mummification C. Maceration D. Putrefaction[5]

These schemes and classifications were brought together, refined, and applied in a *Manual of Antenatal Pathology and Hygiene* (1902/4). The second volume of the *Manual* was concerned with the embryo and its physiological development up to about six weeks, but in the first volume, on the fetus, Ballantyne began to report findings from the examination of nearly 300 fetal specimens that he had collected, although his principal objective was to establish a comprehensive survey of the field.

Four examples will be used here to illustrate his approach, all taken from *The Foetus* (1902). First, Ballantyne went to some considerable lengths to describe the

[4] Ballantyne, *Diseases and Deformities of the Foetus*, i. 24–6. Ballantyne's paper in *American Journal of Obstetrics*, 41 (1900), 577–86 illustrates how he used this scheme to develop a full case history and recommendations for treatment.

[5] Ibid. i. 94–5. Ballantyne devoted five chapters to a historical sketch of studies on fetal diseases, many of which have been considered in Chapter 5 above, but two were singled out for special attention. Joseph Raulin (1708–84) in his *De la conservation des enfans, ou les moyens de les fortifier, de les preserver et quérir des maladies jusqu'à l'âge de puberté*, 2 vols. (Paris: Merlin, 1768, 1769) proposed a classification of causes of fetal death which distinguished between those stemming from the mother (syphilis, malaria, smallpox, measles, convulsions, jaundice) and those particular to the fetus itself (diseases of the skin, head, and abdomen and, even when the mother was healthy, dropsy, smallpox, convulsions, jaundice). A book by Jonas Graetzer (1806–89), *Die Krankheiten des Foetus* (Breslau: Aderholz, 1837), was considered the standard work on diseases of the fetus.

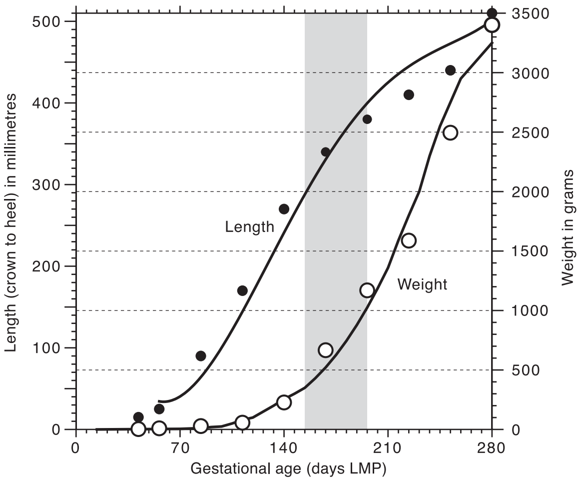


Fig. 6.1: Ballantyne's data on fetal growth in terms of length and weight. (Ballantyne's data have been plotted against the modern, generalized curves shown in Fig. 2.1.)
Source: Based on data reported in Ballantyne, *Manual of Antenatal Pathology, i. The Foetus* (1902), pp. 94–5.

normal pattern of fetal development in terms of weight and length. Figure 6.1 illustrates the data he presented, which runs from 6 to 40 weeks LMP, and, although he did not draw up the generalized curves, his evidence was probably some of the first to describe fetal growth accurately, in detail and in two dimensions.[6] Second, Ballantyne discussed at even greater length what he called the 'symptomatology of foetal death':

For instance, there may be the history of syphilitic manifestations and according to some authorities the 'habitual' foetal death may itself be the manifestation and the sole manifestation of that disease. But there may, in other instances, be a record of long continued anaemia, of malaria, of alcoholism, of lead poisoning, of heart disease, or of renal disease with albuminuria; again, it may be gathered that the mother had for a long time suffered from endometritis, or uterine displacement, or disease of the placenta. Some of the conditions which have been named may be dependent upon each other, as for example placental alterations upon maternal albuminuria. Finally, in some instances, there may be no very evident cause for the recurring foetal deaths either in the mother or in the father. Very curious cases are those in which every alternate pregnancy ended in

[6] J. W. Ballantyne, *Manual of Antenatal Pathology and Hygiene, i. The Foetus* (Edinburgh: Green, 1902), 94–5. J. M. Tanner, *A History of the Study of Human Growth* (Cambridge: Cambridge University Press, 1981), 261–7 appears to credit Carl Heinrich Stratz (1858–1924) with this advance, in a publication of 1909. However, Frederick J. Taussig, *The Prevention and Treatment of Abortion* (London: Keener, 1910), 47 notes as though it is common knowledge the following fetal-growth rule: For months 1–5 the crown-to-heel fetal length in cms equals the square of the number of months; for months 6–9, 5 cms are added each month (i.e. 45 cms at 9 months).

the birth of a dead foetus, or in which all the infants of one sex were born dead and all those of the other alive.[7]

Third, the difficult matter of diagnosing the 'antenatal morbid state' was also addressed.

First, the previous medical history of the woman, both general and sexual, must be inquired into, for there are certain circumstances which may be regarded as commonly preceding the development of morbid states in pregnancy; *secondly*, the past history and present state of the father, and the family history on both sides ought to be taken into account, for there are foetal diseases and embryonic deformities which appear to be hereditarily transmitted; *thirdly*, the maternal symptomatology during pregnancy which is in progress must be carefully investigated; *fourthly*, a very complete physical examination ought to be made of the maternal organs, and especially of the abdominal viscera; *fifthly*, the foetus should be fully examined by the hands, by the ear, by the cephalometer, by the Röntgen rays, and by any other means of exact research that may yet be invented; and, *finally*, the maternal urine and blood should be subjected to chemical and microscopial investigation, as it is beginning to be realised that the condition of the foetus in utero is to some extent reflected in the composition and characters of the maternal excretions.[8]

Fourth, Ballantyne attempted an outline of antenatal therapeutics (primarily maternal, including the 'pre-maternity hospital'), which incorporated a discussion of the 'value of foetal life'. This latter topic required some statement on the fetal-death rate and the frequency of premature births. In maternity hospitals, premature births (under 2500g) were about 20 per cent. For those fetuses reaching a viable age, but born before full term, there was a 30–40 per cent risk of an early-postnatal (i.e. neonatal) death. Ballantyne found it more difficult to give an estimate of fetal mortality in general, and on this occasion avoided the stillbirth rate entirely, although he did feel secure in the following: 'One conclusion may perhaps be safely drawn: through improved obstetric methods, and the elaboration of the means for keeping premature infants in life, and possibly also by the amelioration of the condition of the pregnant woman-worker, the foetal death-rate is perceptibly less than it was, say, fifty years ago'.[9]

In one of his last contributions, Ballantyne returned to the problem of intrauterine death.[10] He discussed again the difficulty of making precise definitions, of standardizing technical language (e.g. stillbirth and dead birth), of specifying causes of death at different fetal ages, and of antenatal therapeutics.

[7] Ballantyne, *Manual*, p. 415. Pneumonia, cholera, and smallpox were also singled out for special mention.

[8] Ibid. 433.

[9] Ibid. 456. Ballantyne gave no further evidence to support his conclusion.

[10] J. W. Ballantyne, 'Ante-natal, intra-natal, and neo-natal death: causes, pathology, and prevention, with special reference to ante-natal death', *British Medical Journal*, 2 (1922), 583–8, a paper given at the annual meeting of the British Medical Association in Glasgow, July 1922. Ballantyne began by looking back to the work of his mentor, Professor Alexander R. Simpson of Edinburgh, and his contribution to the subject published in 'Introduction to a discussion on intrauterine death: its pathology and preventive treatment', *British Medical Journal*, 2 (1888), 866–9.

His review of current thinking on the causes of fetal death will be of most interest here. In terms of age and stage of development, the following classification was adopted:

(1) Antenatal
  a. Germinal (little is known of aetiology, perhaps 40 per cent mortality)
  b. Embryonic (after implantation, termed abortion)
  c. Fetal (after viability, often termed stillbirth)
(2) Intranatal (potential mortality realized)
(3) Neonatal.

Ballantyne's list of causes of death related to the fetus (1c) had ten elements:

1. Syphilis transmitted from the mother.
2. All other kinds of infection or disease transmitted from the mother, and showing itself in similar form in the foetus, such as smallpox, measles, scarlet fever, malaria, pneumonia, tuberculosis (very rarely), cerebro-spinal meningitis, and typhoid fever.
3. Morbid states of the foetus dissimilar from the diseases in the mother which cause them, such as the foetal changes in maternal heart disease, in eclampsia and the pre-eclamptic state, in hepatic disease, in hyperemesis, etc.
4. Morbid states of the foetus, the result of poisoning of the mother with lead, mercury, alcohol, nicotine, etc., including the drugs taken with criminal intent to produce abortion or premature labour.
5. Placental morbid changes of all sorts, but particularly of an haemorrhagic kind. [The overlap between causes is noted here, especially between fetal, maternal, and placental.]
6. Morbid states of the foetal annexa other than the placenta, such as adhesions of the amnion, excess of the liquor amnii, etc.
7. Foetal traumatism, including knots and twisting of the umbilical cord, separation of the placenta, etc.
8. The so-called idiopathic diseases and malformations of the foetus, including general dropsy, ichthyosis, endocarditis, cystic kidneys, and all the grave monstrosities.
9. Morbid states of the foetus of an ancestral nature, such as haemophilia, in which the mother is unaffected, but has transmitted something pathological to the offspring.
10. The group of causes acting from the father through the spermatozoon.[11]

His list for intranatal deaths (2), all of which were stillbirths, could be related to the realization of what he termed 'potential mortality', where life is sustained in the uterus, but cannot be maintained once passage through the birth canal begins (e.g. dropsy, prematurity, postmaturity). A second group included 'all the complications of labour', especially the causes of asphyxia, as well as transverse and breech presentations, and prolapsed umbilical cord. Causes due directly to the methods of delivery made up the third group; infections acquired during labour (e.g. pneumonia) the fourth. As to early-neonatal deaths, a three-fold division was made: antenatally developed conditions incompatible with postnatal

[11] Ballantyne, 'Ante-natal . . . death', p. 585.

existence; conditions contingent on birth due to traumatism or infection; and the new, potentially dangerous conditions of the lethal environment or the 'ignorance and folly' of carers.

Ballantyne turned next to make some observations on the forms of new research that were required to further understanding of the pathology of stillbirths and neonatal deaths. As a first step, he emphasized the importance of studying the process of maceration. But he also mentioned the need to discover 'the laws regulating the transmission of microbes, toxins, toxic agents, and food substances through the placenta to or from the foetus', and 'the effect upon pathological changes in the foetus of the arrival of germs and toxins of disease and of toxic agents of all kinds by way of the umbilicus'.[12]

Finally, several steps could be taken, even with partial understanding of the causes of fetal morbidity and mortality, to assist the prevention of stillbirths and neonatal deaths. Of these, Ballantyne re-emphasized the need for 'watchful, adequate supervision and treatment', for antenatal clinics and the hospitalization of those ill during pregnancy, despite the great expense. He appreciated the need for preventive measures before a woman became pregnant, even as far back as her childhood. He also called for the reordering of values: 'In any case of difficult or dangerous labour, except when there is evidence that the foetus is already dead, that method of delivery should be chosen which without sensibly increasing the risk to the mother holds out a fair chance of life for the child'[13]—meaning that Caesarean section might be considered in more cases, for example. Special, individualized treatment should be available to those experiencing difficult labours and abnormal antenatal lives. Similarly, babies injured at birth or weakened during antenatal development should be followed up, and postnatal care provided in infancy. Ballantyne repeated with approval Eardley Holland's dictum on the need to combine the strategy of antenatal supervision with the tactics of far-sighted intranatal treatment.

From his 1922 vantage point, Ballantyne believed that his field of research had made some progress in recent years, but that much still remained to be achieved:

> It is necessary at the very outset to state and to repeat the statement that there is no more difficult department of investigation than that of the pathology of ante-natal, intra-natal and early post-natal death, and especially of ante-natal death. Omitting the further problems of germinal and embryonic death . . . one is nevertheless faced by an immense field of unresolved problems. Admitting a multiplicity of little understood morbid causes, the investigator is met with the additional difficulty of the comprehension of their mode of action, a mode which must on account of peculiarities of environment and type of life be quite special and be further obscured by being carried on in the concealment of the uterine interior. It will require all the concentration of the workers under the conjoint scheme of investigation which has been set agoing so happily and wisely by the Medical Research Council to clear up not all, but simply some, of the problems of the pathology

[12] Ballantyne, 'Ante-natal . . . death', 586. [13] Ibid. 587.

of ante-natal and early post-natal death, and this must be succeeded by specialized work along new lines to wrest the remaining secrets from 'Nature's close reserve'.[14]

Ballantyne died in January 1923, before the results of the Medical Research Council's Child Life Investigations, to which Eardley Holland was the principal contributor, were fully published, but he obviously appreciated the potential significance of a project that followed his lead in focusing on antenatal pathology and morbid anatomy.

FETAL NECROPSY

Sir Eardley Lancelot Holland (1879–1967) was responsible to the Ministry of Health and the Medical Research Council for the coordination of an extensive research project into the causes of late-fetal and neonatal mortality, a project known as the Child Life Investigations when it was supported by the MRC between 1924 and 1930, but which had been begun by Holland in 1914 under the auspices of the Local Government Board. Holland's first report, not published until 1922, had an introduction by Sir George Newman, Chief Medical Officer to the Ministry of Health.[15] The research was based on the post-mortem examination of 300 fetuses; 133 were macerated, having died in the antenatal state, and 167 were fresh, the result of intranatal death during labour. The 300 fetuses were all viable; that is, their crown-to-heel length was at least 35 cm or their gestational age was at least 28 weeks LMP.[16] Little detailed information was given about how the sample was derived; rather, it appears to have been a collection of dead-born fetuses assembled by Holland from among the London hospitals. More than half came from the two institutions with which he was personally associated: the City of London Maternity Hospital and the London Hospital. Information was also collected from the mothers, although this did not form an important part of the report, which was directed almost exclusively towards immediate cause of death. Table 6.1 shows the primary causes of death identified for the 300.

[14] Ballantyne, 'Ante-natal . . . death', 586.

[15] Eardley Holland, *The Causation of Foetal Death: Report of an Investigation into the Factors which determined Death in a Sample of Three Hundred Foetuses of Viable Age*, Ministry of Health, Reports on Public Health and Medical Subjects, 7 (London: HMSO, 1922). Holland mentions the 'brilliant lead given by Ballantyne of Edinburgh' in his introduction (p. 1). See also Eardley Holland, 'Causes of foetal death', *Journal of Obstetrics and Gynaecology of the British Empire*, 29 (1922), 549–71. In America, the analysis reported by Franklin Paine Mall and Arthur William Meyer, *Studies on Abortuses: A Survey of Pathologic Ova in the Carnegie Embryological Collection*, Contributions to Embryology, 56 (Washington DC: Carnegie Institution of Washington (publication 275), 1921) also set high standards for research on fetal remains. Holland's obituary (*Journal of Obstetrics and Gynaecology of the British Commonwealth*, 74 (1967), 779–81 portrays him as a dedicated—single-minded almost—champion of pathological research.

[16] Holland, *Causation of Foetal Death*, pp. 7–9 has a particularly detailed discussion of the criteria used to define fetal death and viability.

Table 6.1. Percentage distribution of primary causes of death among 300 fetuses examined by Holland, and published in 1922

	Percentage
Complications of labour (including antepartum haemorrhage and post-maturity of the fetus)	51 (30)
Syphilis	16 (16)
Toxaemias of pregnancy	10 (6)
Chronic renal and other maternal diseases	2 (1)
Placental states leading to relative placental insufficiency	6 (0)
Fetal deformities	5 (0)
Cause of death unknown	11 (0)

Note: The figures in brackets give the percentage preventable—53 per cent in total (i.e. all in the case of syphilis, more than half in the case of delivery complications).

Source: Holland, *Causation of Foetal Death* (1922), pp. 125 and 127, based on p. 12, table 1.

Newman's gloss on Holland's detailed findings and conclusions emphasized the two cause-of-death categories at the top of the list. Holland and Newman were both surprised that the percentage of fetal deaths that could be related to maternal syphilis was so low. Following the Royal Commission on Venereal Diseases it was widely believed that syphilis was an especially important contributor to late-fetal mortality. Indeed, Newman's introduction mentions the use of the stillbirth rate as an index of the prevalence of syphilis.[17] But it was the category 'complications of labour' and especially 'excessive cranial stress' that dominated his discussion of the findings, and particularly the implications for preventive measures. For example, 'it appears that more foetuses were killed by the complications of labour than died during pregnancy from maternal or placental disease, a point of great practical importance in its bearing on the teaching of obstetrics and the management of labour', since 'more than half of these children [of the 300 fetal deaths] might have been saved, 20 per cent by ante-natal treatment (this including 16 per cent syphilitic foetuses), 20 per cent by improved technique in treating the complications of labour, and 12 per cent by combination of improved ante-natal and intra-natal methods of treatment'. Newman highlighted the importance of skilled supervision during pregnancy, but also the need to educate mothers to seek that antenatal care. However, the single most important reform required was the reorganization of clinical instruction on obstetrics in the medical schools;

[17] Royal Commission on Venereal Diseases, *Final Report* (Cd 8189) (London: HMSO, 1916), esp. p. 29 and pp. 148–9, app. XVI, which reports some of the evidence on 'hereditary syphilis' and its influence on stillbirths supplied to the Commission. Francis J. Browne, 'Still-birth: its cause, pathology, and prevention', *Edinburgh Medical Journal*, 27 (1921), 153–66, 199–211, and 286–96 examines the causes of death of 200 consecutive cases of stillbirth and neonatal death at the Royal Maternity Hospital, Edinburgh, between August 1919 and October 1920. His conclusion, mentioned by Newman, also cast doubt on the significance of syphilis.

in short, the standard of practical midwifery skills needed to be raised, especially in dealing with abnormal cases.[18]

These findings by Holland, and the implications drawn therefrom, were of considerable significance in 1922, especially as they developed and extended Ballantyne's earlier work in fetal pathology. But they were based on 300 cases drawn from only one set of London hospitals, and although Newman claimed that they were representative of stillbirths in general, both the size of the sample and the selection procedure would have given cause for concern. These concerns were addressed by Holland in a substantially larger study, published in 1926 as part of the MRC's Child Life Investigations.[19] Now there were 1673 cases: 1269 dead births and 404 neonatal deaths (265 were ultimately rejected because of insufficient information or non-viability, leaving 1032 fetal deaths), drawn from hospitals at five sites (London, Glasgow, Liverpool, Edinburgh, and Cardiff) by nine investigators. These cases were analysed and compared using methods similar to those discussed by Holland in his 1922 report. The distributions of primary causes of death are shown in Table 6.2, where they are contrasted with the results from Holland's earlier work and those by Williams in Baltimore and Holt and Babbitt in New York.[20]

Table 6.2 illustrates several important points, some of which have already been flagged. First, the position of syphilis seems to be confirmed, but it was substantially less important than had been anticipated. Second, the importance of delivery complications (1 and 2 in Table 6.2) for late-fetal mortality was also confirmed by the new study, with more than half of all fetal deaths associated with this category. However, the Baltimore and New York studies had lower percentages. Third, the 'unknown causes' category remained substantial, and this was a common feature of all four studies. Fourth, it was also clear to Holland that the comparative evidence on fetal cause of death could not be taken at its

[18] Quoted from George Newman's introduction to Holland, *Causation of Foetal Death*, pp. vii–viii.

[19] Eardley L. Holland and Janet E. Lane-Claypon, *Child Life Investigations: A Clinical and Pathological Study of 1,673 Cases of Dead-births and Neonatal Deaths*, Medical Research Council, special report series, 109 (London: HMSO, 1926). Other reports in the MRC's Child Life Investigations included: M. Bruce Murray, *The Effect of Maternal Social Conditions and Nutrition upon Birth-weight and Birth-length*, 81 (1924); J. N. Cruickshank, *Maternal Syphilis as a Cause of Death of the Foetus and of the New-born Child*, 82 (1924); J. N. Cruickshank et al., *The Estimation of Foetal Age, the Weight and Length of Normal Foetuses and the Weights of Foetal Organs*, 86 (1924); Diarmid Noël Paton and Leonard Findlay, *Studies of Child Life in Cities and Rural Districts of Scotland*, 101 (1926); A. C. Palmer, *The Cause of Foetal Death in 144 Cases*, 118 (1928); and J. N. Cruickshank, *The Causes of Neonatal Death*, 145 (1930).

[20] J. Whitridge Williams, 'The limitation and possibilities of pre-natal care', *Journal of the American Medical Association*, 64 (1915), 75–82; L. Emmett Holt and Ellen C. Babbitt, 'Institutional mortality of the new-born: a report on ten thousand consecutive births at the Sloane Hospital for Women, New York', *Journal of the American Medical Association*, 64 (4) (1915), 287–90. Note that there are some small differences between the results shown in Table 6.1 from Holland, *Causation of Foetal Death* (1922) and the findings as reported in 1926.

Table 6.2. Percentage distributions of primary causes of death among fetuses examined in four studies

Cause of death	1926 study, five UK sites	Holland, London	Williams, Baltimore	Holt and Babbitt, New York
1.	36.0	28.3	22.4	31.1
2.	20.8	22.3	9.9	7.4
3.	11.6	8.6	11.7	9.9
4.	8.7	15.3	12.8	8.3
5.	3.7	8.6	17.2	23.8
6.	11.3	5.6	6.6	3.0
7.	0.4	0.3	5.2	2.8
8.	7.4	10.7	14.3	13.7
Total cases	1032	300	273	636

Note: The causes of death are: (1) complications of labour; (2) antepartum haemorrhage; (3) toxaemia of pregnancy; (4) syphilis; (5) maternal disease, placental states, and various other causes; (6) fetal states; (7) prematurity; (8) unknown.

Source: Holland and Lane-Claypon, *Clinical and Pathological Study* (1926), p. 19, table 5, and p. 21, table 6 (neonatal deaths excluded).

face value. He had, for example, already established that in the Liverpool data the 'fetal states' category was 'excessive' indicating that there had been some selection in the drawing of the sample. Further, when he compared some Dutch data for 1901–22 with the 1926 results he found important differences, the consequence of certain 'national factors'. So that 'in all classifications of dead-births there is always some divergence in the method and in the standard employed, so that unless the dead-births are classified on an agreed basis there is almost certain to be considerable divergence in the results given by different authors, even with the same sample'.[21] And herein lies the most important limitation of studies dependent on post-mortem fetal pathology.

Despite the obvious drawbacks and limitations, Holland used the 1926 study to re-emphasize the results from his earlier work:

> They show that a very high proportion—not less than 25 per cent, and perhaps more—of all dead-births are due to accidents and complications associated with manipulation by midwife or doctor at birth, whether by forceps or version or in other ways. They show the great desirability of reducing to the minimum the occasions for interference with natural birth. They point to more and better antenatal supervision of expectant mothers, and to the advice and safeguards that come from it, as being the true line of immediate preventive progress.[22]

Several other studies were involved in the MRC's Child Life Investigations, and yet more adopted the pathological approach pioneered by Ballantyne and Holland. Many of these studies merely added further detail to Holland's findings,

[21] Holland and Lane-Claypon, *Clinical and Pathological Study*, p. 20. [22] Ibid. 5.

and all dealt with smaller numbers of cases, usually from single institutions. Several, like the 1926 study, were also concerned with the causes of neonatal deaths. For example, A. C. Palmer's study took 144 fetuses from the sample of 1673 discussed in the Holland and Lane-Claypon report (1926) and constructed detailed case notes.[23] Of the 144, 39 were macerated and 99 were fresh stillbirths. The remaining 6 had breathed for a few seconds or a few days. Palmer found that of the 39, 36 per cent were syphilitic, 28 per cent had been the victims of toxaemia, and in 31 per cent of cases the primary cause of death remained obscure. Among the 99 non-macerated fetuses, asphyxia was the ultimate cause of death in 73 per cent of cases. One of J. N. Cruickshank's studies carried out post-mortem examinations on 800 neonates (565 were deaths in the first week) from the Glasgow Royal Maternity and Women's Hospital.[24] Of the 800, 68 per cent of neonatal deaths were related to conditions associated with delivery, especially asphyxia, prematurity, and birth injury; a further 30 per cent were due to some infection acquired before, during, or after delivery. Congenital syphilis was responsible for less than 1 per cent of the cases.

The implications of these findings were broadly as follows: many neonatal deaths occur shortly after birth and their causes are to be found in the causes of stillbirth, rather than those influencing the postnatal experience; complications of labour are the cause of many neonatal deaths, among which asphyxia is particularly significant; prematurity is a 'potent factor' in accentuating the effects of asphyxia and atelectasis (collapsed lung), and it has an important influence in the development of certain complications and diseases among neonates, such as pneumonia and sepsis; and, although some causes of prematurity can be identified (e.g. maternal disease, toxaemia of pregnancy, antepartum haemorrhage), in a large proportion of cases no cause for premature labour can be found.[25]

Other examples could be used, but they would simply elaborate the results available from the various MRC studies.[26] Following Ballantyne, pathologists have displayed an unswerving faith in fetal necropsy. In the absence of reliable registration data on stillbirths, few other approaches are likely to have borne much fruit.[27] But it was also appreciated that, for the twentieth century, hospital-based studies, whether statistical or pathological, were likely to be seriously flawed while only a small proportion of pregnancies ended in hospital deliveries, in which a

[23] Palmer, *Cause of Foetal Death in 144 Cases*.

[24] Cruickshank, *Causes of Neonatal Death*. [25] Ibid. 68–9.

[26] It is worth mentioning two important studies from 1946: Agnes R. Macgregor, 'The pathology of stillbirth and neonatal death: a review of 1053 cases', *British Medical Bulletin*, 4 (3) (1946), 174–8, and V. Mary Crosse, 'The premature baby', *Journal of Obstetrics and Gynaecology of the British Empire*, 53 (1) (1946), 72–83. The former was a traditional study of post-mortem pathology based on cases from Edinburgh hospitals, while the latter reviewed the problem of prematurity, its effects and possible causes.

[27] W. M. Feldman's *The Principles of Ante-natal and Post-natal Child Care* (London: Bale, Sons, and Danielsson, 1927) illustrates what could be done without registration evidence, but there are many speculations and Ballantyne is heavily relied upon.

high proportion of difficult cases were included, and while antenatal supervision was so poorly developed. Studies of entire populations of pregnant women were required in order to avoid the potential selection effects of institutional deliveries, and even when these were begun and combined with enquiries employing registration data, there were fresh problems in distinguishing the pathological from the social. But during the late 1930s and 1940s the research pendulum swung away from pathology towards sociology, from proximate to ultimate or background causes. Instrumental in developing this new focus was Dugald Baird, a Glasgow-trained obstetrician made famous by his work in Aberdeen.

SOCIAL OBSTETRICS

Originally from Ayrshire, Dugald Baird qualified as a doctor in 1922. He was an assistant to Professor J. M. Munro Kerr at the Glasgow Royal Maternity Hospital and, after taking his MD in 1934, moved to become Regius Professor of Midwifery at the University of Aberdeen in 1937, a post he occupied until retirement in 1965. He was knighted in 1959. Baird is best known for his championing of the cause of induced abortion for socio-economic reasons and his support for abortion-law reform, which finally came in the 1960s. But his most important work involved the study of late-fetal and neonatal mortality. His approach to these subjects was distinctly demographic, epidemiological, and sociological, while maintaining a clinical basis. It led to the formation of an MRC Obstetric Medicine Research Unit in 1955 and to the MRC Medical Sociology Unit from 1965 to 1984. Baird was obviously instrumental in the creation of these research units, but their location in Aberdeen was also encouraged by the unique database he had established at the Aberdeen Maternity Hospital from 1938, using the linked records of pregnancies occurring in the city. This database was fundamental to Baird's most innovative research publications, which are listed in the Bibliography.[28]

Baird's early career as an obstetrician in Glasgow was particularly influential in shaping his attitudes and approach to 'social obstetrics'. His first paper,

[28] Edwin van Teijlingen, 'The man and his vision. Sir Dugald Baird: three decades of transforming work in reproductive health', in Sarah James (ed.), *Evidence and Action: A Decade of Research on Women's Health, 1995–2005* (Aberdeen: Dugald Baird Centre for Research on Women's Health, 2005), 6–9 outlines Baird's career in Aberdeen and his legacy. His obituary in *The Times*, 18 November 1986, p. 22, describes him as

> a rational though also an opinionated man, utterly convinced of the rightness of what he was doing. He saw himself as a humanitarian, keen to help those who he felt were unable to help themselves. His activities often drew the censure of fellow obstetricians, but in retirement he still received grateful letters from patients of his early days in Glasgow

In 1985 Sir Dugald gave a long interview about his work and career, which is now part of the Aberdeen University Oral History Archive (transcript, University of Aberdeen Library, special collections, MS 3620/1/21, 22).

combined with the brief account he gave in later life, reveals a deep concern with the high rate of maternal mortality in Glasgow in the 1920s and 1930s, and the apparent indifference of some of his senior colleagues. Baird analysed the cases of 999 maternal fatalities at the Glasgow Royal Maternity and Women's Hospital, distinguishing between the two five-year periods 1925–9 and 1930–4. In the first period the maternal-mortality rate was 283 and in the second 204 per 10 000 deliveries (19 134 and 22 425 deliveries, respectively). The most significant condition on admission was abortion (17 and 14 per cent) and the highest case-fatality rate related to cases of eclampsia (18 per cent). Baird provided an interesting note and comment on one eclampsia case, that is worth quoting in full:

Mrs A, aged 22; first pregnancy, LMP 24 March 1934.

On 24 December she was sent to the out-patient department of the Maternity Hospital from a local authority clinic because of slight oedema and headache of two weeks' duration. Blood pressure 160/108; urine clear. Hospital treatment was refused, but on 31 December she was admitted to hospital after persuasion; BP 168/110.

3 January 1935: urine clear; very slight oedema; BP 154/108; urinary output good. As patient was at term castor oil and quinine given.

4 January: labour pains began at 7 pm; urine clear at 8 pm; eclamptic seizure at 11 pm, with BP 156/82 and a cloud of albumin in the urine.

5 January, 11 am: 14 fits to date; forceps delivery under local anaesthesia; child 7 lb stillborn. Uninterrupted recovery; urine clear on the third day.

This case is a striking demonstration of the fact that raised blood pressure is one of the most reliable pre-eclamptic signs, and may be present long before there is any albumin in the urine. There was no albuminuria in this case three hours before the onset of eclampsia.

In conclusion, it would appear that strict antenatal care can reduce the incidence of eclampsia and also its severity; for when eclampsia develops, despite good antenatal care, it seems to take the form of seizures brought on by the stress of labour, with rapid recovery in the puerperium.[29]

[29] Dugald Baird, 'Maternal mortality in hospital: a review of 999 fatal cases in the Glasgow Royal Maternity and Women's Hospital during the years 1925–34', *Lancet*, 1 (1936), 295. Although not mentioned in the paper, the work of his mentor John M. Munro Kerr (1868–1956), Regius Professor of Midwifery at the University of Glasgow (1927–34), was particularly influential. Examples are J. M. Munro Kerr, 'The causes of stillbirth', *Glasgow Medical Journal*, 87 (1917), 283–91 and *Maternal Mortality and Morbidity: A Study of their Problems* (Edinburgh: Livingstone, 1933), which contains an analysis of 466 maternal deaths at the Glasgow Royal Maternity Hospital during 1926–30 (pp. 37 and 57) as well as a chapter on the influences of abortion on maternal mortality (pp. 129–43). See also Dugald Baird, 'The evolution of modern obstetrics', *Lancet*, 2 (1960), 557–64 and 609–14, which contains recollections of his early career in Glasgow, including the absence of proper obstetric training and supervision, and Baird, 'Interview transcript' (1985), pp. 25–6. Glasgow also appears to have had a particularly high stillbirth rate in the 1890s (see p. 92, Table 4.3, and Robert Jardine, 'A year's work at the Glasgow Maternity Hospital', *Glasgow Medical Journal*, 50 (1898), 89–111). The SBR for Glasgow in 1897 may have been as high as 80.

The general conclusions to the paper were written in an even more trenchant style:

The maternal death-rate in the Glasgow Royal Maternity Hospital is falling—partly because of an all-round improvement in technique and partly because the more abnormal cases, which were formerly sent in as emergencies, are now being sent to hospital before labour or in the early stages of labour.

There is room for improvement both inside and outside the hospital. The chief faults inside the hospital are (1) the lack of proper organisation for immediate blood transfusion in cases of haemorrhage, and (2) the fact that many urgent cases, which present most difficult obstetric problems, have to be dealt with by junior members of staff because their seniors are non-resident. The faults outside the hospital are the lack of adequate antenatal supervision, particularly in the toxaemias, and unjustifiable attempts to perform major obstetric procedures under adverse conditions. The problem outside the hospital, however, is more difficult owing to ignorance and lack of cooperation on the part of the patient. Moreover in Glasgow rickets in childhood (causing a high incidence of contracted pelvis), multiparity, poor housing, and poverty are all very important factors. As the class from which our hospital patients come cannot afford even a small fee to a family doctor, an extension of antenatal supervision by the local authority—possibly with compulsory notification of pregnancy—is urgently required. More hospital accommodation, especially for antenatal cases, is also a pressing need.

It is clear that in some 9 per cent of the fatal cases pregnancy was a grave risk which the patient should not have been allowed to undertake. Sterilisation or contraception was indicated. Experience at the voluntary birth control clinic shows that most of the patients cannot pay the sum necessary for the purchase of contraceptive materials, and as there are no birth control clinics under the local authority in Glasgow, this matter deserves their immediate attention.[30]

On arrival in Aberdeen Baird found the obstetric position worse than in Glasgow. Bed spaces were limited and staffing was inadequate. With characteristic energy and considerable campaigning skills he set about the task of raising the status of obstetric services in the community. His wife, Dr May Baird, became a Labour town councillor and was chair of the North-Eastern Regional Hospital Board between 1947 and 1965. But one of Baird's most important initiatives involved the collection of data on pregnancies, their outcomes, and where and how they were delivered. Aberdeen was sufficiently isolated, not too large, and yet not so inconsequentially small as to make statistical arguments inappropriate. These data made population- and not just hospital-based studies possible, which,

[30] Baird, 'Maternal mortality', p. 298. Baird got himself into trouble with the hospital authorities, not to mention the Catholic Church. This official reaction encouraged him to leave Glasgow for Aberdeen, where he found the local health establishment far more responsive to his initiatives, including abortion followed by sterilization for high-parity women from poor households. Gayle Davis and Roger Davidson, ' "A fifth freedom" or "hideous atheistic expediency"? The medical community and Abortion Law reform in Scotland, *c*.1960–1975', *Medical History*, 50 (2006), 29–48 discusses in detail Baird's subsequent contribution to the reform of the Abortion Law in 1967.

alongside such innovations as the creation of a premature-baby unit equipped with some early incubators manufactured by the anaesthetist Dr Tommy Macdonald in his garage, made progress possible in terms of evidence and action.[31]

However, Baird's first paper to focus on the issues with which he is most often associated—stillbirth and neonatal mortality—used data from the Aberdeen Maternity Hospital for 1938–40.[32] Table 6.3 shows the material employed. Baird used this evidence and the related cause-of-death breakdown to emphasize the following points. First, whilst it was obvious that the emergency cases were at far greater risk in terms of both late-fetal and neonatal mortality, the pre-booked deliveries still experienced rather high levels of mortality compared with the Aberdeen population as a whole. Second, the influence of prematurity was particularly important, with 53 per cent of the stillbirths and 60 per cent of the neonatal deaths falling into this category. In most of these cases the reason for the premature labours could not be identified. Third, as far as mortality among the emergency cases was concerned, 'a big reduction could be achieved by checking the blood-pressure regularly, avoiding the use of forceps till the head is low in the pelvis, and by sending all cases of antepartum haemorrhage to hospital as soon as there is any bleeding'.[33]

It is clear that Baird was not able to achieve what he had hoped for in this study, since he could not distinguish fully between social groups in terms of their delivery experiences, although he was able to establish that, as far as the combined stillbirth and neonatal-mortality rate was concerned, for those in specialist private

Table 6.3. Late-fetal and neonatal mortality at the Aberdeen Maternity Hospital, 1938–40

	Total	Booked places	Emergencies
Deliveries	4043	3427	616
Live births	3763	3334	429
Stillbirths	(69.3) 280	(27.1) 93	(303.6) 187
Mature	132	49	83
Premature	148	44	104
Neonatal deaths	(46.0) 173	(28.2) 94	(184.1) 79
Mature	70	46	24
Premature	103	48	55

Note: The figures in brackets give the stillbirth (SBR) and neonatal-mortality rates. The equivalent rates for Aberdeen were 39 and 33 per 1000, respectively. 'Premature' relates to infants weighing less than 2500g, regardless of gestational age.

Source: Based on data in Baird and Wyper, 'High stillbirth' (1941), pp. 657–8.

[31] Baird, 'Interview transcript', p. 7 tells the story of the home-made incubators.

[32] Dugald Baird and James F. B. Wyper, 'High stillbirth and neonatal mortalities', *Lancet*, 2 (1941), 657–59. Wyper was Baird's registrar at the Aberdeen Maternity Hospital.

[33] Ibid. 658.

practice it was 12, in hospital practice it was 55, and in domiciliary practice it was 79 per 1000. 'Unfavourable economic conditions, and malnutrition and fatigue in the mother' were, he believed, the key contributors to the wastage of life at early age. These are the themes taken up in the larger, population-based studies undertaken during the 1940s.

In a third *Lancet* paper Baird attempted to clear away some of the statistical fog created by co-varying and masking factors, by analysing the new data available on stillbirths from the vital-registration system.[34] He wanted to demonstrate not only the influence of social class, maternal age, and parity on the stillbirth and neonatal-mortality rates, but also the contribution of obstetric practice as it might be differentiated between private specialist care and that available in a maternity hospital. To oversimplify, he attempted to establish the relative contributions of class and care, concluding that the effects of the former could not be counteracted entirely by the quality of the latter. Baird also made the following observation:

> Under ideal conditions neither the stillbirth rate nor the neonatal mortality rate need be more than 10. Where mothers are of good physique, are well fed during pregnancy, receive expert medical and nursing care, and have families of three or four children before the age of 30, the chance of a stillbirth or neonatal death would be slight. Death from gross malformations or haemolytic disease of the foetus would still occur, but other causes of death would be rare. This would not require any new knowledge of the causes of foetal death, but application of what is already known.[35]

Baird also came to believe that the substantial decline in prematurity, which made a sizeable contribution to the reduction in late-fetal mortality during the 1940s, could probably be associated with the improvement in maternal-nutritional status assisted by wartime food rationing. Prematurity and diet became a preoccupation.

Although Baird showed himself adept at analysing national vital statistics, several other specialist epidemiologists whose research proved to be more influential in contemporary debates dominated the field.[36] Baird was most effective in analysing the Aberdeen pregnancies. Using an expanded sample for 1938–44 he distinguished three groups for comparative purposes: (1) nursing-home group, 1419 cases delivered mainly by family doctors; (2) cases pre-booked at the Aberdeen Maternity Hospital, 8808 cases all under the care of specialists; and (3), 501 cases from specialist private practice.[37] Groups 2 and 3 enjoyed the

[34] Dugald Baird, 'Social class and foetal mortality', *Lancet*, 2 (1947), 531–5. This paper contains some remarkable early three-dimensional graphs used to illustrate how the stillbirth rate varied by social class and maternal age.

[35] Baird, 'Social class', p. 535.

[36] Ian Sutherland, *Stillbirths: Their Epidemiology and Social Significance* (London: Oxford University Press, 1949) and J. N. Morris et al., 'Social and biological factors in infant mortality', *Lancet*, 1 (1955), 343–9, 395–7, 445–8, 499–502, and 554–9 provide good examples.

[37] Dugald Baird, 'The influence of social and economic factors on stillbirths and neonatal deaths', *Journal of Obstetrics and Gynaecology of the British Empire*, 52 (1945), 217–34 and 339–66. This is a rather rambling and ill-disciplined paper, but it does reflect the way Baird's ideas were developing and his use of social-science research methods.

same obstetric care but differed in terms of social status, while group 1 may have had similar social status to group 3 but lacked specialist obstetric care. Baird found that the stillbirth and neonatal-mortality rates per 1000 were as follows for 1938–44: group (1), 25.4 and 13.7; group (2), 30.4 and 34.5; and group (3), 10.0 and 8.1. Although these differences are both interesting and suggestive, some of the study's most important observations relate to the way in which the experience of a particular group changed over time. For example, it was found that among group (1), nursing-home deliveries, the stillbirth rate declined from 47.6 in 1933–7 to 14.9 in 1944. This prompted these speculations:

It might be argued that the improvement could be explained by advances in our knowledge of nutrition and improved diets for expectant mothers. It is true that these social classes are usually the first to take advantage of any advance in medical science. At the same time it is very doubtful if, at this economic level, there has been, so recently as 1933 or even earlier, any deficiency in nutrition sufficient to affect the stillbirth figures. It is much more likely that the improvement has been brought about mainly by better antenatal care and by improved technique during labour, with more frequent resort to specialist advice in abnormal cases. In group 2 [booked hospital deliveries] there appears to be little scope for further reduction in the stillbirth rate by improved obstetrical care during labour. Further improvement must come from better health of the mother before and during pregnancy.[38]

In group (2) the primary need is to improve social and economic conditions and so raise the standard of nutrition and general health. This would result in less prematurity and fewer feeble babies. Contraceptive advice should be made more easily available to this group, as the stillbirth rate is high after the fifth pregnancy, and few of these women wish to have more than 5 children. Since, in Scotland, about 90 per cent of the mothers are in lower income groups corresponding to group (2) in this series, the biggest reduction in Scotland's stillbirth and neonatal mortality rates will result from improvement in social and economic conditions.[39]

In the second part of his 1945 paper Baird turned to the problem of prematurity. Focusing on group-(2) women in particular, he argued that prematurity was almost twice as high among the lower social classes as the higher; that among the former as much as half of all the cases of low birthweight could not be explained; and that where they could the chief cause was eclamptic toxaemia, which was 'twice as common among the poor as the well-to-do for the same age and parity group'. He was able to illustrate how there tended to be a positive association between maternal height and class/wealth, and between height and birthweight. By this route, wealth/nutrition affected both maternal physique and birthweight prematurity. Once again Baird concluded that food rationing during the Second World War, in combination with the end of high unemployment during the 1930s, had been responsible for the decline in late-fetal and neonatal mortality.

[38] Baird, 'Influence of social and economic factors', 221. The nursing-home fees for group 1 varied from £15.75 to £26.25 (excluding doctors' fees) while for the group-2 hospital patients it was £2.

[39] Ibid. 233.

During the early 1950s Baird contributed to a series of papers on the causes and prevention of stillbirths and first-week deaths.[40] These tended to develop old themes—class, prematurity, maternal nutrition, quality of obstetric care—using more extensive sources and setting Aberdeen's experience alongside those of Scotland and England and Wales. The first paper in the series used vital statistics to illustrate the decline of perinatal mortality, referred to as the 'obstetric death rate'. It re-emphasized the role of 'nutrition and general health of women, not merely during pregnancy, but also during growth and adolescence', since 'such a sudden and widespread effect [the decline of the stillbirth rate] cannot be attributed to the application of new medical skill', and '[n]o new advance in medical knowledge—comparable in effect to the introduction of the antibiotics—came into use in 1941 and 1942 suddenly and markedly to improve the chances of survival of the foetus'.[41] However, it was also accepted that the influence of medical interventions could not be adequately evaluated using vital statistics alone.

In the second paper Baird returned to the Aberdeen pregnancies—9718 in the three years 1949–51, with 75 per cent at the Aberdeen Maternity Hospital, 16 per cent delivered at home, and the remaining 9 per cent in nursing homes. Baird was also able to determine the stillbirth, early-neonatal- (first-week), neonatal-, and postneonatal-mortality rates for Aberdeen from 1931 to 1951 using material collected by the local Medical Officer of Health (1931–8) and from vital registration (1939–51). These series are illustrated in Figure 6.2. This evidence for the whole 'at risk' population provided an especially important background picture—one that captured both the pre-decline and early-decline periods for late-fetal mortality. Baird also created a new classification for causes of death among stillbirths and neonatal deaths based on clinical causes and not just pathological ones. The seven-part classification is outlined in Table 6.4 and its use on perinatal deaths illustrated. The classification was amplified and justified in the third paper in the series, and applied on several subsequent occasions with minor emendations.

Regrettably, Baird did not produce detailed tables, but relied on graphical comparison to illustrate his discussion of trends in the clinical causes of late-fetal mortality in Aberdeen during the 1940s. He believed that these generally downward trends had five probable causes: the improved health and nutrition of women during and after the war; a substantial increase in the proportion of women delivered in hospital, where high-risk cases could be cared

[40] Ethel H. L. Duncan, Dugald Baird, and A. M. Thomson, 'The causes and prevention of stillbirths and first-week deaths, pt. I: The evidence of vital statistics', *Journal of Obstetrics and Gynaecology of the British Empire*, 59 (1952), 183–96; Dugald Baird, A. M. Thomson, and Ethel H. L. Duncan, 'The causes and prevention of stillbirths and first-week deaths, pt. II: Evidence from Aberdeen clinical records', *Journal of Obstetrics and Gynaecology of the British Empire*, 60 (1953), 17–30; Dugald Baird, J. Walker, and A. M. Thomson, 'The causes and prevention of stillbirths and first-week deaths, pt. III: A classification of deaths by clinical cause: the effect of age, parity and length of gestation on death rates by cause', *Journal of Obstetrics and Gynaecology of the British Empire*, 61 (1954), 433–48.

[41] Duncan, Baird, and Thomson, 'Causes and prevention, pt. I', p. 195.

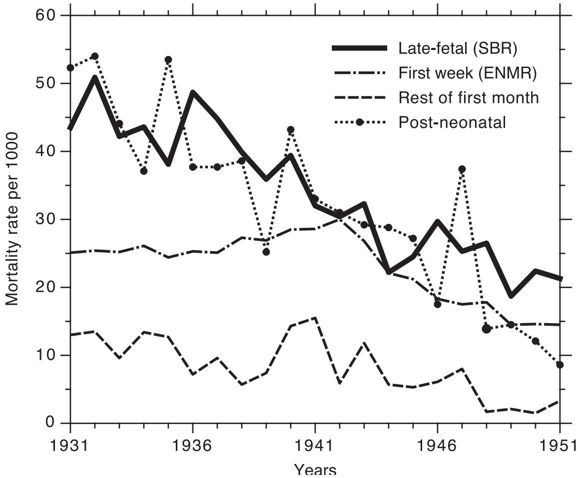


Fig. 6.2: Early-age mortality rates: Aberdeen, 1931–51.

Source: Based on data reported in Baird et al., 'Causes and prevention, pt. II' (1953), p. 19, table II.

Table 6.4. Baird's classification of the causes of late-fetal and early-neonatal deaths

Clinico-pathological cause	Percentage of perinatal deaths	
	(a)	(b)
(1) Mature, cause unknown (O)	13.7	15.1
(2) Birth trauma, mechanical causes (O)	18.8	13.1
(3) Pre-eclamptic toxaemia (O)	10.0	13.1
(4) Premature (less than 2500 g), cause unknown (E)	19.7	17.4
(5) Antepartum haemorrhage (APH) (E)	10.9	13.1
(6) Fetal deformity, malformations (E)	15.6	18.0
(7) Other causes (e.g. maternal disease (E), infection (E), rhesus factor-serological incompatibility (O))	11.3	10.2

Note: The letters O and E refer to 'obstetrical' and 'environmental' causes. The last two columns give the percentage distributions among the seven groups of those 'obstetric deaths' (i.e. perinatal) that occurred among (a) booked (non-emergency) cases at Aberdeen Maternity Hospital, 1938–52 (26 116 cases, 1008 deaths), and (b) British Perinatal Mortality Survey data for legitimate, singleton stillbirths and early-neonatal deaths, March 1958 (2210 deaths).

Source: Classification of causes: Baird, Thomson, and Duncan, 'Causes and prevention, pt. II'(1953), p. 19; percentage distributions: Baird, Walker, and Thomson, 'Causes and prevention, pt. III' (1954), p. 436, table 1, and Baird and Thomson, 'Perinatal deaths re-classified' (1969), p. 207, table 11.2. Maternal disease and rhesus incompatibility were also distinguished as separate causes in the more detailed versions of this nosology.

for more effectively; improvements in the management of pregnancy and labour as well as the improved postnatal care of infants; fewer high-parity births; but also a sudden rise in the birth rate immediately after the war. And these in turn led to three emphases for public and professional policy: the maintenance of a high level of health and nutrition among women; the provision of the highest standard of obstetric care, especially in maternity hospitals and targeted at the high-risk cases; contraception and sterilization measures to help the 'physically unfit and those worn out by childbearing' to avoid further pregnancies.

There were, however, several limitations to these analyses of clinical cases, some of which were clearly recognized by Baird and his team. For example, it had to be admitted that there were in fact no data available for Aberdeen that would demonstrate the improvement of health and nutrition among women and their direct impact on the decline of stillbirth mortality via the reduction in prematurity. The hypothesis that the war actually had a positive benefit, at least on the diets of some women from poorer households who became pregnant, would have to remain 'not proven'.[42] But it was the classification itself that came in for most criticism:

> It is not possible, with present knowledge, to classify a series of stillbirth and first week deaths according to true underlying causes, the removal of which would be the principal aim of prevention. All forms of classification must involve compromise in greater or lesser degree. We have noted that classification based primarily on findings at autopsy is unsatisfactory both in theory and in practice, and still more comprehensive and careful autopsies would be unlikely to solve many of the residual problems of aetiology and prevention. To take into account all the clinical circumstances, as well as the pathological findings, is sounder in theory and we have found the method described to work well, provided the full case notes normally prepared in a teaching hospital are available. It seems fair to assume that obstetric deaths occurring in association with well marked clinical abnormalities of pregnancy could be substantially reduced by preventing or treating these abnormalities, and that many deaths primarily due to trauma could be avoided by improved management of difficult labour.[43]

Baird clearly believed, and repeated on several occasions, that autopsy might be able to show how a fetus had died, but in a majority of cases it was not capable of establishing why the death had occurred. His classification based on clinical causes of death and not mainly on pathological findings was, therefore, superior to existing classifications, yet still limited. Although it appeared that perhaps a third of deaths had 'causes unknown', Baird persisted with an essentially causes-based summary of the ways in which perinatal deaths could be reduced further:

> Ignoring the very few deaths in the first week due to diseases acquired during this period (nearly all infections), obstetric deaths [i.e. perinatal, stillbirths plus first-week] can be attributed to three main causes:
>
> (1) Deaths which can be prevented by skilful management of the labour (birth trauma);

[42] Baird, Thomson, and Duncan, 'Causes and prevention, pt. II', p. 21.
[43] Baird, Walker, and Thomson, 'Causes and prevention, pt. III', p. 443.

(2) Deaths due to recognised diseases of the mother during pregnancy where skilled medical or obstetrical care can greatly lessen the risk to the baby (pre-eclamptic toxaemia; antepartum haemorrhage, especially placenta praevia; maternal disease);
(3) Deaths due to unexplained physiological faults or hereditary defects which are not easy to influence by medical treatment during pregnancy or obstetrical skills during labour (fetal deformity; premature, cause unknown; mature, cause unknown; and some forms of antepartum haemorrhage).[44]

According to Table 6.4, these three groups of deaths would, in very broad terms, make the following percentage contributions: 20, 25, and 55. Complete elimination of group-(1) and group-(2) deaths would have reduced the stillbirth rate to about 10 per 1000 total births in Aberdeen during the early 1950s, just the level Baird believed represented an 'irreducible minimum' achievable in 'ideal conditions'. However, Baird also recognized that while 'the application of a very high standard of midwifery to a community helps to produce and maintain a low obstetric death rate, especially by reducing deaths from trauma', it was also true that the 'lowest possible obstetric death rate cannot be achieved by good obstetric care alone', that 'a higher level of health among mothers and reproduction at more favourable ages' would also be required.

During the 1960s Baird became involved with a third set of data, which he could compare with vital statistics and the Aberdeen material. The National Birthday Trust Fund sponsored the 1958 British Perinatal Mortality Survey, to which Baird contributed several studies that were published in the second report.[45] The principal survey was conducted during the week 3–9 March 1958 and covered 17 419 births in Great Britain (98 per cent of those registered), while the survey of stillbirths and neonatal deaths was extended to cover March, April, and May (7851 deaths, 94 per cent of total). A detailed questionnaire was undertaken among the mothers and a post-mortem pathological analysis was conducted on nearly all the stillbirths and neonatal deaths in March and a majority in April and May. The stillbirth rate in the control week was 22.3 and the neonatal mortality rate was 16.4. The various studies in the reports emphasized the effects of maternal age, parity, social class, height, smoking habit, and propensity to high blood pressure (pre-eclampsia). The influence on birthweight was discussed at length; low birthweight was related to primiparity, severe pre-eclampsia, smoking in pregnancy, and short maternal stature, while high parity was associated with higher than average birthweight, but high maternal age and low social status had no significant effect on birthweight in their own right. The particular risks faced by 'small-for-dates' babies were also

[44] Baird, Walker, and Thomson, 'Causes and prevention, pt. III', p. 443.
[45] Neville R. Butler and Eva D. Alberman (eds.), *Perinatal Problems: The Second Report of the 1958 British Perinatal Mortality Survey* (Edinburgh: Livingstone, 1969). The first report was published in 1963: Neville R. Butler and Dennis G. Bonham (eds.), *Perinatal Mortality: The First Report of the 1958 British Perinatal Mortality Survey* (Edinburgh: Livingstone, 1963).

identified and distinguished from those affecting cases of low birthweight because of low gestational age.[46]

With his team in Aberdeen, Baird made separate classifications of the clinico-pathological causes of death of singleton births to married women according to the scheme he reported in 1954.[47] This proved to be an especially interesting exercise because it provided the opportunity to compare the results obtained by the Aberdeen classification with those available from more traditional post-mortem pathological analysis. Understandably, Baird concluded that his clinico-pathological classification was in many respects superior, especially in cases other than those of malformations and rhesus incompatibility. For example, '[p]ost-mortem evidence of cerebral birth trauma and of infection was often unreliable as an indication of why a baby died in the light of the sequence of clinical events which culminated in death'.[48] Table 6.4 shows the classification in its basic form and the percentage distributions of Aberdeen and British Survey perinatal deaths. The correspondence is reasonably close, but not perfect.

Baird used the clinico-pathological classification of causes, with its focus on 'why' rather than not just 'how' death had occurred, to make the distinction between two broad, yet not entirely mutually exclusive, categories: obstetrical (associated with the complications of pregnancy and labour, avoidable with a high level of obstetric skill) and environmental (the effect of unfavourable environment reducing the reproductive capacity of the mother and not easily prevented by good obstetric care). These are also identified in Table 6.4.

> The first group, consisting of deaths attributed to toxaemia, mechanical causes, unexplained death of mature babies (placental insufficiency), and Rhesus incompatibility, is dominated by the influence of age and parity. Socio-economic status and height are much less significant. The second group—unexplained prematurity, malformations, antepartum haemorrhage and miscellaneous causes—are less influenced by age and parity, and are more clearly affected by differences of maternal physique and socio-economic status.[49]

Further analysis using just these two categories led to the conclusion that higher perinatal mortality in northern Britain could be associated with excessive mortality due more to the environmental than the obstetrical. But Aberdeen demonstrated what could be achieved with a high standard of obstetric care, especially deliveries in specialist hospitals supervised by skilled and well-organized staff.[50]

[46] The various studies associated with the 1958 survey represent a remarkable account of obstetric and paediatric knowledge in the early 1960s.

[47] Dugald Baird and A. M. Thomson, 'The survey perinatal deaths re-classified by special clinico-pathological assessment', in Butler and Alberman (eds.), *Perinatal Problems*, pp. 200–10.

[48] Ibid. 209.

[49] Dugald Baird and A. M. Thomson, 'The effects of obstetric and environmental factors on perinatal mortality by clinico-pathological causes', in Butler and Alberman (eds.), *Perinatal Problems*, p. 224; see also table 12.6.

[50] Dugald Baird and A. M. Thomson, 'Reduction of perinatal mortality by improving standards of obstetric care', in Butler and Alberman (eds.), *Perinatal Problems*, pp. 255–82.

Baird's publishing career spanned half a century; he was still writing papers in his seventies and eighties. Much of this later work re-emphasized his argument concerning the joint effects of maternal physique—due to heredity and childhood-nutritional experience—and maternal health during pregnancy. For example, he illustrated the cohort effects associated with maternal physique and its influence on restricted intrauterine growth (IUGR) using historical evidence: '[B]etween 1880 and 1900 social conditions deteriorated and unemployment rates were high so that women born in this period and who started childbearing from 1900 onwards were stunted in growth, malnourished and almost certainly had high perinatal mortality from factors which were dependent basically on the reproductive efficiency of their own mothers'.[51] And, in more general terms, Baird outlined the following hypothesis:

> The existence of a cohort effect in the perinatal mortality rate is supported by secular differences in the rates for age and parity groups, particularly amongst the 'environmental' causes of death. It is further supported by the remarkable conformity of the secular fluctuations in mortality rates from malformations of the central nervous system (CNS). The time relations suggest that girls who were born during periods of severe socio-economic depression and environmental degradation may have grown up to be physiologically inefficient as well as anatomically stunted and will have relatively high perinatal mortality rates throughout their reproductive life.[52]

In one of his last papers Baird returned to the related problem of low birthweight. He came to regard the low-birthweight baby as the 'greatest single problem in obstetrics'.[53] But in searching for causes he turned again to maternal physique, the cohort effect from earlier generations and poverty in the 1930s working through to affect births decades later. Using Aberdeen data for 1948–72, Baird had already shown how low birthweight (under 2500g) had varied by maternal parity and social class.[54] He suspected that the increase in perinatal mortality in Aberdeen during the late 1960s was associated with the increase in the proportion of low-birthweight babies born especially to women under 20 and over 35 from the lower social classes. As far as the younger women were concerned, he blamed the poor reproductive efficiency of their mothers born 1929–37 and the perpetuation of a high incidence of low birthweight through the generations.

Although these studies from the 1970s and 1980s are still of relevance—as we shall see in the next section, and certainly because they demonstrate the value

[51] Dugald Baird, 'Environment and reproduction', *British Journal of Obstetrics and Gynaecology*, 87 (1980), 1066.

[52] Ibid. Dugald Baird, 'Epidemiology of congenital malformations of the central nervous system in (a) Aberdeen and (b) Scotland', *Journal of Biosocial Science*, 6 (1974), 113–37 also discussed CNS problems.

[53] Dugald Baird, 'Changing problems and priorities in obstetrics', *British Journal of Obstetrics and Gynaecology*, 92 (1985), 115–21.

[54] Dugald Baird, 'The epidemiology of low birth weight: changes in incidence in Aberdeen, 1948–72', *Journal of Biosocial Science*, 6 (1974), 323–41.

of the Aberdeen statistical data and the development of his thinking—it is with a paper from 1960, when Baird was at the pinnacle of his career and influence, that we will close. On 18 May 1960 Sir Dugald gave the Ingleby lectures at the University of Birmingham on 'The evolution of modern obstetrics'.[55] The lectures raised many important points, but their key themes emphasized the health and physique of the patient and the standard of obstetric care; what had been achieved since the 1930s, when Baird was in Glasgow; and what the priorities for the future should be. Most of the findings on the effects of environmental factors will be very familiar by now (age, parity, class, poverty, north and south, etc.), but Baird also made a particular point of stressing the benefits of inducing labour among elderly primigravidae when they had passed full term, and certainly when they had reached 42 weeks LMP, to avoid the risk of placental insufficiency, and of a more liberal use of Caesarean section for similar reasons.[56] In the old days in Glasgow, there were some harrowing stories:

> In the 1920s the training of the family doctor in midwifery was very unsatisfactory and he had to learn from experience under most unfavourable conditions. Some measure of the low standard of obstetrics was the frequency of what was known as the 'failed forceps outside' type of case. In the years 1925–34, 426 cases were admitted to the Glasgow Royal Maternity Hospital after an unsuccessful attempt by the general practitioner to deliver with forceps in the patient's home. The maternal mortality was 14 per cent. During the years 1932–34, 167 'failed forceps' cases were sent in by 121 practitioners, 95 doctors sent one case each, but 3 doctors were together responsible for twenty cases, and one of them sent in a total of 9 cases in the three years. This doctor had acquired the reputation, in the poorer parts of the city, of being able to deliver the baby with the minimum delay when sent for by the tired midwife.
>
> It must be pointed out, however, that failure to deliver the baby with forceps occurred inside the hospital as well as outside, sometimes even in booked cases. During 1925–34, 373 craniotomies were performed with a maternal mortality of 9 per cent. These deplorable figures may to some extent be excused if it is remembered that Caesarean section in such cases carried an even higher death rate.[57]

The standard of obstetric care had obviously been improved, but there was scope for even more to be done. Many of Baird's proposals were radical for 1960, and several still defy medical culture. For example: 'Good running of a hospital naturally includes treating the patient as an individual and with kindness as well as at a high level of technical efficiency'; and: 'Only a proportion of doctors will practise obstetrics and only those who have had postgraduate experience should do operative obstetrics'—and who have, ideally, taken the diploma in obstetrics of the Royal College of Obstetricians and Gynaecologists (founded in 1929). Baird also made some interesting observations on the problems facing

[55] Baird, 'Evolution', pp. 557–64 and 609–14.

[56] Ibid. 562. See also Baird, 'Interview transcript', p. 17.

[57] Baird, 'Evolution', p. 609. Jardine, 'A year's work' also mentions that the hospital had to deal with the after-effects of abortions.

obstetricians, the need for research, and how it should be conducted to best advantage:

> The main problems today are medical and physiological rather than surgical. The origins of pre-eclampsia and eclampsia—the main causes of maternal mortality—are as mysterious as those of puerperal sepsis half a century ago. To uncover them, the obstetrician needs a sound knowledge of the hypertensive and renal diseases, and of the factors which alter water and electrolyte metabolism. Prematurity has replaced birth trauma as the main cause of perinatal mortality, and, although the management of the liveborn premature has improved, we know little about the reasons why foetal growth is impaired or why labour starts, whether it be at term or very much earlier. The pathologist is often unable to determine the causes of stillbirth and neonatal death. Even if the necropsy shows that the immediate 'cause' was asphyxia, atelectasis, or immaturity, it cannot show *why* the baby was asphyxiated or was born immature.[58]

Baird's emphasis on the importance of research; his insistence that clinicians should involve themselves in this work; his championing of multidisciplinary research teams in which clinicians and non-clinicians had equal status; his stress on the need for high-quality clinical records, particularly the keeping of detailed case notes; and his appeal to 'numerical fact' over 'subjective impressions' typify his programme for the improvement of obstetric training and thus of the quality of care.[59]

THE CLASSIFICATION OF CAUSES

In 1986, the year of Baird's death, the *British Journal of Obstetrics and Gynaecology* published a series of papers on the classification of perinatal deaths, all of which took as their starting-point his approach via obstetrical antecedent causes, especially the Baird and Thomson reclassification of 1969. Some authors simply wanted to make the Aberdeen classification more sophisticated by adding new subgroups, but others proposed new approaches stressing fetal and neonatal factors. This debate between the obstetricians and the pathologists continues still and is in a way a tribute to both Ballantyne and Baird. The pathologists stress the need for fetal and neonatal autopsies. They rue the declining rate of perinatal necropsy in Britain and argue that without rigorous post-mortem examinations the 'unclassified' or 'unknown cause' category will continue to be unreasonably high. The obstetricians remain sceptical. They stress the need for classifications that allow the causes of avoidable deaths to be targeted, especially by further improvements in antenatal, obstetric, and neonatal care. The remainder

[58] Baird, 'Evolution', p. 613.

[59] However, Baird was not always so enthusiastic about the value of sociologists, 'quite nice people when you got to know them', and his defence of doctors, criticized for arrogance and love of technology, was characteristically robust (Baird, 'Interview transcript', pp. 28–30).

of the chapter discusses this continuing debate, with competing classifications championed by the heirs of Ballantyne and Baird. The significance of their pioneering work, as well as its unfinished nature, will be demonstrated in this way.

Immediately after the Second World War the pathological work of Eardley Holland and his colleagues was continued along much the same track. A paper in the *British Medical Journal* of 1956 reported the results of 337 fetal necropsies (including 185 stillbirths) conducted at University College Hospital, London, between 1948 and 1955.[60] The paper attempted a rebuttal of Baird's challenge to the value of fetal and neonatal post-mortems.[61] It claimed that a classification based on pathological evidence is less susceptible to differences of opinion than one founded on clinical data. The examples given to support this claim are drawn mainly from congenital malformations, birth trauma, toxaemia of pregnancy, and especially the cases of neonatal death among premature births The analysis of clinical associations focused on maternal age, toxaemia and hypertension, and antepartum haemorrhage, but its guidance for clinicians is poorly developed. This 1950s study is interesting for two reasons: its methods hark back to those of the early twentieth century, and its tone is clearly defensive. Perinatal pathology was under attack.

In 1980 the distinguished perinatal pathologist Professor Jonathan S. Wigglesworth, of Hammersmith Hospital, London, set out a new classification of causes of death—one that followed a pathophysiological approach.[62] His objective was to suggest a simple classification of perinatal deaths that could be used by health authorities as well as individual maternity hospitals to 'initiate cost-effective improvements in perinatal care'—one that would identify major pathological subgroups whilst taking birthweight into account. He recognized that individual causes of death rarely worked in isolation; that, for example, '[a] woman of low socioeconomic status is more likely to be a heavy smoker, to develop pre-eclamptic toxaemia, to be unsure of her dates, to have inadequate antenatal care, to go into spontaneous preterm labour'. Although Wigglesworth's classification has proved to be something of a new beginning for such nosologies, it was based on traditional physiological evidence. Table 6.5 illustrates the principles involved, using births at Hammersmith Hospital, 1978–9. Wigglesworth noted the importance of very-low-birthweight babies (ones < 1000g would have been regarded as previable), but also the impact of modern methods of perinatal care, especially via Caesarean section for preterm breech presentations and the selective delivery of high-risk cases at specialist regional centres. The classification

[60] J. P. Bound, N. R. Butler, and W. G. Spector, 'Classification and causes of perinatal mortality', *British Medical Journal*, 2 (1956), 1191–6 and 1260–5. Butler and Bonham, *Perinatal Mortality: First Report*, pp. 186–227 developed the work of the 1956 paper along similar lines.

[61] Baird, Walker, and Thomson, 'Causes and prevention, pt. III' (1954), p. 433.

[62] Wigglesworth, 'Monitoring perinatal mortality: a pathophysiological approach', *Lancet*, 2 (1980), 684–6; see also Wigglesworth, *Perinatal Pathology* (Philadelphia, Pa.: Saunders, 1984), esp. ch. 2: 'Causes and classification of perinatal death'.

Table 6.5. Wigglesworth's classification of the causes of perinatal deaths at Hammersmith Hospital, London, 1978–9

	Birthweight (g)					
Cause or mode of death	< 1000	1000–1499	1500–1999	2000–2499	> 2500	Total (%)
1 Normally formed, macerated (S) {deaths before the start of labour}	7	10	—	1	—	18 (24)
2 Congenital malformations (S or EN)	3	2	2	1	2	10 (14)
3 Conditions associated with immaturity (EN only) {conditions associated with preterm birth or immaturity, only live births <37 weeks LMP}	19	9	1	2	—	31 (42)
4 Asphyxial conditions developing in labour (fresh S/EN) {all fetal deaths regardless of weight without malformations or specific disorders}	2	2	—	1	7	12 (16)
5 Specific conditions other than above	—	1	1	—	1	3 (4)
Deaths/total births	31/37	24/79	4/83	5/148	10/2043	74/2390

Note: S refers to stillbirths (35) and EN to early-neonatal deaths (39). The late-fetal-mortality rate (SBR) was 14.6 and the perinatal-mortality rate was 31.0 per 1000 total births. The 1989 revisions are in { } brackets.

Source: Wigglesworth, 'Monitoring perinatal mortality' (1980), p. 685, tables I and III, and Keeling et al., 'Classification of perinatal death' (1989), pp. 1346–7.

is intended to help draw out the implications for clinical management. For instance, (1) points to antenatal care and maternal factors; (2) indicates greater emphasis on prenatal screening; (4) stresses obstetric management, especially for normal-weight births > 2500g; while (3) also indicates the need to assess paediatric (effective resuscitation, avoidance of hypothermia) as well as obstetric care for preterm deliveries. The use of simple categories, its stress on clinical implications, emphasis on differentiation by birthweight, and its value even in the absence of autopsy findings are all positive aspects of the Wigglesworth classification. The emphasis on birthweight and not gestational age raises some important issues, however. Since for legal and registration purposes stillbirths are defined by gestational age (more than 28 weeks LMP before 1992, 24 weeks thereafter in the UK), it is essential to have such information so that late miscarriages can be excluded. Where LMP date is not known and ultrasound techniques have not been used to derive gestational age, then births under 1000g may not be counted. This can lead to a degree of imprecision that will prove damaging to such a classification. It is also important to emphasize the supportive rather than essential role of perinatal autopsy here.

Since 1980 advances in ultrasound technology and developments in intensive neonatal care have focused attention on intrauterine growth restriction (IUGR), small-for-gestational-age (SGA) babies, and the problems associated with very premature live births. They have also encouraged more discussion on the utility of cause-of-death classifications and the balance between clinical and pathological evidence. Greater refinement and higher levels of sophistication have been called for, but this has often led to embellishment for its own sake. Everyone, it seems, would like to have his or her own model classification. For example, a team based in Glasgow have proposed the term 'total perinatally related wastage' (TPRW), which comprises not only stillbirths and neonatal deaths, but also perinatally related infant deaths (postneonatal) and late miscarriages (20–7 completed weeks LMP).[63] The new classification developed from Baird's allocated 43 of the 94 late miscarriages to 'Spontaneous preterm'—the successor to 'Premature unknown'—and 27 of the 93 early-neonatal deaths, but none of the 67 stillbirths. Birthweight was not used.

Baird's own classification was revised with his approval in 1986.[64] The authors repeated again their confidence that the Aberdeen scheme showed 'remarkably few signs of obsolescence' and that it was preferable to classify a high proportion of deaths with reasonable certainty than to use a more complicated classification in which a high proportion of deaths cannot be classified. They also emphasized their point that the chief purpose of a classification was to assist prevention, and asserted that necropsy findings may be inconclusive because they indicate how and not why a death occurred, and that even simple, yet essentially pathological, classifications were susceptible to interpretation in varying ways by different clinicians.

Wigglesworth and his colleagues quickly took up what amounted to a challenge.[65] The pathologists argued that the Aberdeen classification concentrated on maternal factors and took little account of the fetus or neonate as a separate individual, the clinico-pathological processes within the baby, and the way they contribute to, and help to explain, the cause of death. However, they did acknowledge that the Wigglesworth classification, like its predecessors, was designed to deal only with cases that had been the subject of autopsy, and that since only two-thirds of perinatal deaths in Britain were then the subject of post-mortem examination, a 'national disgrace' in their view, some revision was required so that most cases could be classified even when information from autopsy was lacking. In a follow-up study a panel of six specialists used the Aberdeen and Wigglesworth classifications to categorize the cause of 233 perinatal

[63] C. R. Whitfield et al. 'Perinatally related wastage: a proposed classification of primary obstetric factors', *British Journal of Obstetrics and Gynaecology*, 93 (1986), 694–703. They analyse 307 deaths out of 13 446 total births at the Glasgow maternity hospital during the four years 1979–82. The SBR was 5 and the perinatal mortality rate was 12—remarkably low compared with Hammersmith Hospital.

[64] S. K. Cole, E. N. Hey, and A. M. Thomson, 'Classifying perinatal death: an obstetric approach', *British Journal of Obstetrics and Gynaecology*, 93 (1986), 1204–12 followed Baird and Thomson, 'Perinatal deaths re-classified' (1969) and Baird, Walker, and Thomson, 'Causes and prevention, pt. III'.

[65] E. N. Hey, D. J. Lloyd, and J. S. Wigglesworth, 'Classifying perinatal death: fetal and neonatal factors', *British Journal of Obstetrics and Gynaecology*, 93 (1986), 1213–23, and J. W. Keeling et al., 'Classification of perinatal death', *Archives of Disease in Childhood*, 64 (1989), 1345–51.

Table 6.6. Aberdeen and Wigglesworth classifications of causes of perinatal death applied to the same 233 cases

	Wigglesworth classification etc.					
Aberdeen classification	**1**	**2**	**3**	**4**	**5**	Total
(1) Mature, cause unknown	47	4	—	39	4	94
(2) Birth trauma, mechanical causes	—	9	13	34	—	56
(3) Pre-eclamptic toxaemia	17	4	43	9	4	77
(4) Premature, cause unknown	94	17	211	17	30	369
(5) Antepartum haemorrhage	47	—	26	30	9	112
(6) Fetal deformity, malformations	—	185	—	—	13	198
(7) Other causes	21	—	9	—	64	94
Total	226	219	302	129	124	1000

Note: The 233 classified cases have been set equal to 1000 for ease of comparison. The Baird or Aberdeen classification is shown in Table 6.4 (p. 172), and the five-group Wigglesworth classification in Table 6.5 (p. 180). Aberdeen is in brackets and Wigglesworth in bold.

Source: Based on Keeling et al., 'Classification of perinatal death' (1989), p. 1349, table 2.

deaths.[66] They found that there was an unacceptable amount of disagreement between the classifiers in 15 per cent of cases, but that it was possible to produce a joint, two-dimensional classification using both schemes. The results of this exercise are shown in Table 6.6. It is clear that the Wigglesworth classification provides a more evenly spread distribution, while the Aberdeen scheme is dominated by class (4), 'Premature, cause unknown', with 37 per cent of cases. However, it must also be noted that for all but a handful of the 233 cases detailed autopsy evidence was available, so that refined judgements could be made.

How would these classifications operate in situations where there is substantially higher mortality and where medical facilities are poorly developed? Two studies from Tanzania provide examples. The first, from Lugarawa Hospital in the south-western highlands, showed a stillbirth rate of 48 per 1000 total births for 1971–6, which had been reduced to about 25 in 1977–9.[67] Preventing prolonged labour, more effective detection of fetal distress at an earlier point, and better selection of women with high-risk pregnancies brought about this reduction in SBR. Baird's clinico-pathological classification was used in preference to Wigglesworth's because it enabled 'avoidable' deaths to be focused on with greater insight. Some

[66] Keeling et al., 'Classification of perinatal death' (1989). This is an old problem, known as 'inter-rater agreement', has often received attention, and remains a challenge for all nosologies.

[67] J. van Roosmalen, 'Perinatal mortality in rural Tanzania', *British Journal of Obstetrics and Gynaecology*, 96 (1989), 827–34. There are many other examples of hospital-based studies employing modified versions of the Baird classification. See, for example, R. C. Pattinson, G. De Jong, and G. B. Theron, 'Primary causes of total perinatally related wastage at Tygerberg Hospital', *South African Medical Journal*, 75 (1989), 50–3 (SBR of 20 in 1986), and Nhu Thi Nguyen Ngoc et al., 'Causes of stillbirths and early neonatal deaths: data from 7,993 pregnancies in six developing countries', *Bulletin of the World Health Organization*, 84 (9) (2006), 699–705.

25 per cent of stillbirths in 1971–6 were regarded as avoidable, most were classified under (2) 'Birth trauma, mechanical causes', and of these, 85 per cent had a normal birthweight over 2500g. This hospital-based study takes us close to the earlier experience of Baird's work in Aberdeen. The second study, from northern Tanzania in 1995–6, was population- rather than hospital- based.[68] It showed a stillbirth rate of about 17, and used 'verbal autopsies' in retrospective household surveys and an extended form of the Wigglesworth classification to construct cause-of-death categories. Of the 60 stillbirths, 13 were regarded as avoidable, with 5 linked to asphyxia and 5 to malaria-related infection. Asphyxia and malaria were of similar importance among the early-neonatal deaths. Closer attention to the maternal and fetal effects of malaria, and the need for improvements in obstetric care for home deliveries were the principal policy conclusions of the study. These two Tanzanian studies highlight some of the problems to be faced by efforts to identify the causes of perinatal deaths in high-mortality developing countries. While hospital studies are of value, they may not reflect conditions in the wider population, although one would expect such institutions to be pioneers in health intervention. Population-based studies will have to cope with the underreporting of fetal deaths and the imprecision of 'verbal autopsies'. However, they may be more realistic in focusing on infections alongside level of skill of birth attendants, environment, and obstetric care. In terms of the classifications of perinatal deaths, both clearly have their supporters in these situations, but the Wigglesworth classification needed to be extended to give greater prominence to fetal infection and the Aberdeen scheme was not tested in the field.[69]

Outside Britain, there have been several attempts to derive alternative cause-of-death classifications, or to modify Aberdeen and Wigglesworth to fit local circumstances. The Nordic-Baltic perinatal-death classification focuses explicitly on time of death, distinguishes carefully between singleton and multiple births, and begins by separating off fetal malformations from the remainder.[70] The thirteen-part classification is given in Table 6.7, with the number of perinatal deaths in Denmark and Sweden combined in 1991, and in Lithuania in 1993–4. The study demonstrated the value of the classification for comparative work, especially where, as in this case, registration was complete, virtually all deliveries had taken place in hospitals, and autopsy findings were available. Although mortality rates for classes II and III were similar between the two regions,

[68] Sven G. Hinderaker et al., 'Avoidable stillbirths and neonatal deaths in rural Tanzania', *British Journal of Obstetrics and Gynaecology*, 110 (2003), 616–23.

[69] The WHO estimate of SBR in Tanzania in the year 2000 was 38. It seems likely that late-fetal mortality was seriously underestimated in the study by Hinderaker et al. (2003). Christopher J. M. Whitty, Sally Edmonds, and Theonest K. Mutabingwa, 'Malaria in pregnancy', *British Journal of Obstetrics and Gynaecology*, 112 (2005), 1189–95 have recently reviewed the impact malaria can have on mothers in terms of maternal mortality and the unborn in terms of perinatal mortality.

[70] Jens Langhoff-Roos et al., 'Potentially avoidable perinatal deaths in Denmark, Sweden and Lithuania as classified by the Nordic-Baltic classification', *British Journal of Obstetrics and Gynaecology*, 105 (1998), 1189–94.

Table 6.7. Nordic-Baltic perinatal-death classification

	Category description	D–S	L
I	Fetal malformation (with 9 subcategories related to site of malformation) (no benefit from intervention in most cases)	305	296
II	Antenatal death: single growth-retarded fetus > 28 weeks' gestation	150	92
III	Antenatal death: single fetus > 28 weeks' gestation	398	182
IV	Antenatal death: < 28 weeks' gestation (miscarriage)		
V	Antenatal death: multiple pregnancy	55	12
VI	Intrapartum death: after admission, > 28 weeks' gestation	50	92
VII	Intrapartum death: after admission, < 28 weeks' gestation (miscarriage)		
VIII	Neonatal death: 28–33 weeks' gestation, Apgar score > 6 after 5 mins.	42	92
IX	Neonatal death: 28–33 weeks' gestation, Apgar score < 7 after 5 mins.	39	94
X	Neonatal death: > 34 weeks' gestation, Apgar score > 6 after 5 mins.	22	51
XI	Neonatal death: > 34 weeks' gestation, Apgar score < 7 after 5 mins.	41	59
XII	Neonatal death: < 28 weeks' gestation	175	172
XIII	Unclassified	5	7
	Total perinatal deaths	1282	1149

Note: The Apgar score uses five criteria (skin colour, heart rate, reflex/irritability, muscle tone, respiration), which are each graded 0–2. Cumulative scores < 4 are critically low, 4–7 fairly low, 8–10 normal. The last two columns give the numbers of perinatal deaths in Denmark and Sweden (D-S) in 1991 and Lithuania (L) in 1993–4 (two years). Total births were 188 205 (D-S) and 90 180 (L), with SBRs of 5.1 and 7.5.

Source: Langhoff-Roos et al., 'Nordic-Baltic classification' (1998), pp. 1191–2, tables 1–3.

differences did exist in classes I and VI, and among neonatal deaths. Access to technical equipment was thought to be one important influence limiting the effectiveness of antenatal and neonatal care in Lithuania.

Researchers in Australia and New Zealand have developed their own classification, known as the Perinatal Society of Australia and New Zealand perinatal-death classification (PSANZ-PDC).[71] Its focus is paediatric care, and its approach is to identify the factor that initiated the sequence of events that led to death. However, there is a clear need for autopsy findings to support largely clinical evidence, but autopsy rates vary from 23 to 63 per cent among the Australian states, which makes the harmonization of any standardized classification problematical. In the Netherlands a new classification has been devised, known as Tulip.[72] Its purpose is to allow distinctions to be made between cause and mechanism of

[71] A. Chan et al., 'Classification of perinatal deaths: development of the Australian and New Zealand classifications', *Journal of Paediatrics and Child Health*, 40 (2004), 340–7.

[72] F. J. Korteweg et al., 'The Tulip classification of perinatal mortality: introduction and multidisciplinary inter-rater agreement', *British Journal of Obstetrics and Gynaecology*, 113 (2006), 393–401.

death. The latter is defined in terms of the organ that has failed, while the cause relates to the circumstances that have led to that failure. Six major categories are used for each dimension. The originators claim that Tulip is simple to use, has a high level of inter-rater (inter-observer) agreement, that the scheme is flexible, and that it is directed towards improving specialist care. However, its avowedly patho-physiological approach and seemingly demanding data requirements make its general utility questionable.

In Britain there is classification chaos, with extended Aberdeen and Wigglesworth systems in use in England and Wales, and separate schemes, essentially Baird-inspired, in operation in Scotland. The 'dispute' between the obstetricians and the pathologists has not been resolved, and the value of autopsies, as well as the extent to which they should be required, continues to provoke debate.[73] And new systems are still being developed.

The most recent addition to the set of classifications has focused explicitly on stillbirths and conditions that could explain what had happened prior to death, rather than cause itself.[74] The explicit objective was to reduce the proportion, usually half to two-thirds, of stillbirths placed in the unclassified or unexplained categories. The ReCoDe (relevant condition at death) system was applied to the 2625 stillbirths occurring in the West Midlands region of England during the seven years 1997–2003. The principal categories are shown in Table 6.8. The six-group Wigglesworth classification was also used, with 66.2 per cent of stillbirths allocated to the 'Unexplained antepartum fetal death' category.[75] Using ReCoDe, 16 per cent of stillbirths went unclassified, and this with only 47 per cent of stillbirths the subject of a post-mortem examination. The importance of ReCoDe lies in its emphasis on category A7, 'Fetal-growth restriction', which accounted for 43 per cent of stillbirths. Growth restriction (IUGR) was identified by using constitutional characteristics (sex, maternal height, weight, parity, ethnic group) to estimate optimal fetal weight for gestational age, which could then be compared with actual weight at death.[76] A fetus below the tenth centile of this customized

[73] The debate about the value of perinatal autopsies has been overtaken by an increase in the percentage of parents refusing permission for such post-mortem examinations to be undertaken. Patrick H. T. Cartlidge et al., 'Value and quality of perinatal and infant postmortem examinations: an analysis of 400 consecutive deaths', *British Medical Journal*, 310 (1995), 155–58, and R. Adappa et al., 'Perinatal and infant autopsy', *Archives of Disease in Childhood: Fetal and Neonatal Edition*, 92 (2007), F49–50 illustrate the two points. In Wales, parental refusal has increased from 22 per cent in 1995 to 42 per cent in 2003.

[74] Jason Gardosi et al. 'Classification of stillbirth by relevant condition at death (ReCoDe): population-based cohort study', *British Medical Journal*, 331 (2005), 1113–17.

[75] Hey et al., 'Fetal and neonatal factors', p. 1219, table 3. This version of Wigglesworth differs slightly from the original shown in Tables 6.5 and 6.6; see Table 6.9 below.

[76] There is a growing literature on customized estimates of fetal weight by gestational age, which has been facilitated by the development both of ultrasound techniques and of statistical models designed to predict normal growth largely from maternal characteristics prior to pregnancy. Interest in the effects of maternal obesity has also stimulated these initiatives. See, for example, J. Gardosi, et al., 'An adjustable fetal-weight standard', *Ultrasound Obstetrics and Gynecology*, 6 (1995),

Table 6.8. ReCoDe classification applied to stillbirths in the West Midlands Region, England, 1997–2003

	Category description	Percentage
A	**Fetus**	**64.3**
A1	Lethal congenital anomaly	14.9
A2	Infection	3.0
A3	Non-immune hydrops	1.4
A6	Twin-twin transfusion	1.4
A7	Fetal-growth restriction	43.0
B	**Cord**	**3.4**
B2	Constriction loop or knot	2.9
C	**Placenta**	**8.9**
C1	Placenta abruptio	6.9
C5	Placenta other	1.0
D	**Amniotic fluid**	**0.8**
E	**Uterus**	**0.1**
F	**Mother**	**3.1**
F1	Diabetes	1.3
G	**Intrapartum**	**3.4**
G1	Intrapartum asphyxia	3.4
H	**Trauma**	**0.0**
I	**Unclassified**	**16.0**

Note: Only subcategories containing more than 1 per cent of total stillbirths have been listed. There were 2625 stillbirths and 451 197 total births, giving an SBR of 5.8 for 1997–2003.

Source: Gardosi et al., 'Classification by ReCoDe' (2005), p. 1115.

optimal-weight-for-age distribution was considered to have experienced growth restriction. This procedure was designed to allow constitutional influences to be removed and for pathological smallness for gestational age to be recognized. It has been argued that from a quarter to a third of babies considered small for gestational age (SGA) by using population-based weight standards should really be regarded as 'small normal', since they are not subject to higher mortality risk. What ReCoDe does not do is explain the causes of IUGR, but it does very effectively shift emphasis from intrapartum to antenatal conditions, by pointing to the need for better detection of fetal-growth restriction in a way that other classifications of the causes of perinatal death are less able to do.

The Confidential Enquiry into Maternal and Child Health (CEMACH) considers stillbirth and early-neonatal deaths in England, Wales, and Northern Ireland.[77] It produces an annual report on these cases, which covers risk factors,

168–74, and Lesley M. E. McCowan, Jane E. Harding, and Alastair W. Stewart, 'Customised birthweight centiles predict SGA pregnancies with perinatal morbidity', *British Journal of Obstetrics and Gynaecology*, 112 (2005), 1026–33.

[77] For example, CEMACH, *Perinatal Mortality, 2005: England, Wales and Northern Ireland* (London: Confidential Enquiry into Maternal and Child Health, 2007).

birthweight distributions, and causes of death. Three classification schemes are used: extended Wigglesworth, supplemented by obstetric or Aberdeen, and the fetal and neonatal classifications.[78] Deaths are classified using the perinatal-death notification form (PDN), which is routinely completed for each fetus born after 22 weeks of pregnancy or where the birthweight is more than 400g, and each live birth dying before 28 completed days of life. In 2005, post-mortem examinations were conducted on 45 per cent of stillbirths and 29 per cent of neonatal deaths. The resulting classification of 3590 stillbirths is shown in Table 6.9. As might be anticipated, a little over half were placed in the 'Unexplained antepartum fetal death' category and a further 16 per cent appeared in 'Congenital malformations'. The development of new, more discriminating classifications is under consideration by CEMACH.[79]

Table 6.9. Confidential Enquiry into Maternal and Child Health (CEMACH) hybrid classification of cause of death applied to stillbirths in England, Wales, and Northern Ireland, 2005

	Category description	Number	Per cent	SBR per 100 000
a	Congenital malformations (W)	558	15.5	87
b	Antepartum haemorrhage (APH) (A)	300	8.4	47
c	Maternal disorder (A)	207	5.8	32
d	Pre-eclampsia (A)	107	3.0	17
e	Death from intrapartum causes (W)	268	7.5	42
f	Infection (W)	69	1.9	11
g	Other specific causes (W)	227	6.3	35
h	Accident or non-intrapartum causes (W)	1		
i	Unexplained antepartum fetal death < 2500g (W)	1129	31.4	176
j	Unexplained antepartum fetal death > 2500g (W)	689	19.2	107
k	Unclassifiable (W)	35	1.0	5
	Total stillbirths	3590	100.0	559

Note: W and A indicate that the categories have their origin in the extended Wigglesworth and modified Aberdeen classifications as reported by CEMACH. The number of total births was 642 094. About 90 per cent of stillbirths were antepartum.

Source: Based on CEMACH, *Perinatal Mortality, 2005* (2007), p. 25, table 13.

[78] Details of these classification systems are at <www.cemach.org.uk/pdn_classifications.htm>, accessed Feb. 2009. They owe their origins to either Baird or Wigglesworth, although they have been extended and amended.

[79] The report for 2006, CEMACH, *Perinatal Mortality, 2006: England, Wales and Northern Ireland* (London: Confidential Enquiry into Maternal and Child Health, 2008), p. 71, table 5.15 presents the results of a pilot study using a new obstetric-classification system. The old system placed 55.4 per cent of the 85 stillbirths occurring in three English health regions in 2007 in the category 'Unexplained antepartum fetal deaths', while the new classification placed 37.6 per cent in the category 'No antecedent or associated factors'. Patrizia Vergani et al., 'Identifying the causes of stillbirth: a comparison of four classification systems', *American Journal of Obstetrics and Gynecology*,

All those who have attempted a classification of late-fetal or neonatal causes of death, whether obstetrician, paediatrician, or pathologist, have recognized the potential value of such a device as a means of summarizing scientific findings and as part of a strategy for the influence of health-care policy to be directed at failures in the delivery system (especially obstetric and neonatal care) and at the most at-risk groups of pregnant women (antenatal care). None of the classifications has proved to be entirely successful, however.[80] Part of the reason for this must relate to disciplinary perspective and method of enquiry. 'How can death be avoided?' and 'How did it occur?' are very different questions, to the extent that answers to the latter do not necessarily assist with the former. There is no doubt that Ballantyne and his successors have contributed enormously to the scientific understanding of morbid states and that even in the highly demanding field of fetal pathology this has led to important clarifications. In the early twentieth century the attack on poor-quality obstetric practices and emphasis on the need for better training and delivery management was given the force of supporting evidence by Eardley Holland and other pathologist contributors to the Child Life Investigations. Intrapartum deaths among full-term, normal-weight fetuses should be avoidable. In the late twentieth century medical opinion began to question the contribution of small-scale, hospital-based necropsy studies to perinatal audit. The swing of parental opinion against post-mortems has meant that only a minority of deaths are now likely to receive pathological investigation. Dugald Baird and his successors wanted to know which deaths were avoidable and how they might target interventions. Their approach was essentially 'low-tech', it could be applied in high-mortality populations, and it could be shown to work. Baird was close to his public; he had a feeling for what to tackle next, an appreciation of broader, often sociological, research methods. He would have appreciated the potential importance of Table 6.8 and its stress on intrauterine-growth restriction as the continuing challenge, and been dismayed by Table 6.9 and its majority 'unexplained'.[81]

199 (3) (2008), 319–22 reports a retrospective study of 154 stillbirths (SBR of 4) in which the ReCoDe classification produced the lowest unexplained rate (14.3 per cent), while Wigglesworth gave 47.4 and Tulip 16.2 per cent. Clearly there is scope for more refinement in this difficult area.

[80] Wigglesworth, *Perinatal Pathology*, p. 17 has observed that the '[d]ifficulty in classifying perinatal deaths by cause arises less from a lack of information about causes of perinatal deaths than from the difficulty that medical scientists have in accepting or handling the concept of the multifactorial nature of the causation of death or disease in general and in perinatal death in particular'. The problem persists (see Gordon C. S. Smith and Ruth C. Fretts, 'Stillbirth', *Lancet*, 370 (2007), 1715–25).

[81] Of course, he would have been reassured to find that the stillbirth rate had fallen below 6—well below 10, the rate he once associated with 'ideal conditions'.

7

Arguments from medical history and demography

Four different sets of observations need to be emphasized. First, because both the everyday and the technical languages with which we are dealing are subject to change and variation, the concept of fetal mortality, especially stillbirth, will be difficult to define in a consistent manner. 'Live birth' and 'fetal viability' will often be problematical, therefore, and this will affect comparison over time and space. Second, despite this obvious and persistent problem, many of the major characteristics of fetal-mortality patterns may now be sketched with reasonable confidence, if not absolute certainty. The profile of survival chances with gestational age can be drawn even for a high-mortality population, although precision is not yet possible for the very early phase of pregnancy. The significance of birth order and maternal age is also clear, as are most of the important risk factors. Third, there is also some order to be found among national time-series for late-fetal mortality. For England, the best available estimates suggest that the stillbirth rate fell from 50–60 per 1000 total births in the eighteenth century to 5–6 in the year 2000. Whereas 5–6 in every hundred viable fetuses were born dead three hundred years ago, now the figure is 5–6 in every thousand. It is also clear that in the late 1930s or early 1940s there was a common turning-point among the medically developed countries we have been able to compare. Fourth, since the recognition and classification of immediate or proximate cause of fetal death remain both contentious and unresolved issues, there may be implications for our ability to develop convincing explanations of those regularities and changes that can be recognized. It is appreciated that the 'causes of fetal mortality' can be discussed on a number of levels, ranging from risk factors to the mechanism of dying to the aetiology of death. While it is the last-mentioned that is often uncertain, the factors that control risk can be clarified, as may the mechanism associated with final demise. The causes of miscarriage, antepartum stillbirth, and intrapartum stillbirth should, ideally, be treated separately.

Some of these observations are negative—problems of definition and aetiology for example—while others hold out the possibility that solutions can be found and sensible interpretations constructed. Taking a long-term perspective on fetal mortality in the last one, two, or three hundred years also requires contributions from a number of disciplines, principally medical history and demography.

From the former we have searching questions on forms of midwifery, antisepsis practice, the adoption of drug therapy, the effects of advances in ultrasound technology, for example, while from the latter comes a rigorous approach to the analysis of mortality, combined with a concern for impact in terms of health, life chances, and patient outcomes in general. Here the two will be made to work together.

HOW SHOULD FETAL MORTALITY BE EXPLAINED?

Figure 2.3, on page 31, presented a model intended to summarize the important influences on fetal mortality and survival chances. The model has served its purpose in listing key features and illustrating the complexity of linkages between factors. For example, the 'socio-economic conditions' box is linked to five others, three of which have a direct bearing on 'health of fetus', but there is no direct effect itself. The 'health of fetus' box is influenced by 'biogenetic factors', the 'health of mother', and 'delivery conditions'. While the evidence assembled in Chapters 3–6 has underlined the importance of these associations, Figure 2.3 does not help us to represent the strength of competing factors, nor is it time- and place-specific. For instance, Chapter 5 discussed the ways in which mainly male, textbook-writing midwives addressed the problem of fetal death during the eighteenth and nineteenth centuries. We could see their approach, the way practice changed, especially with the use of instruments, and how their enquiries were modified by the use of retrospective surveys. However, we would also like to evaluate the contribution these authors made. How were their proposals received and adopted? Did their work have any tangible bearing on fetal health and mortality? In terms of the model in Figure 2.3, what was the contribution of obstetric conditions to 'health of fetus'? On the basis of the evidence presented in Chapter 6, it appears that a further limitation of the model is its combining within the 'health of mother' box the effects of maternal infections communicated to the fetus, and the possibility that nutritional status before and during pregnancy may also have a bearing on fetal growth and the risk of premature birth. These are likely to be extremely important factors, especially in low-life-expectancy populations. They need to be treated separately and given due weight. Finally, Figure 2.3 may also be criticized for concentrating on background causes and not dealing with the immediate physiological or pathological causes of fetal death. Chapter 6 demonstrated how complex this matter could be; it needs to be incorporated and emphasized.[1]

[1] Jonathan S. Wigglesworth, *Perinatal Pathology*, 2nd edn. (Philadelphia, Pa.: Saunders, 1996), 16–17 has reminded us:

The causes of perinatal deaths are complex. Death may result from genetic factors causing abnormal development, a range of environmental influences operating through maternal health before and

Table 7.1. Principal causes of fetal and neonatal death

Principal cause	Miscarriage	Antepartum stillbirth	Intrapartum stillbirth	Neonatal death
Genetic	X	—	—	—
Infection	—	X	—	X
Growth restriction	—	X	—	X
Obstetric	—	—	X	X

Note: X indicates a category in which the cause is particularly important.

Table 7.1 highlights for each of the usual age-groups the likely source of most causes of fetal and neonatal death. Intrapartum stillbirths will be affected by the quality of obstetric services, skilled or traditional birth attendants especially, but this 'cause' will also be an important contributor to early-neonatal deaths. Antepartum stillbirths will be related to intrauterine-growth restriction (IUGR) and maternal infections—which may themselves influence IUGR. The sources of particular forms of infection and the ultimate causes of IUGR will also need to be specified, where possible. Following this line of argument, the principal influences on late-fetal mortality are reduced to three summary categories. The stillbirth rate will be controlled by all three; they will combine in different ways depending on time and place. Where rates are low (SBR of 4–6 per 1000 total births) the contribution from intrapartum deaths will be negligible, obstetric care will be of a high quality, and antepartum stillbirths will dominate (90 per cent or more). In these circumstances IUGR is likely to be of considerable importance. At the upper end of the range, where the stillbirth rate is or was 40–60, we would expect intrapartum deaths to be considerably more important, 40 per cent perhaps, and, depending on the disease environment, infections to make a greater relative contribution. We might also expect maternal-nutritional status to have a bearing on IUGR and the increased risk of premature birth. Finally, Table 7.1 emphasizes the importance of genetic factors and their contribution via fetal malformations to early pregnancy termination by miscarriage. Of course, genetic factors can be influential in each gestational age-group, but they are usually believed to dominate among miscarriages.

Compared with the model in Figure 2.3, Table 7.1 focuses on the more immediate factors responsible for death. It has the advantage of distinguishing between age-groups, but it does leave unmentioned some of the important background-risk factors, like maternal age and birth order. Table 7.1 is also extremely simple in its use of 'principal cause'. It points to where we should

during pregnancy, obstetric factors around the time of birth, or environmental factors operating after birth. In any case, these factors usually operate sequentially so that a single defined 'cause' for a perinatal death is the exception rather than the rule.

look for explanation, and it helps us to manage the complexity of associations in circumstances where immediate cause of death may be uncertain even in low-mortality populations and largely unknown where fetal mortality is or was high.

We have already noted, in Chapter 4, that Irvine Loudon's comparative account of maternal mortality in the nineteenth and twentieth centuries stressed the importance of standard of care provided by birth attendants. Skilled birth attendants, whether female midwives or male physicians, knew when and how to intervene during labour; they were trained and experienced, and, from the 1870s, the best of them were aware of the need to take antiseptic precautions. It has been argued that in Britain '[a]ntiseptic methods in lying-in hospitals after the 1870s helped to reduce maternal mortality, but only to the same level as in domestic midwifery'.[2] This observation may also apply to fetal mortality, although, as has often been noted, it is difficult to compare the risks to in-patient and home deliveries between the 1870s and the 1930s. The availability of the sulphonamide range of antibiotics from the late 1930s, as well as penicillin from 1944, was responsible for initiating a steep and sustained fall in puerperal-fever deaths, and thus maternal mortality.[3]

Figure 4.16, on page 98, illustrated what are currently our best estimates of the maternal-mortality rate (MMR per 10 000) for England, London, and among wives of the British peers. There appears to have been a substantial decline in maternal mortality during the eighteenth century, followed by a period of stagnation up to the late 1930s. Table 4.4, on page 95, and Figure 4.16 also indicate that maternal mortality in England and London may have been broadly similar, and certainly that they declined together in the eighteenth century. However, maternal mortality was higher among the peers' wives than the general population of pregnant women, and convergence did not take place until the late nineteenth century. The implication to be drawn from these rates and Loudon's argument is that the quality of birth attendants did indeed improve during the eighteenth century; that the aristocracy also benefited, but that, strangely, they did not secure superior-quality obstetric services and even higher maternal survival.[4]

[2] M. Anne Crowther and Marguerite W. Dupree, *Medical Lives in the Age of Surgical Revolution* (Cambridge: Cambridge University Press, 2007), 195. However, the account of actions taken at the Glasgow Maternity Hospital given in Malcolm Black, 'Antiseptic midwifery', *Glasgow Medical Journal*, 50 (1898), 12–22 indicates that there was still much to be done, as Dugald Baird found in the 1920s (p. 165). Black's account is entirely directed at ensuring the safety of the mother. A comparison of the various editions of J. M. Munro Kerr's *Operative Midwifery* (London: Baillière, Tindall and Cox, 1908; 3rd edn. 1916; 4th edn., as *Operative Obstetrics*, 1937) reveals that, while stressing the need to scrub up effectively, he only began to use sterilized rubber gloves in about 1906, that he removed them if the infant was slippery, and that it was not until the 1937 edition that he changed his view and insisted on their use in all operative procedures. Kerr was Professor of Midwifery in Glasgow.

[3] Irvine Loudon, *Death in Childbirth* (Oxford: Clarendon, 1992), 517, and, *The Tragedy of Childbed Fever* (Oxford: Oxford University Press, 2000), 186. See also p. 83 above.

[4] Judith Schneid Lewis, 'Maternal health in the English aristocracy: myths and realities, 1790–1840', *Journal of Social History*, 17 (1) (1983), 97–114; *In the Family Way: Childbearing*

The case of Sweden, which was also raised in Chapter 4 and illustrated by Figure 4.8, on page 68, appears to demonstrate that although maternal and late-fetal mortality may move together during some periods, as well as sharing common turning-points in the late 1930s, the association is not a necessary one. Between 1750 and 1850 fetal mortality did not decline in step with maternal mortality. It is possible that in Sweden there were some improvements in the competence of birth attendants during the late eighteenth century, there certainly were in the late nineteenth, and it may be that stillbirths were undercounted in the early decades of registration.[5] Sweden's mortality history warns us to be more cautious about reading health-care improvement simply from mortality decline.

This point needs to be borne in mind when we combine the national and regional time-series first presented in Chapter 4. Figure 7.1 summarizes fifteen late-fetal mortality (SBR) series. Most only cover the twentieth century,

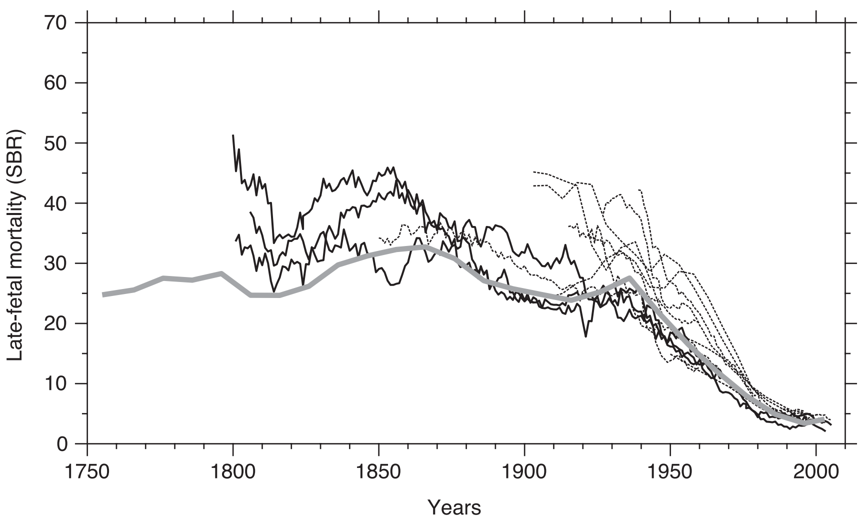


Fig. 7.1: Variations in late-fetal-mortality (SBR) time-series. (The time-series for Sweden, Norway, Denmark, and Iceland are emphasized.)

Source: Figs 4.1, 4.4, 4.5, 4.6, 4.9, 4.11, and 4.12.

in the British Aristocracy, 1760–1860 (New Brunswick, NJ: Rutgers University Press, 1986); and, especially, ' " 'Tis a misfortune to be a Great Ladie": maternal mortality in the British aristocracy, 1558–1959', *Journal of British Studies*, 37 (1998), 26–53 chart the experience of aristocratic wives. Lewis concludes that, in fact, it was not a misfortune to be a great lady, but that there was a period in the early eighteenth century when peers' wives did suffer from overinterventionist, mainly male, midwives. Her picture of maternal-mortality levels and trends is not entirely consistent with those shown in Figure 4.16, on p. 98, however.

[5] This issue is considered again later in the chapter when the possible effects of smallpox are discussed.

but they were derived from registration systems intended to record all stillbirths as well as live births. Although individual countries and regions have already been considered, combining the series provides some new perspectives. First, it emphasizes the degree of conformity at low levels and of convergence since 1950. Second, for most of the series there is a common turning-point in the late 1930s or early 1940s when national stillbirth rates fell in the range 25–40 per 1000 total births. Third, for those places for which we have time-series there is evidence of increase in late-fetal mortality during the first half of the nineteenth century and decline during the second half. The reasons for the increase in SBR are unclear, while those for the decline in Scandinavia and the Netherlands may partly be related to improvements in obstetric care associated with midwifery and new antiseptic practices. National stillbirth rates of 25 were possible even in 1900 in favourable circumstances. Although the series in Figure 7.1 do provide some valuable guidance, it also seems most likely that the levels of late-fetal mortality experienced in many other countries prior to 1900 were at a higher level: 40–60 perhaps. Furthermore, the state-sponsored emphasis on maternal and infant care developed in Scandinavia was as unusual as the early importance attached to the accurate registration of vital events, fetal deaths included. Scandinavia may prove to be a rather special case, therefore; unlike the rest of the world, but far better documented.

This brings us back to the case of England. Here, as Chapter 4 also described, it was necessary to estimate the level of fetal mortality before the late 1920s. The various approaches were set out in Table 4.5 and illustrated in Figure 4.17, on pages 96 and 100. The 'best estimate' of the national stillbirth rate (SBR*) shows that it peaked in the late seventeenth century at about 60 per 1000 total births and thereafter declined steadily to around 40 by the mid-nineteenth century, after which it remained roughly constant until the 1930s turning-point. The eighteenth century was a period of decline in perinatal and maternal mortality, therefore, as was the late twentieth century, but there was little change between the 1830s and the 1930s. The record of the lying-in hospitals and the domiciliary charities helps to confirm the broad outlines of this pattern, at least for the late eighteenth and early nineteenth centuries, when most deliveries took place at home and the hospitals did not specialize in difficult cases. The category 'abortions and stillbirths' reported in the London Bills of Mortality provides the opportunity to derive stillbirth-rate estimates, and these are also shown in Figure 4.17. They are substantially lower than the national estimates and must be treated with suspicion, since all other indices of mortality favour England over London; but the stillbirth rate does trend in a downward direction from around 35 to 25 through the eighteenth century. Regrettably, it is not possible to look in a systematic way at other geographical aspects of fetal mortality in England and Wales before registration, so we can only speculate on the extent to which the 1931 pattern shown in Figure 4.10, on page 72, was present in earlier centuries. It is likely that the picture was just as unclear, with certain regions and localities standing out, as they did in Norway and Italy in the 1870s (Figs 4.3 and 4.14, on pp. 61 and 81). Fetal, infant, and maternal mortality were only loosely associated, with each having its own determining factors and particular sensitivities to registration conventions. We know that in the 1930s some districts, in Wales and the north of England, were recorded as having stillbirth rates in the sixties and seventies while for others, in the south-east of England, it was around 25. If national rates were 50–60 in the eighteenth century, even higher rates must have been suffered in some areas, while other favoured families and places were far less afflicted. Again, we can only speculate, but it is just possible that the minimum and maximum remained roughly constant while the centre of the distribution shifted downwards. There were fewer places with higher rates, so the national average declined.[6]

With respect to the course of late-fetal mortality in England and Wales, and the way it appears to have shifted and changed during the last 400 years, we have now reached the critical point at which we must spell out the various possibilities, to attempt an assessment of causes. Table 7.1 reminds us that as far as broad generalization is concerned there are three possibilities. Intrapartum stillbirths could have been affected by improvements in the quality of obstetric care, while antepartum stillbirths may have been influenced by changes in the burden of those infectious diseases communicable from mother to fetus, and by enhancement in maternal-nutritional status that could benefit fetal growth. It would also have been possible for fertility patterns to change so that, for example, fewer older women became pregnant, and for other risk factors to shift over the centuries. In very simple terms, we can think of two forms of explanatory arguments: the first comes from medical history and emphasizes the importance of skilled birth attendants and the technology that supports their work; the second is more demographic, epidemiological, and economic in origin, stressing the role of disease and the biological standard of living in general. It will be convenient to think of these as competing arguments in which applied science combats cruel nature, but the causes of long-term change are never clear-cut.

Figure 7.2 helps to draw out some of the issues for interpretation. Maternal and late-fetal mortality did not behave in quite the same way; Sweden and England differed before 1940, yet in the second half of the last century their experiences were very similar.

[6] The stillbirth rate was probably far less sensitive to those environmental factors associated with population density, for example, than postneonatal mortality was, but it is nonetheless a matter of considerable interest whether if the risk of fetal death was geographically clustered, the worst areas got better and the best stayed the same or life chances improved everywhere. See Robert Woods, *The Demography of Victorian England and Wales* (Cambridge: Cambridge University Press, 2000), esp. pp. 247–309, on infant mortality, and Chris Galley, 'On the stillbirth rate in early modern England', *Local Population Studies*, 81 (2008), 75–83, on variations in SBR among English parishes.

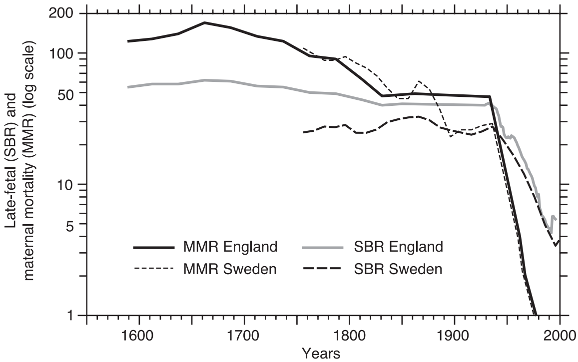


Fig. 7.2: Late-fetal (SBR) and maternal mortality (MMR): Sweden and England and Wales. (The time-series have been simplified to allow comparison. SBR is per 1000 total births and MMR per 10 000 deliveries or births.)

Source: Figs 4.8 and 4.16.

ARGUMENTS FROM MEDICAL HISTORY

One of the longest-running debates in the history of medicine is concerned with impact on health, well-being, and life chances. Before the twentieth century and the major advances in therapeutics associated with drug technology, anaesthetics, surgery, immunization, screening programmes, and so forth, medicine and members of the medical profession could have had very little positive impact on health and risk of early death. In a recent addition to this negative literature, David Wootton has argued, in *Bad Medicine* (2006), that the turning-point was 1865—a date associated with Joseph Lister's discoveries and the recognition of good antiseptic practice in hospitals and among health professionals in general.[7] Before 1865 the story of medicine is largely one of failure, whereas after 1865 some forms of success were increasingly possible. There was a transition from 'bad' to potentially 'good'. 'Before 1865 all medicine was bad medicine; that is to say, it did far more harm than good.'[8] Wootton sees medicine as a technology:

> I have deliberately introduced the term 'technology' because I want to stress that medicine, at least since Hippocrates, has always been a technology, a set of techniques used to act on the material world, in this case the physical condition of the patient's body. With technology it is perfectly legitimate, and not at all anachronistic, to talk about progress . . . In the case of medicine, progress means that pain is alleviated, periods of sickness are shortened, and/or death is postponed.[9]

[7] Wootton, *Bad Medicine: Doctors Doing Harm Since Hippocrates* (Oxford: Oxford University Press, 2006).

[8] Ibid. 26. [9] Ibid. 8.

He believes that history, medical included, has favoured the 'worm's eye view', 'in which small things loomed large, and it was impossible to get one's bearings', over the 'bird's eye view', 'which surveyed the past from the point of view of the present, and was necessarily biased and anachronistic'.[10] And he notes that progress in medical knowledge and therapy are not necessarily linked, since, for example, 'if you look at therapy, not theory, then ancient medicine survived more or less intact into the middle of the nineteenth century and beyond'.[11]

So, if all medicine before 1865 was ineffective or dangerous, why was this not recognized by doctors and why did patients keep on paying to be harmed? Wootton has several answers. One relates to the 'placebo effect'. Patients could believe that they were being helped; their purchase of medical advice, recipes, and physical treatment was in hope, or desperation of an alternative.[12] A second possibility brings us closer to a critical point. Doctors relied on anecdotal evidence, on apparently successful case histories, and on the assumption that ailments should be treated in ways that were specific to each patient. Until the early decades of the nineteenth century and Pierre Louis's work in Paris, they did not, according to Wootton, apply statistical reasoning in their accounts:

> We might go so far as to say that the statistical table was the first direct threat that Hippocratic medicine had faced in over two thousand years. By 1860 the revolution represented by the table was complete.[13]

Wootton displays considerable enthusiasm for the statistical approach, and observes at one point that '[i]n order to get the achievements of modern medicine in perspective we have to start thinking about life expectancies'.[14] But he also warns that although between 1865 and 1942 'doctors began for the first time to defer deaths in significant numbers' this cannot account for the 'astonishing increase in life expectancy that took place during the same period. Medicine has been taking the credit for something that would have happened anyway'.[15] He supports Thomas McKeown's argument in *The Modern Rise of Population* (1976) that 'medicine has had almost nothing to do with modern gains in life expectancy'; is critical of the neglect of fertility; and concludes that 'McKeown's thesis that increased life expectancy is due to improved nutrition is thus, if one accepts [Robert] Fogel's argument, broadly correct, but it requires

[10] Ibid. 15. This passage refers to Herbert Butterfield's *The Whig Interpretation of History* (1932).

[11] Ibid. 17. The point is made in relation to blood-letting: 'A doctor in ancient Rome would have done you just about as much good as a doctor in early nineteenth-century London, Paris, or New York' (p. 70).

[12] Ibid. 67–70.

[13] Wootton, *Bad Medicine*, p. 176. Pierre-Charles-Alexandre Louis (1787–1872) is often credited with the first use of statistical tables in medicine, especially in the comparison of treatment among groups of patients, but there are many examples from the eighteenth century to counter this claim (see Andrea A. Rusnock, *Vital Accounts: Quantifying Health and Population in Eighteenth-century England and France* (Cambridge: Cambridge University Press, 2002)).

[14] Wootton, *Bad Medicine*, p. 270.

[15] Ibid. 269.

one simple modification: what is crucial is nutrition in infancy and childhood, and here what matters is not only the number of calories consumed, but also the consumption of protein and vitamins'.[16]

Bad Medicine raises important issues, therefore, and it has answers. It champions the bird against the worm; demands the reinstatement of 'progress'; returns 'success' and 'failure', 'good' and 'bad' to the lexicon; draws a clear time line in the sand, before and after 1865; it applauds statistical tables; tests medical efficacy using life expectancy; and, failure demonstrated, it turns to psychological and cultural blockages in the medical profession ('doctors' sense of themselves') to explain the slow pace of change. Wootton is moving along the right lines in his stress on an evidence-based approach, but his argument lacks rigour because it fails to deal in sufficient detail with the question 'What is medicine for, what is its purpose?' and it avoids a sophisticated discussion of method—health-impact assessment in history, for example. In terms of purpose and progress, medicine must, surely, be about more than pain alleviated, sickness shortened, death postponed. Life expectancy is given a touchstone role, but then doubts are raised over its power, since its level is acknowledged to be due to multiple causes, not just medicine.

Wootton is prepared to accept that certain very specific developments prior to 1865 could have had positive benefits. Two examples from his rather short list are obstetric forceps and vaccination against smallpox.[17] We will return to smallpox in the next section, along with other maternal infections, but the role of instruments and the wider contribution of skilled birth attendants need to be considered in more detail.

The World Health Organization has developed an extensive international database for the year 2000, which includes maternal-mortality and late-fetal-mortality rates (MMR and SBR) and the percentage of births delivered by skilled birth attendants. We have already noted the problems associated with making estimates of the stillbirth rate and it is obvious that there will have been equivalent problems in the derivation of the other two measures.[18] Maternal deaths are

[16] Wootton, *Bad Medicine*, p. 282. Thomas McKeown, *The Modern Rise of Population* (London: Edward Arnold, 1976) and Robert W. Fogel, *The Escape from Hunger and Premature Death, 1700–2100* (Cambridge: Cambridge University Press, 2004) are referred to. McKeown's rejection of medicine and emphasis on nutrition began in Thomas McKeown and R. G. Brown, 'Medical evidence related to English population changes in the eighteenth century', *Population Studies*, 9 (2) (1955), 119–41, where he argued that the institutionalization of deliveries had an adverse effect on mortality, but that 'the only change in obstetric practice likely to have contributed to a reduction of maternal or infant mortality was an improvement in the hygiene of the labour room' (p. 123). Some earlier interpretations—for example, M. Dorothy George, 'Some causes of the increase of population in the eighteenth century as illustrated by London', *Economic Journal*, 32 (1922), 325–52—were very positive about the contribution of William Smellie (p. 340), as well as medicine and midwifery in general.

[17] Wootton, *Bad Medicine*, pp. 273–4 and 280–1. Quarantine against bubonic plague and some of the early sanitary measures also appear on his list.

[18] The estimates are provided in three separate WHO reports: *Maternal Mortality in 2000: Estimates Developed by WHO, UNICEF, UNFPA* (Geneva: World Health Organization, 2004),

difficult to define in a consistent way, and the level of skill required in order to be counted as a 'skilled birth attendant' must be a matter for debate and local uncertainty. The WHO uses the following definition, which is accompanied by a detailed list of the individual skills required:

> A skilled attendant is an accredited health professional—such as a midwife, doctor or nurse—who has been educated and trained to proficiency in the skills needed to manage normal, uncomplicated pregnancies, childbirth and the immediate postnatal period, and in the identification, management and referral of complications in women and newborns.[19]

The WHO has grouped countries into fourteen subregions each of which is allocated to a mortality stratum defined in terms of the relationship between child and adult mortality. Stratum A has very low levels of both, and thus high life expectancy at birth ($e(0)$ of 77–81 years), while stratum D has high levels of both ($e(0)$ of 51–66) and stratum E has high child and very high adult mortality ($e(0)$ of 44 years in 2000). Figure 7.3 focuses on just four of the subregions with the highest mortality and labels all other countries as the 'remainder' where life expectancy at birth was at least 66 years. The four subregions cover Africa (two regions), the Middle East and south-east Asia.[20] It illustrates what happens when maternal mortality (MMR) and late-fetal mortality (SBR) are associated with the percentage of skilled birth attendants. In the case of maternal mortality (Fig. 7.3*a*), all the countries with very high levels of skilled birth attendants have secured low maternal-mortality rates, as would be expected, but among the other countries, mostly from the four subregions highlighted, there was considerable variation. A few countries managed to have low maternal mortality and low percentages of skilled attendants. When the same exercise is repeated using late-fetal mortality as the dependent variable (Fig. 7.3*b*) then the pattern of association is very different: there is a far wider spread at all levels of skilled attendance. The key point to emerge from Figure 7.3 is that, at least as far as international variations in 2000 were concerned, the percentage of deliveries managed by skilled birth attendants appears to have had a positive and significant effect in

*Neonatal and Perinatal Mortality: Country, Regional and Global Estimat*es (Geneva: World Health Organization, 2006), *Skilled Attendant at Birth, 2006 Updates* (Geneva: World Health Organization, 2006). Kenneth Hill et al., 'Estimates of maternal mortality worldwide between 1990 and 2005: an assessment of available data', *Lancet*, 370 (2007), 1311–19 brings the MMR estimates to 2005 and shows continuing slow decline (see Robert Woods, 'Long-term trends in fetal mortality: implications for developing countries', *Bulletin of the World Health Organization*, 86 (6) (2008), 460–6).

[19] WHO, *Making Pregnancy Safer: The Critical Role of the Skilled Attendant. A Joint Statement by WHO, ICM and FIGO* (Geneva: World Health Organization, 2004), 1. This document is aimed at those countries where less than 85 per cent of birth attendants are skilled, most being traditional birth attendants (TBAs).

[20] The WHO labels these regions AFRO E (20 countries), AFRO D (26 countries), EMRO D (eastern Mediterranean, 9 countries dominated by Egypt and Pakistan) and SEARO D (south-east Asia, 7 countries dominated by India and Bangladesh). The letters E and D refer to the mortality strata. WHO, *Neonatal and Perinatal Mortality*, p. 69 defines the subregions.

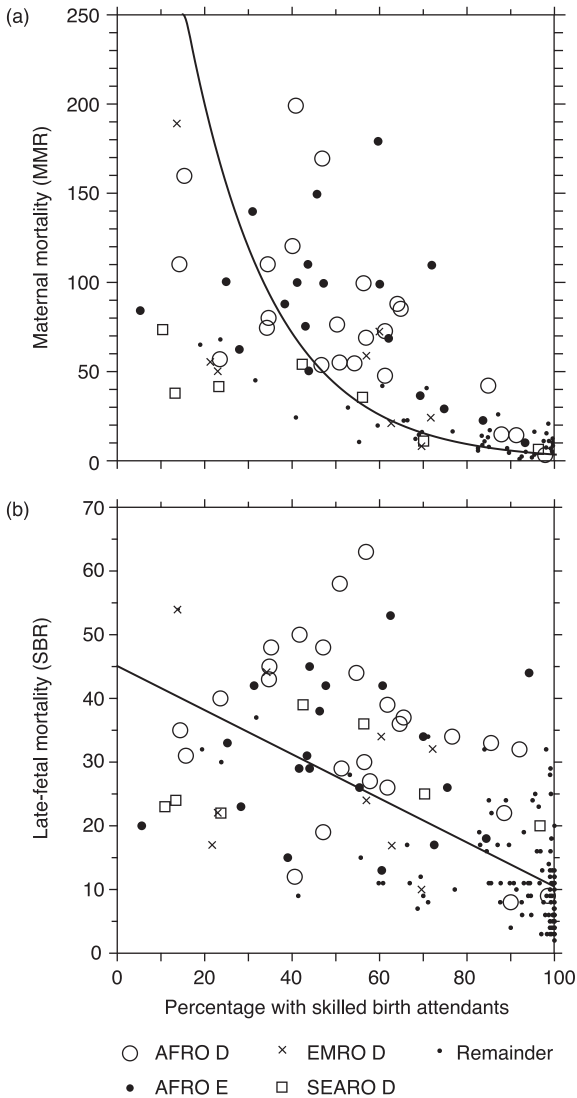


Fig. 7.3: Relationships between maternal mortality (MMR), late-fetal mortality (SBR), and percentage of births with skilled birth attendants: international variations, 2000. (The four WHO regions identified are Africa mortality strata D and E, eastern Mediterranean D, and south-east Asia D.)

Source: Based on estimates reported in WHO, *Maternal Mortality* (2004); WHO, *Neonatal and Perinatal Mortality* (2006); WHO, *Skilled Attendant* (2006).

reducing both maternal and stillbirth mortality, but that the effects were different and far from clear-cut even within geographical subregions that are supposed to have experienced similar high-mortality patterns. The skilled-attendant factor had a greater and more obvious impact on maternal than late-fetal mortality. Access to skilled birth attendants did not guarantee very low levels of stillbirth mortality; other influences were at work.[21]

Figure 7.3 offers an important warning and emphasizes a point that is by now well established. Although improved access to skilled birth attendants must be beneficial to mother and fetus, the extent of the benefit in terms of enhanced life chances is likely to differ and vary; it may thwart simple measurement. If the picture in 2000 proves difficult to interpret, we should expect the causes of long-term trends to be no less obscured.

In the eighteenth and nineteenth centuries most midwives in England were not formally trained or accredited, although they appear to have been able to cope successfully with 'normal, uncomplicated pregnancies'—at least the delivery aspects. In Scandinavia, from the late eighteenth century midwives were educated, trained, and licensed by the state; they were highly skilled birth attendants who could tackle some complicated cases. Training, skills, and professional status normally go together and may be accompanied by technological advances. In this particular historical case we need to explore both the extent of training and the obstetric skills that could be acquired to cope not only with normal cases, but also with unnatural presentations. We need to be able to assess the changing ability to save the lives of, first, the mother and, second, the unborn. We need to explore further the possibility that the men-midwives, the early obstetricians, acquired skills and techniques that made them more successful in tackling the emergency cases, although they may also have used these skills to enhance their financial and social positions in relation to women-midwives. Even in England there were some women-midwives who should not be seen as 'traditional birth attendants', including Sarah Stone, because they had gained sufficient anatomical knowledge and practical experience either from other skilled midwives or through being trained by the lying-in charities, especially in London, or attended the short courses run by Dr Smellie, among others.[22] In order for the 'skilled birth attendants' argument to be sustained it must be demonstrated that skills improved and that access to the skilled increased. Thanks to the textbooks

[21] Figure 7.3*a* plots 172 countries in total, while Figure 7.3*b* shows 187. There must be considerable uncertainty about the quality of estimates for high-mortality and low-skilled-attendance countries.

[22] John Douglas—*Short Account of the State of Midwifery in London, Westminster, &c*. (London: Printed for and sold only by the Author in Lad Lane near Guildhall, 1736), 68–70—was radical in his early call for the thorough and systematic training of 'midwomen' so that they could make safe deliveries. This might involve the use of instruments when it was absolutely necessary and a surgeon was not available. Thomas R. Forbes, 'The regulation of English midwives in the eighteenth and nineteenth centuries', *Medical History*, 15(4) (1971), 352–62 outlines the ways in which midwives were actually regulated.

and case notes, it may be possible to judge the level of obstetric skill that could be achieved and how it was improved, but the matter of access to professionals who had acquired those skills is far more difficult to assess.

For example, it would be helpful to know the extent of William Smellie's teaching and private practice. In the preface to the first edition of his *Treatise*, Smellie provided this information:[23]

> Neither did I pretend to teach Midwifery till after I had practised it successfully for a long time in the country; and the observations I now publish are the fruits not only of that opportunity, but more immediately of my practice in London during ten years [1741–51], in which I have given upwards of two hundred and eighty courses in Midwifery, for the instruction of more than nine hundred pupils, exclusive of female students; and in that series of courses one thousand one hundred and fifty poor women have been delivered in presence of those who attended me; and supported during their lying-in by the stated collections of my pupils; over and above those difficult cases to which we were often called by midwives, for the relief of the indigent.[24]

Concerning his courses, the following notice appeared in the *Daily Advertiser* for Wednesday 8 October 1746. It accompanied similar notices for lectures on anatomy by William Hunter and William Hewitt:[25]

On Wednesday next, 15 October 1746, at Four in the Afternoon, will begin
A course of Lectures on the Theory and Practice of Midwifery.
By William Smellie, MD
At his House in Gerrard-Street, Soho.
Where may be had, his Proposals for the said Course, with an Abstract of the Subjects treated of in the several Lectures.
Note, Those who attend the course may also have the Opportunity of attending real Labours.

Surviving programmes for 1742 and 1745 give outlines of the course of twelve lectures under the headings shown in Fig. 7.4.[26]

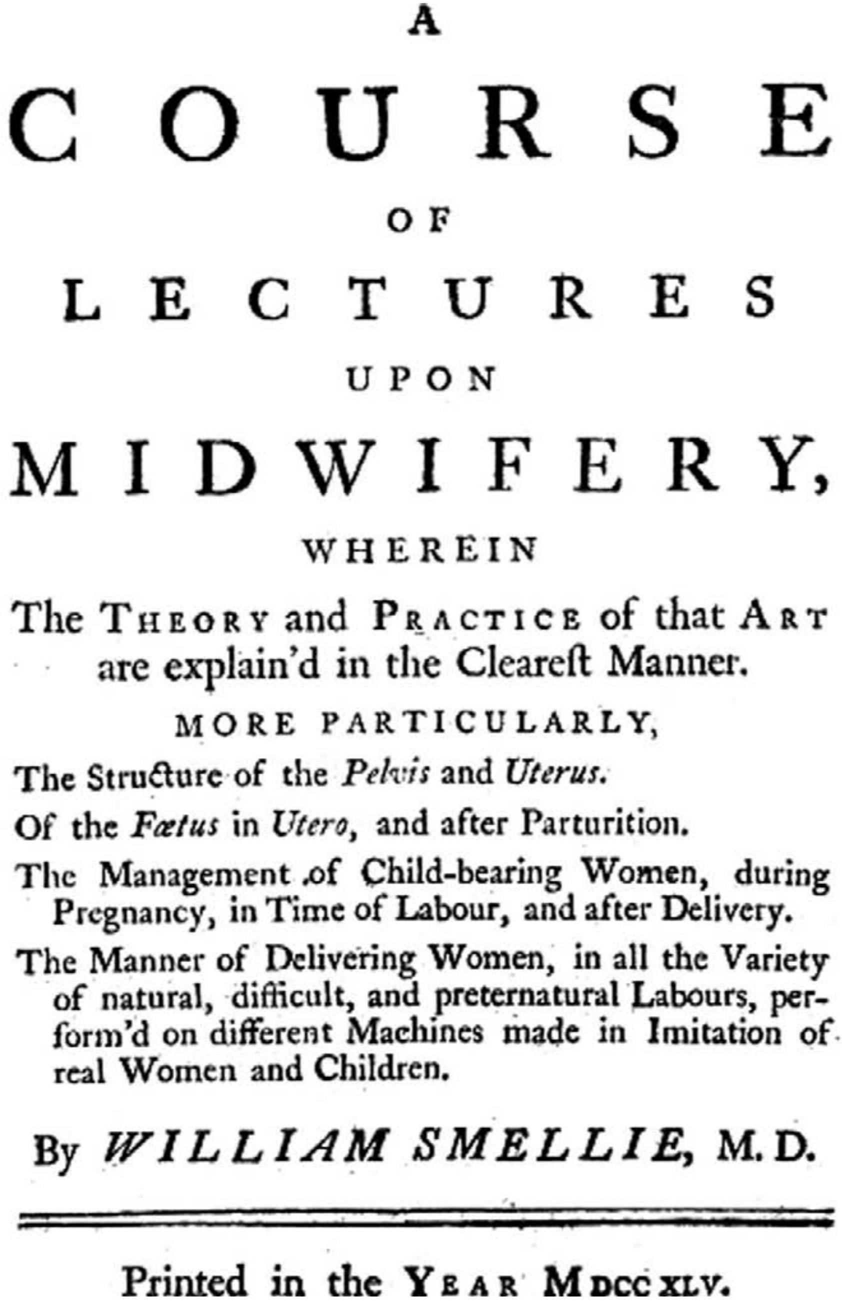
It is known that Smellie offered short courses for small groups of pupils and that the material covered was eventually summarized in the first volume of his *Treatise*. The lectures were conducted at his homes, first in Gerrard

[23] Miles H. Phillips, 'William Smellie and the maternal mortality problem', *Transactions of the Edinburgh Obstetrical Society*, 92 (1933), 130–56 appears to offer us a steer in this regard, but fails to develop a rigorous methodology with which to assess relative contributions.

[24] William Smellie, *Smellie's Treatise on the Theory and Practice of Midwifery*, 3 vols. ed. and annot. Alfred H. McClintock (London: New Sydenham Society, 1876–8); *Smellie's Treatise*, i. 26–7 is quoted here.

[25] Reproduced in Bryan Hibbard, *The Obstetrician's Armamentarium: Historical Obstetric Instruments and their Inventors* (San Anselmo, Calif.: Norman, 2000), 34, fig. 3.1.

[26] The title page for the 1742 brochure is reproduced in R. W. Johnstone, *William Smellie: The Master of British Midwifery* (Edinburgh: Livingstone, 1952), fig. 1, facing p. 24. A detailed eight-page prospectus for 1745 survives at the Wellcome Library, London, as MS 4630. This course outline is accompanied by handwritten notes on the lectures. Fig. 7.4 also comes from the Wellcome Library (WMS 5675).



A

COURSE

OF

LECTURES

UPON

MIDWIFERY,

WHEREIN

The THEORY and PRACTICE of that ART are explain'd in the Clearest Manner.

MORE PARTICULARLY,

The Structure of the *Pelvis* and *Uterus*.

Of the *Fœtus* in *Utero*, and after Parturition.

The Management of Child-bearing Women, during Pregnancy, in Time of Labour, and after Delivery.

The Manner of Delivering Women, in all the Variety of natural, difficult, and preternatural Labours, perform'd on different Machines made in Imitation of real Women and Children.

By *WILLIAM SMELLIE*, M.D.

Printed in the YEAR MDCCXLV.

Fig. 7.4: Programme for a course of lectures on midwifery by Dr William Smellie, London, 1745.

Source: Wellcome Library, London.

Street and then Wardour Street, Soho. They had a theoretical introduction, but were principally concerned with the practical matters of delivery, which were illustrated initially by the use of one or more phantoms designed by Smellie himself. Pupils were also instructed at the labours of real women, chiefly the poor of St Giles parish nearby. These women had their lying-in supported by financial contributions from Smellie's pupils in exchange for the privilege of being present at and assisting with their deliveries. John Glaister, the first biographer, says that Smellie's students each contributed 6 shillings to a 'common fund' for the lying-in costs of patients; that initially there were twelve lectures in each fortnight-long course; that the cost for one course was 3 guineas, with four courses in two months for 9 guineas, and 20 guineas for the year; that by 1753 there were eighteen lectures in a course and students were charged from 5 to 10 shillings per confinement, depending on difficulty; and that in each course a student could expect to be present at 4 deliveries and to undertake 1.[27] One of Smellie's pupils was Richard Kay, of Bury in Lancashire. He attended lectures at Gerrard Street in May, June, and July 1744 while also taking hospital courses as a trainee surgeon. On 1 August he was called to attend the labour of one of Smellie's poor women—the second labour he had attended. On 28 August he received a certificate in surgery from Guy's Hospital, on the 29th he inspected his new surgical instruments, and on 4 September he left London for home. Kay did not become a specialist midwife, but as a surgeon he was required to deliver dead-born infants on at least three occasions (25 September 1748, 24 December 1748, 10 January 1749). His more regular work involved amputations and a mastectomy. He died in 1751, aged 35.[28]

The Bills of Mortality record that during the ten years 1741–51 there were 144 595 baptisms in London—so that Smellie's 1150 pregnant, poor women may have represented some 0.7 per cent, although his entire case load would have been closer to 1 per cent. The number of pupils passing through his course was considerable, however. If there were about 900 pupils and the course ran 280 times, it confirms that it was up to two weeks long, and that there were three or four pupils on each course. Given that in London during the 1740s about forty

27 John Glaister, *Dr William Smellie and His Contemporaries: A Contribution to the History of Midwifery in the Eighteenth Century* (Glasgow: Maclehose, 1894), 58. P. H. Nankivell, 'Certificate of attendance at William Smellie's lectures, 1757', *Medical History*, 1 (1957), 279–81 reproduces a certificate of attendance for Mr James Nankivell, Surgeon, dated 13 June 1757. Pam Lieske, 'William Smellie's use of obstetric machines and the poor', *Studies in Eighteenth-century Culture*, 29 (2000), 65–86 discusses his design and use of teaching models and his approach to the delivery of poor women. John Harrison, *A Short Comparative View of the Practice of Surgery in French Hospitals* (London: Printed for Jacob Robinson, at the Golden Lion, in Ludgate Street, 1750), 49–52 notes the superiority of Dr Smellie's teaching machines compared with the French equivalents, and says that two courses with Smellie cost 5 guineas, for which the pupils attended four labours and delivered the last, for an additional guinea.

28 W. Brockbank and F. Kenworthy (eds.), *The Diary of Richard Kay, 1716–51, of Baldingstone, near Bury: A Lancashire Doctor*, Chetham Society, Remains Historical and Literary, 3rd ser. (Manchester: Manchester University Press, 1968).

women went into labour each day, then at least eighty full-time women-midwives would have been required. However, most midwives, women and men, were part-timers, called upon when needed. The number of midwives would have been considerably more than eighty, but it is impossible to guess how many.[29]

That Smellie had upwards of 900 male pupils suggests several observations, therefore. First, it might be assumed that such a large number means that all medical practitioners working in the metropolis could have attended his course at some time—the younger ones at least. Second, Smellie also trained many provincial practitioners, like Richard Kay. The potential influence of Smellie's teaching and textbook would have been considerable. Third, there is, however, the possibility that some of those who attended his course were merely curious gentlemen seeking some interesting diversion for a few days and with no intention of practising as men-midwives. This is suggested by the cost and by the way in which the course was advertised alongside anatomy lectures by William Hunter, for example, which it is unlikely were intended exclusively for the training of surgeons. However, against this speculation it must also be mentioned that Dr Pieter Camper's account of the midwifery course indicates that it was of great value to a qualified physician. Further, it is unclear how the fortnight-long courses were organized, since they cannot have covered the same material each time. And, finally, Smellie hints that he also ran courses for women-midwives, although he does not offer any information on the scale of this activity. While Smellie's greatness and lasting fame are universally recognized by historians of medicine, the quantitative impact of his teaching still remains a matter for conjecture.[30]

It has been observed that traditionally midwives delivered live births while surgeons delivered the dead-born, and, for both groups, the survival of the mother was of paramount importance.[31] During the eighteenth century the new men-midwives, surgeons and physicians, developed techniques that improved the likelihood not only of being able to save the woman when the fetus had died, but of being able to keep both alive. Success in delivering high-risk, emergency cases, and thus of reducing the rate of intrapartum stillbirths, is virtually the only way in which the skills of birth attendants could have had a positive bearing on fetal mortality prior to the 1930s. In this regard, obstetric instruments, careful physical examination, external manipulation of the fetal position, and improved exchange of knowledge between practitioners were to be the most important potential contributors.

[29] Adrian Wilson, *The Making of Man-midwifery: Childbirth in England, 1660–1770* (Cambridge, Mass.: Harvard University Press, 1995), 34 suggests that some midwives may have dealt with 200 deliveries a year, while the 'urban' rate was closer to 50 per year. This would suggest a range of from 290 to around 70 for the number of midwives working in London. He also has a list of 28 named men-midwives practising in London between 1700 and 1750 (p. 83, table 6.1).

[30] Johnstone, *William Smellie*, pp. 126–36 salutes the doctor's posthumous fame without considering his influence on the effectiveness of contemporary health care and survival chances.

[31] Wilson, *Man-midwifery*, p. 113 makes this point.

The use of obstetric instruments, especially forceps, represented a point of conflict among midwives and the medical establishment in general during the eighteenth century. Although some viewed the overenthusiastic use of forceps as a dangerous crime against women and the unborn, it is far more likely that improved varieties of the instrument, especially the ones made of steel with curved blades that were capable of locking round the infant's head (known as French forceps), could be an important and valuable addition to the birth attendant's skills. They allowed labour to take place more quickly, avoiding some problems of asphyxia; they assisted in the delivery whole of fresh, dead fetuses, which would otherwise have been subjected to craniotomy and dismemberment; and they helped midwives to turn a malpresenting fetus so that it could move more easily down the birth canal, although this procedure was regarded as dangerous by many. Forceps, as 'artificial hands', were also far superior to other, more traditional, devices: knives, including penknives, scissors, hooks, crochets, fillets, and the single-blade vectis.[32] However, in unpractised or unsympathetic hands they could also prove instruments of permanent damage to mother and infant, and they did tend to be the preserve of surgeon or physician men-midwives. Their use implied the performance of an operation.

It is quite possible that the introduction, adoption, and refinement of obstetric forceps had a positive impact on both maternal and late-fetal mortality during the eighteenth century, and especially from the 1740s onwards. Assisting in the delivery of a live-born rather than a dead-born infant would have been its greatest contribution, and in this regard its effect on the reduction of intrapartum stillbirths could have been significant. But was it substantial? The authorities assure us that forceps were only used sparingly, and that, anyway, complicated, emergency cases made up only a small minority of all deliveries. However, it has proved extremely difficult to be precise about the proportions involved, simply because the complicated cases were the best documented and the normal, uneventful deliveries went unremarked. For example, William Giffard's case notes from 1728–31 have been used to argue that his effective use of forceps led to a drop in the proportion of stillbirths from 25 to 10 per cent, and that the presumption in his emergency cases shifted from the delivery of a dead- to a live-born child.[33] Adrian Wilson has also attempted a more general assessment of the incidence of difficult births by combining evidence from the surveys prepared

[32] Wilson, *Man-midwifery*, esp. pp. 79–103, discusses the politics and effectiveness of forceps in more detail, including the attack on men-midwives by Mrs Elizabeth Nihell, 'Professed Midwife', in her *A Treatise on the Art of Midwifery* (London: Printed for A. Morley, at Gay's Head, near Beaufort Buildings, in the Strand, 1760). Hibbard's *Obstetrician's Armamentarium* deals with shapes and sizes. His chapter entitled 'Smellie and Levret: trend setters for the late eighteenth century' (pp. 33–44) is especially useful in illustrating the way in which forceps changed from devices for extracting dead fetuses to ones designed to assist the delivery of live-born infants.

[33] Wilson, *Man-midwifery*, p. 97–8. William Giffard, *Cases in Midwifery, Revised and published by Edward Hody, MD, FRS* (London: Printed for B. Motte, T. Wotton, and L. Gilliver, in Fleet Street; and J. Nourse, without Temple-Bar, 1734). See also Chapter 5, p. 109.

by Giffard, William Smellie, and Robert Bland. This gives a range of from 1.5 to 2.6 per cent of total births.[34] Neither of these two pairs of figures can be taken at face value. The 'difficult births' proportions are too low, while the stillbirth proportions do not represent a full range of cases and their abrupt decline is far too dramatic. Most of the evidence available for eighteenth-century England shares these difficulties; it dwells on specific cases, and, for the institutions like lying-in hospitals and workhouses, the specially selected patients.

One exception, but from the early nineteenth century, is reported by Edward Copeman in *Cases in Midwifery, By the Late John Green Crosse, MD, FRS, Arranged (with an Introduction and Remarks)* (1851).[35] Crosse undertook an extensive range of medical activities in Norfolk during the 1820s and 1830s, including private and consulting practices and hospital work as a surgeon. He kept detailed notes on 1377 labours in his private practice, which Copeman tabulated and edited. The 1377 labours produced 71 stillbirths and 1323 live births, and 14 mothers died (including 2 from consumption). There were 17 sets of twins; the average age of the mothers was 30; the average duration of labour was 8 hours. Of the 1394 presentations, 74 were unnatural. Instruments were used in 84 cases (forceps in 25, the single-blade vectis in 59), 42 being first births, of which there were 356 in all. In terms of rates, we have the following: stillbirth, 50.9 (per 1000 total births); maternal mortality, 102 (per 10 000 deliveries); unnatural presentations, 5.3 per cent; instruments used, 6.1 per cent of all labours and 11.8 per cent of first labours. Copeman compared these figures with those from his own practice in a 'tolerably healthy country district' of Norfolk between 1835 and 1845. In 1037 deliveries, there were only 2 maternal deaths and the stillbirth rate was 40.2. Crosse's evidence and Copeman's comparisons are also significant because they help us to see which aspects of midwifery were of importance to contemporaries and what they regarded as normal, acceptable, or controversial. For example, in more than 90 per cent of cases no obstetric intervention was required during delivery; the fetus was alive and correctly positioned, the mother was well and capable of giving birth. The details of Crosse's records demonstrate his appreciation of risk factors such as mother's age and parity, the sex of the fetus and its *in utero* position, the dangers

[34] Wilson, *Man-midwifery*, p. 18, table 2.4. Bland's work on the records of the Westminster General Dispensary for 1774–81 is referred to in Table 4.3, on p. 92.

[35] Copeman (ed.), *Cases in Midwifery, By the Late John Green Crosse, MD, FRS, Arranged (with an Introduction and Remarks)* (London: Churchill, 1851). See also V. Mary Crosse, *A Surgeon in the Early Nineteenth Century: The Life and Times of John Green Crosse, 1790–1850* (Edinburgh: Livingstone, 1968) and Irvine Loudon, *Medical Care and the General Practitioner, 1750–1850* (Oxford: Clarendon, 1986), esp. pp. 97–9. Irvine Loudon, 'General practitioners and obstetrics: a brief history', *Journal of the Royal Society of Medicine*, 101 (2008), 531–5 speculates that by 1800 'it is probable that about half the total deliveries in England and Wales were home deliveries by medical practitioners', principally surgeon-apothecaries, and that the remainder were conducted by female midwives (p. 531). Less than 1 per cent took place in lying-in hospitals. In 1700 nearly all deliveries were by 'uneducated female midwives'. It would be very difficult to substantiate the estimates for 1800, and in doing so it would be necessary to distinguish between live- and dead-born.

of instrumental delivery, and the principal causes of maternal death. Yet among Crosse's private patients his maternal-mortality rate, even excluding the 2 cases of consumption, was 87 and the stillbirth rate was 50.[36]

If we could use Crosse's notes as a way of looking back on the eighteenth century, what would they suggest? We might expect that about 10 per cent of all deliveries would have turned out to be complicated in one way or another and that around half of these might require some form of instrumental intervention, with forceps vying with the more simple vectis. However, more than 10 per cent of first births could have required instrumental delivery, which indicates that an even higher proportion, it might have been 20 per cent, were not straightforward.[37] Without forceps and the vectis, would Dr Crosse's stillbirth rate have been even higher—in the sixties, perhaps?

It is understandable why medical history has become infatuated with the forceps, but it is very difficult to imagine how such instruments could, on their own, have made a substantial contribution when they were probably used in a very small proportion of deliveries. Their use had positive benefits that should not be ignored or trivialized or exaggerated. Alongside obstetric instruments, the production and distribution of midwifery textbooks may also have been helpful, especially when combined with short, practical courses and the development of midwifery education in certain medical schools. But, once again, it is very difficult to be precise about the impact. That a market for midwifery education, professional training, and technical literature developed in the eighteenth century and was sustained in succeeding centuries should represent an important, positive advance. Birth attendants could become more skilled if they could read. Knowledge could be accumulated and transferred more efficiently. Patient care might be improved and good, standard practice disseminated more widely. However, the spread of courses and textbooks could also serve to confirm old, potentially harmful conventions. Blood-letting, opiates, and essentially herbal remedies were important elements of early modern medicine

[36] The detail of Crosse's data is unusual. Thomas Higgins of Wem, Shropshire, kept a record of nearly 1200 infants he had delivered between 1781 and 1803, but this was principally for financial purposes. His SBR lay between 43 (49 dead-born, 1078 live-born) and 65 (75 dead-born if all cases of unstated outcome are also regarded as dead-born). However, his sex ratio among live births was 116 (males per 100 females), which can be reduced to 106 (close to the biological mean) if all those live-born infants without a reported sex are taken to be female. The sex ratio among dead-born fetuses was 242, or 145 if all those dead-born without a stated sex are taken to be female. Higgins's SBR fits into the broad pattern, therefore, although, unfortunately, he provides no further obstetrical information (see Alannah Tomkins (ed.), 'The registers of a provincial man-midwife, Thomas Higgins of Wem, 1781–1803', in D. C. Cox (ed.), *Shropshire Historical Documents: A Miscellany*, Shropshire Record Series, 4 (Keele, Staffs.: University of Keele, 2000), 65–148).

[37] These figures are also broadly consistent with the experience of Thomas W. Jones, who noted the delivery of 422 infants between 1791 and 1800, 18.5 per cent of which were difficult and 6.2 per cent of which required the use of instruments (in 19 of the 26 forceps were used). But Jones noted only 5 stillbirths and no maternal deaths (see Joan Lane, 'A provincial surgeon and his obstetric practice: Thomas W. Jones of Henley-in-Arden, 1764–1846', *Medical History*, 31 (1987), 333–48).

each of which was routinely prescribed during pregnancy.[38] On balance, the midwifery-textbook revolution of the eighteenth century should probably be accepted as a generally beneficial development. Matters of practice were, at least, laid open to critical debate.[39]

However, the demographic evidence as represented in Figures 4.16 and 4.17 also indicates that in England maternal and stillbirth mortality both peaked in the late seventeenth and declined throughout the eighteenth century. Improved delivery practices may well have contributed positively, but their effects are unlikely to have been felt much before 1740. There were other contributory causes at work.

ARGUMENTS FROM DEMOGRAPHY, ETC.

Demography, broadly conceived, has several arguments to contribute. Shifts in reproductive behaviour will affect the pattern of maternal risk. Older women bearing children for the first time or having higher-order births will be at greatest danger of fetal loss. The nutritional status of young women before and during pregnancy will affect their ability to carry to term, but especially the chance of intrauterine-growth restriction (IUGR), premature delivery, and low birthweight. The prevailing disease environment will also have an important influence on maternal infections, the likelihood of fetal mortality, and growth restriction. Demographic influences are essentially biological. They may have displayed a high degree of autonomy, which was in large part beyond effective human control until the twentieth century.

As part of a wider argument about the causes of population increase in eighteenth-century England and the relative contributions of mortality (represented by life expectancy at birth in years, $e(0)$) and fertility (represented by the gross reproduction rate, GRR: the number of daughters produced by the average woman on reaching the end of her reproductive period), E. A. Wrigley demonstrated the superior power of the latter over the former: fertility over

[38] Robert Woods, 'Dr Smellie's prescriptions for pregnant women', *Medical History*, 52 (2) (2008), 257–76 provides examples. These everyday practices typify what Wootton would call 'bad medicine'.

[39] For example, when Professor Alexander Hamilton edited Smellie's obstetric atlas, *Anatomical Tables, With Explanations, and an Abridgment of the Practice of Midwifery; With a view to illustrate a Treatise on that Subject, and Collection of Cases* (Edinburgh: Printed for William Creech, 1787) he not only inserted references to his own publications, but also rejected the author's use of forceps in certain cases, turning included, as well as the quality of the instruments themselves. Eardley Holland, 'The Princess Charlotte of Wales: a triple obstetric tragedy', *Journal of Obstetrics and Gynaecology of the British Empire*, 58 (6) (1951), 905–19 suggests that the increasing reluctance to use forceps, encouraged by such authorities as Hamilton and Thomas Denman, contributed to the death of Princess Charlotte on 6 November 1817. Her labour was allowed to become dangerously protracted by her obstetrician, Sir Richard Croft, who rejected decisive, early intervention with instruments.

mortality. One element of his explanation for the contribution of fertility relates to rising marital fertility. It was observed through a 5 per cent shortening of mean birth intervals, which 'accounted for about a seventh of the rise in the GRR over the period' 1670–99 to 1800–37:

> There is good reason to suppose that the reduction in the mean birth interval is attributable to a major decline in the stillbirth rate. By the mid-nineteenth century the stillbirth rate in England was probably in the range 40–50 per 1000 total births whereas in the later seventeenth century it was probably between 100 and 125 per 1000.[40]
>
> If the stillbirth rate fell from 100 to 50 per 1000 total births between the end of the late seventeenth century and the early nineteenth century, the live birth rate would have risen by 5.6 per cent. The change in the mean birth interval corresponds closely with this figure.[41]

In accounting for the decline of stillbirth mortality, Wrigley stressed the important role of birthweight, especially low birthweight at full term (under 2500g), and the contribution of maternal-nutritional status to fetal growth:

> Since low birthweight in turn is strongly conditioned by nutritional status, the marked fall in the stillbirth rate during the long eighteenth century is strong evidence against the supposition that levels of nutrition deteriorated during this period.[42]

Wrigley's argument links maternal-nutritional status, intrauterine-growth restriction, late-fetal mortality, birth intervals, marital fertility, overall fertility, and population growth. While stillbirths occupy only a small part of the whole picture, their position is both critical and new, since changes in marital fertility played little part in earlier interpretations. Such a key position would favour an account of economic–demographic relations that is even more closely tied to material conditions and living standards, since the decline in the stillbirth rate and the fall in the mean age at marriage for women are, in combination, credited with producing 75 per cent of the rise in fertility (GRR). Mortality decline would also be given both a direct effect (increase in $e(0)$ from 35 to 41 years) and an indirect effect through fertility (SBR decline). On the age-specific aspects of the direct effect, Wrigley observed that neonatal (thus endogenous-mortality) and adult-mortality (including maternal-mortality) declines made positive contributions and that, in general, '[t]he period immediately before birth, birth itself, and the period immediately after birth became radically less dangerous to both mother and child during the long eighteenth century'.[43]

[40] E. A. Wrigley, 'British population during the "long" eighteenth century 1680–1840', in Roderick Floud and Paul Johnson (eds.), *The Cambridge Economic History of Modern Britain, i. Industrialisation, 1700–1860* (Cambridge: Cambridge University Press, 2004), 71. See also E. A. Wrigley, 'Explaining the rise in marital fertility in England in the "long" eighteenth century', *Economic History Review*, 51 (3) (1998), 435–64. Wrigley's estimates are illustrated as SBR2 in Table 4.5, on p. 96.

[41] Wrigley, 'British population', p. 72. [42] Ibid. 74. [43] Ibid. 83.

However, it is more likely that the stillbirth rate fell from 60 (70 at most) to 40 during the eighteenth century and that this would have made only a 2.1 per cent contribution to the rise in crude birth rate, which increased from 31 to 39 per 1000 live births. There are two reasons to be sceptical concerning Wrigley's stress on the role of late-fetal mortality. First, it has not been possible to find credible empirical examples, either historical or modern, in which 10–12 per cent of viable fetuses were born dead. Were fetal wastage to have been at such a high level and to have been followed by child mortality (ages 0–9) of 30 per cent, it is very difficult to imagine how fertility could have kept pace and the population not gone into steep decline. Second, it must be remembered that those aspects of demographic life that may be said to have improved during the eighteenth century probably deteriorated during the seventeenth. The causes of this fall-and-rise trajectory remain, to say the least, obscure. Wrigley's stress on maternal nutrition and birthweight, suggested by lower fetal mortality, may prove wide of the mark, a distraction from more strictly demographic-epidemiological concerns.

The wider debate among economic historians on material conditions during the British industrial revolution has led to the acceptance that living standards cannot simply be reflected by real wages. There is a biological standard of living, which relates to diet and nutrition, the height and weight of the population, and an environmental standard of living, which reflects housing quality as well as the disease environment where that housing is used, especially whether it is urban or rural. Higher wages in a dangerous urban environment where poor-quality food and large amounts of alcohol are consumed will not guarantee a healthier quality of life.[44] It is also appreciated that different sections of society may have had different experiences. In this case, we would like to know what happened to the health and nutritional status of young females, and how changes in their particular circumstances would have affected their ability to conceive, carry to term, and produce live-born infants. Since most of the height data upon which historical studies of nutritional status are so dependant relates to young males, it has proved difficult to gain a clear picture of mothers and potential mothers. Even W. Peter Ward's exhaustive studies of birthweight data from five major lying-in hospitals between the 1850s and the 1930s have failed to yield a conclusive account of changes in women's nutritional status in this period.[45]

[44] The literature on these issues is enormous. See, for example, John Komlos, 'The secular trend in the biological standard of living in the United Kingdom, 1730–1860', *Economic History Review*, 46 (1) (1993), 115–44, which argues, on the basis of height data, that among the lower sections of society nutritional status deteriorated during the eighteenth and early nineteenth centuries. Peter Razzell and Christine Spence, 'The hazards of wealth: adult mortality in pre-twentieth-century England', *Social History of Medicine*, 19 (3) (2006), 381–405 has recently reopened an old debate on alcohol and tobacco consumption, which echoes points raised in George, 'Some causes', p. 333 on 'the orgy of spirit-drinking' between 1720 and 1751.

[45] Ward, *Birth Weight and Economic Growth: Women's Living Standards in the Industrializing West* (Chicago, Ill.: University of Chicago Press, 1993). The lying-in hospitals are Edinburgh,

Lying-in hospitals were relatively small, they were selective, and, in any case, the mean birthweight is doubtless a rather poor guide to maternal physique and well-being. Pelvic deformity due to rickets in childhood, itself related to vitamin-D deficiency, proved a serious complication to successful delivery in many of the cases mentioned in the case notes of eighteenth-century authorities. But it would not be justifiable to use these references as a guide to the progress of reproductive competence, since vitamin-D deficiency can be caused by both poor diet and lack of access to sunlight.[46] All in all, there is no direct and reliable evidence upon which to base a firm conclusion about trends in the nutrition of young females during the eighteenth and nineteenth centuries. If they were like the males, the grounds for a positive interpretation are not overwhelming.

Of the arguments from demography, it is the role of maternal infections that may prove to be the most interesting, and probably the most important. A number of reviews undertaken in the early twenty-first century have pointed to the infectious origins of antepartum stillbirths. They list, among others, the following maternal diseases: malaria, bacteria such as *E. coli*, chickenpox, German measles (rubella), measles, smallpox, syphilis, and HIV.[47] The importance of malaria in pregnancy, especially in areas where it is still endemic, but also under epidemic circumstances, cannot be exaggerated. It is devastating in tropical Africa, and was probably just as dangerous in southern regions of Europe and the USA prior to the 1930s.[48] But malaria will not have had a considerable impact in northern Europe outside certain localized marshland environments,

Dublin, Vienna, Boston, and Montreal. The percentage of stillbirths is also shown for the hospitals, but this too proves to be an ambiguous index of maternal well-being. Richard H. Steckel, 'Birth weight and stillbirths in historical perspective', *European Journal of Clinical Nutrition*, 1st ser., 52 (1998), 16–20 also reproduces Ward's figures.

[46] Table 5.1, on p. 113, shows that Mrs Stone had to cope with at least 5 cases in which the fetus was stuck on the share-bone, presumably because of a deformed pelvis. Similarly, Smellie's great obstetric atlas paid special attention to the deformed pelvis and how fetuses could be delivered in such circumstances. Loudon, *Death in Childbirth*, pp. 135–43 has attempted to derive an estimate of the percentage of deliveries encountering a contracted pelvis. He suggests less than 1 per cent in the nineteenth century.

[47] See especially Robert L. Goldenberg and Cortney Thompson, 'The infectious origins of stillbirth', *American Journal of Obstetrics and Gynecology*, 189 (3) (2003), p. 863, table 1, and Robert L. Goldenberg, R. Kirby, and J. F. Culhane, 'Stillbirth: a review', *Journal of Maternal–Fetal and Neonatal Medicine*, 16 (2004), p. 86, table 1. Eugene D. Weinberg, 'Pregnancy-associated depression of cell-mediated immunity', *Reviews of Infectious Diseases*, 6 (6) (1984), 814–31 reviews the ways in which immunity may be depressed during pregnancy. When Dr Robert Lee, FRS, gave his lectures on midwifery at St George's Hospital, London, in 1842–3, lecture XIX was entitled 'On the communication of scarlet fever, measles, smallpox, syphilis, and other diseases, to the foetus in utero'. Lee was quite clear about the roles of smallpox and syphilis, although his evidence for the other diseases was rather sketchy (Robert Lee, *Lectures on the Theory and Practice of Midwifery* (London: Longman, Brown, Green, and Longman, 1844), 195–201).

[48] See Christopher J. M. Whitty, Sally Edmonds, and Theonest K. Mutabingwa, 'Malaria in pregnancy', *British Journal of Obstetrics and Gynaecology*, 112 (2005), 1189–95, and Jean-Pierre van Geertruyden et al. 'The contribution of malaria in pregnancy to perinatal mortality', *American Journal of Tropical Medicine and Hygiene*, 2nd ser., 71 (2004), 35–40. Robert Sallares, Abigail Bouwman, and Cecilia Anderung, 'The spread of malaria to southern Europe in antiquity: new

where it may have influenced both infant and fetal mortality.[49] *E. coli* is likely to have been present while domestic-cooking arrangements were less than adequate and before the widespread availability of refrigerators in the twentieth century. Although the historical influence of such bacteria among pregnant women is impossible to gauge, it is also difficult to believe that its effect could have changed dramatically before the twentieth century. It was a constant danger of unknown proportion.

A number of common infectious diseases of childhood raise the risk of fetal loss if contracted during pregnancy, and in certain cases they have direct consequences for growth restriction. Today, most of these diseases are of little or no consequence for the populations of developed countries. In developing countries measles and rubella are still important diseases, but their contribution to fetal mortality remains uncertain.[50] Although smallpox was eradicated in the late 1980s, it is a disease of immense historical and demographic importance. It is also a disease that is known to have been more virulent when contracted by pregnant women, to have adversely affected fetal-survival chances, and, through inoculation in the eighteenth century and vaccination in the nineteenth, to have been responsive to medical intervention. Smallpox in pregnancy merits consideration in considerable detail, therefore, although it should be stressed that other infectious diseases will also have played a part in reducing intrauterine-survival chances in the past.[51]

Smallpox in pregnancy

The definitive World Health Organization account of the eradication of smallpox makes the following bald statements: ‘It is universally agreed that smallpox was more severe in pregnant women than in non-pregnant women or in men, irrespective of vaccination status’, and ‘Smallpox caused premature termination

approaches to old problems’, *Medical History*, 48 (2004), 311–28 speculates on the impact of malaria on fetal mortality in ancient Rome.

[49] Mary J. Dobson, *Contours of Death and Disease in Early Modern England* (Cambridge: Cambridge University Press, 1997), 340 notes the likely association between stillbirths, neonatal deaths, and the presence of malaria in English marshland parishes. The point is re-emphasized and broadened in geographical scope in Randall M. Packard, *The Making of a Tropical Disease: A Short History of Malaria* (Baltimore, Md.: Johns Hopkins University Press, 2007). Malaria will have had an important, yet localized, impact on reproductive wastage, which diminished before the end of the nineteenth century.

[50] F. T. Cutts et al., ‘Control of rubella and congenital rubella syndrome (CRS) in developing countries, pt. I: burden of disease from CRS’, *Bulletin of the World Health Organization*, 75 (1) (1997), 55–68.

[51] Carolyn M. Constantin et al., ‘Smallpox: an update for nurses’, *Biological Research for Nursing*, 4 (4) (2003), 282–94, and Carolyn M. Constantin et al., ‘Smallpox: a disease of the past? Consideration for midwives’, *Journal of Midwifery and Women’s Health*, 48 (4) (2003), 258–67 describe the current situation. They are clear that ‘[w]omen with smallpox infection during pregnancy have higher rates of abortions, stillbirths, and preterm deliveries than women without the disease’ (p. 258).

Table 7.2. Smallpox in pregnancy: Infectious Diseases Hospital, Madras, India, 1959–62

Cases	255
Maternal deaths	81
Case-fatality rate (%)	32
Termination rate (%)	57
Miscarriages	26
Stillbirths	25
Live births	81

Note: A total of 8133 cases of smallpox were admitted during a 38-month period, of which 255 were pregnant women, and, of these, 132 pregnancies terminated during the course of the disease in hospital.

Source: Rao et al., 'Pregnancy and smallpox' (1972), p. 356, table 2. Rao, *Smallpox*, p. 122, table 16.1 has a slightly enhanced set of cases.

of pregnancy in 75 per cent of women who got the disease during the early weeks of pregnancy and in 60 per cent of those who contracted it after the fetus had become viable but before it had reached full term'.[52] The evidence for this finding comes from the work of A. Ramachandra Rao, whose study *Smallpox* (1972) reported statistics from the Infectious Diseases Hospital, Tondiarpet, Madras, India.[53] Some of Rao's most interesting results are summarized here in Table 7.2. The case-fatality rate among the pregnant women was 32 per cent, with 21 per cent among those who had been vaccinated, but among vaccinated males and non-pregnant females it was less than 5 per cent. The stillbirth rate was 236 per 1000 total births, and for every 100 live births there would have been 63 fetal deaths. Rao's data appear conclusive, and it is understandable why the WHO and other authorities should assert that smallpox in pregnancy was so dangerous for women, and the unborn, even if they had been vaccinated.[54] However, it must be remembered that we are dealing with hospital rather than population statistics, that sample sizes were quite small, and that among the unvaccinated, for non-pregnant females the case-fatality

[52] Frank Fenner et al., *Smallpox and its Eradication* (Geneva: World Health Organization, 1988), 54 and 55.

[53] Rao, *Smallpox* (Bombay: Kothar, 1972), esp. pp. 120–9. His classic papers are: Rao et al., 'Pregnancy and smallpox', *Journal of the Indian Medical Association*, 40 (1963), 353–63, and Rao, 'Haemorrhagic smallpox', *Journal of the Indian Medical Association*, 43 (1964), 224–9.

[54] The survey by C. W. Dixon, *Smallpox* (London: Churchill, 1962), 326 also claims that mortality from smallpox in the unvaccinated pregnant woman is about 50 per cent, and notes the high likelihood of abortion or prematurity. Other more recent studies which rely on Rao's work include Victor R. Suarez and Gary D. V. Hankins, 'Smallpox and pregnancy: from eradicated disease to bioterrorist threat', *Obstetrics and Gynecology*, 100 (2002), 87–93, and Daniel E. Hassett, 'Smallpox infections during pregnancy: lessons on pathogenesis from nonpregnant animal models of infection', *Journal of Reproductive Immunology*, 60 (2003), 13–24, which concludes that 'Variola is clearly much more pathogenic during pregnancy and infections are associated with significant maternal, fetal, and neonatal mortality. Protective immunity primed by vaccinia vaccination prior to pregnancy is also impaired during pregnancy. Surprisingly, there is very little direct information on the *in vivo* causes of these phenomena' (p. 20).

Table 7.3. Smallpox unvaccinated case-fatality rates by age-group: Indian studies

Age-group	Madras, 1961–9	India, 1974–5
0–4	42	46
5–9	22	16
10–14	12	6
15–19	22	15
20–4	33	20
25–9	41	23
30–4	43	24
35–9	42	25
40–4	37	27
45–9	—	30
50–4	—	27

Note: The case-fatality rates are percentages. They have been rounded and generalized to cover males and females in five-year age-groups.

Source: Based on Fenner et al., *Smallpox* (1988), p. 54, table 1.13. The Madras rates are from Rao, *Smallpox*.

rate was 26 per cent while for the pregnant women it was 75 per cent (9 out of 12 died).

Rao's data have also contributed to an assessment of the age pattern of case-fatality rates among unvaccinated cases. Table 7.3 compares them with other Indian rates for non-hospitalized cases. It is clear that the case-fatality rate follows the same distinctive tick-shaped curve that age-specific mortality normally does. It is high in infancy and early childhood, declines towards the age-group 10–14, and then increases into adulthood. But it is also obvious that rates can vary between studies and circumstances. Case-fatality rates were not constant for given age-groups. The India 1974–5 study also showed that in the 0–4 age-group, although 46 per cent of the unvaccinated died, less than 10 per cent of the vaccinated did. In the age-group 15–39, the child-producing group, 21 per cent of the unvaccinated died and only 5 per cent of the vaccinated.[55]

Most historical studies are convinced that prior to 1800 and the development of increasingly effective vaccination programmes smallpox was principally a disease of infancy and childhood. Where the disease was endemic in the towns, children were the main victims, but where, because of low population density, the disease was epidemic then adults might be exposed for the first time and be subject to higher case-fatality rates. The point has also been made that in metropolitan centres, like London, and urban places experiencing rapid growth by in-migration, some of the rural migrants would not have been exposed to the disease before their arrival in town. They could become adult victims

[55] Fenner et al., *Smallpox* (1988), p. 176, table 4.3.

alongside the children.[56] Of course, none of these studies can match Rao's work in providing a highly detailed age, sex, and pregnancy disaggregated description, which also takes vaccination status and variety of smallpox into account. Most rely on data relating to smallpox as a cause of death; occasionally age and sex are also specified. Peter Sköld's work on eighteenth- and nineteenth-century Sweden is among the best documented because he is able to show the age-specific mortality rates from smallpox and how they declined, partly as a result of the state-initiated vaccination programme.[57] Table 7.4 illustrates some of

Table 7.4. Age-specific mortality rates from smallpox: Sweden, 1776–80, 1861–5, and 1871–5

Age-group	1776–80	1861–5	1871–5
0	2517	163	328
1–4	2885	36	97
5–9	429	5	15
10–14	94	3	8
15–19	37	4	14
20–4	15	10	31
25–9	4	12	34
30–4	2	13	45
35–9	0.6	14	47
40–4	0.4	11	41
45–9	0.2	10	38
50–4	—	9	30
55–9	—	9	28
Total	275	14	37

Note: The age-specific mortality rates are expressed per 100 000.
Source: Sköld, *Two Faces of Smallpox* (1996), p. 87, table III.3.2a, and p. 88, table III.3.2d.

[56] See Charles Creighton, *A History of Epidemics in Britain, ii. From the Extinction of the Plague to the Present Time* (Cambridge: Cambridge University Press, 1894; London: Cass, 1965), esp. pp. 434–631, 'Smallpox', and Peter Razzell, *The Conquest of Smallpox* (Firle: Caliban, 1977), which remains the classic study; also his important early paper, 'Population change in eighteenth-century England: A reinterpretation', *Economic History Review*, 18 (2) (1965), 312–32, which gives smallpox inoculation a particularly significant role. Razzell is now more sceptical about the effects of inoculation (personal communication). Criticisms of Razzell's emphasis are summarized in Deborah Brunton, 'Smallpox inoculation and demographic trends in eighteenth-century Scotland', *Medical History*, 36 (1992), 403–29, which argues that in Scotland inoculation had a minor effect because it was not taken up generally. Here she supports the old argument of, for example, McKeown and Brown, 'Medical evidence', p. 126: '[I]t is hard to believe that inoculation can have been responsible for a reduction in the incidence of smallpox large enough to have had a substantial effect on national mortality trends'.

[57] Sköld, *The Two Faces of Smallpox: A Disease and its Prevention in Eighteenth- and Nineteenth-century Sweden*, Demographic Database, Umeå University, report 12 (Umeå: Umeå University Press, 1996); 'From inoculation to vaccination: smallpox in Sweden in the eighteenth and nineteenth centuries', *Population Studies*, 50 (1996), 247–62; and 'The key to success: the role of local government in the organization of smallpox vaccination in Sweden', *Medical History*, 45 (2000),

these rates. It demonstrates that smallpox in late eighteenth-century Sweden was overwhelmingly a disease of childhood. It was endemic, and most infants and young children appear to have been exposed to the disease at a very early age. They either died or if they survived they acquired some immunity in later life. By the middle of the nineteenth century, total smallpox-mortality rates were very much lower, although adults in their thirties and forties experienced higher rates than formerly.

The evidence available for eighteenth-century Britain is more fragmentary and also suggests a situation not entirely identical to that seen in Sweden. The London Bills of Mortality give the number of deaths from smallpox each year and, because there was a long and bitter dispute within the medical profession about the benefits of inoculation, several authorities made a point of collecting information on the number of cases, resulting deaths, and whether patients had been inoculated. Surveys were also conducted in several provincial towns of the number of smallpox deaths and these can often be related to the total number of deaths. The percentage of deaths due to smallpox and the approximate case-fatality rate, occasionally disaggregated by age, are the closest we come to any precision on the impact of the disease. These limitations have meant that although the potential influence of smallpox in pregnancy has been noted by historical demographers, little further progress has been thought possible by way of elaborating its exact contribution.[58]

There are, however, three distinct ways in which the argument might be taken further. First, we can see from case notes and scientific papers how contemporaries viewed the matter. This will not add quantitative weight, but it will illustrate how the presence of smallpox in pregnancy was recognized and reported. Second, despite its obvious limitations compared with Madras and Sweden, the statistical evidence available for eighteenth-century England is capable of suggesting some implications for the smallpox-in-pregnancy problem. For instance, it may be possible to associate the decline in maternal and fetal mortality through the century with changes in the contribution of smallpox to total mortality. This would not offer a proof, but it would assist in the building of a plausible case. Third, because modelling the impact of inoculation and vaccination has a remarkably long and richly developed history, it ought to be possible to elaborate existing models so that they can deal with not only the

201–26. Research on the Netherlands by Willibrord Rutten—'Smallpox, subfecundity, and sterility: a case study from a nineteenth-century Dutch municipality', *Social History of Medicine*, 6 (1) (1993), 85–99, and *'De vreselijkste aller harpijen': Pokkenepidemieen enpokkenbestrijding in Nederland in de achttiende en negentiende eeuw: een sociaal-historische en historisch-demografische studie, AAG Bijdragen*, 36 (1997)—notes the role of smallpox in causing miscarriages (p. 162) as well as the point that it was neither universal nor always a disease of childhood (*Kinderziekte*).

[58] Razzell, 'Population change', p. 322 follows Dixon, *Smallpox*, p. 326 in noting the connection, and in *Conquest of Smallpox*, at p. 110, he refers to Rao et al., 'Pregnancy and smallpox'. Razzell focuses on the fertility rather than the fetal-mortality effects.

shifting impact of smallpox on life expectancy at birth but also more specific mortality measures relevant to females in the reproductive age-group and to the fetus.

The influential French man-midwife Guillaume Mauquest de La Motte (1655–1737) noted in one of his chapters the significance of what he called 'internal' causes in producing miscarriages, but especially distempers:

> A *miscarriage* through any distemper, is more dangerous according to the malignity of the distemper, as when it is a malignant fever, the smallpox, *&*c. almost all women with child that are attacked with any of these miscarry, and are in great danger of their lives.[59]

This remark of 1722, which La Motte supported with cases, is further illustrated by the English examples listed in Table 7.5. It summarizes a number of cases reported in learned journals or books of case notes. They span the eighteenth and nineteenth centuries, and in tone as well as content they are remarkably similar. It was recognized from at least the early 1700s that an infected woman could communicate smallpox to a fetus and that this might lead to miscarriage, stillbirth, or premature birth. The physical signs of the disease could be manifest on the body. In some instances, both mother and fetus would succumb, in others the mother might survive, and in yet others the mother would survive, the infant live-born, but be initially unresponsive to vaccination. There was agreement on the dangers of inoculating pregnant women, but uncertainty over the diagnosis of smallpox *in utero*. Vaccination in infancy clearly did not provide security from reinfection later in life, nor did it protect the unborn. The cases in Table 7.5 combine to establish a convincing argument, although it must be emphasized that to contemporaries each one represented a single instance. The general principle by which a virus like smallpox was communicated to the fetus was speculated upon, but not understood.[60]

Most of the items listed in Table 7.5 are short, single or multiple case notes. Their purpose is to establish the facts, report a curious example, or add a personal medical opinion to those already published. Most are very brief, often in letter

[59] La Motte, *Traité complet des accouchements naturels, non naturels, et contre nature, expliqué dans un grand nombre d'observations et de réflexions sur l'art d'accoucher* (Paris: rue de la Harpe, chez Laurent d'Houry, Imprimeur-Libraire, vis-à-vis la rue S. Severin, au St Esprit, 1722), quoted from his *A General Treatise of Midwifery: Illustrated with upwards of Four Hundred Curious Observations and Reflexions Concerning that Art. By Lamotte, Sworn surgeon and man-midwife at Valognes, Translated into English by Thomas Tomkyns, Surgeon* (London: Printed for James Waugh at the Turk's Head, in Gracechurch Street, 1746), 185. William Smellie instigated the translation. Tomkyns is mentioned in Smellie's cases 66 and 509 as a former student and surgeon at the Foundling Hospital in London. Tomkyns's 'Translator's Preface' (p. xi) praises Dr Smellie and remarks that soon the English will not need to rely on French works, however good they might be. Smellie's *Treatise* (1751, 1754, 1764) makes frequent reference to La Motte's case notes.

[60] David E. Shuttleton, *Smallpox and the Literary Imagination, 1660–1820* (Cambridge: Cambridge University Press, 2007), 31–9 discusses the perceived vulnerability of pregnant women and the belief that smallpox could be imprinted on the fetus by the mother's fear of the disease. The first case in Table 7.5 is also mentioned, as is the neglect by traditional medical historians of 'contagion by fearful conceits or maternal imprinting' (p. 36).

Table 7.5. Reports on the effects of smallpox in pregnancy

Year	Author	Title	Content	Publication
1701	Dr Cromwell Mortimer	The case of a lady, who was delivered of a child, which had the smallpox appeared in a day or two after its birth	Infant born with the smallpox after mother had contact with infected person; infant died from the disease within a few days; 'mother took no infection'; case related by woman's daughter	*Phil. Trans*. 46 (1749–50), 233–4
1713	Revd W. Derham	The case of a woman big with child, who recovered of the smallpox, and was afterwards delivered of a dead child full of the pustules of the distemper	Antepartum stillbirth died 5 or 6 days before delivery, 'very full of the smallpox'; mother survived the disease; case related by midwife	*Phil. Trans*. 28 (1713), 165–6
1720s	Sarah Stone	Observation XXIX	Antepartum stillbirth born prematurely; mother died of smallpox having not previously been infected	*A Complete Practice of Midwifery* (1737) (see p. 116 above)
1745	Dr William Watson	Some accounts of the foetus *in utero* being differently affected by the smallpox	3 cases, 1 each from own practice, Mead, and Mauriceau; in 2 smallpox communicated to fetus even when mother had already had disease, but showed no new symptoms herself on reinfection—'foetus does not always partake of the infection from its mother'	*Phil. Trans*. 46 (1749–50), 235–39
1749	Dr William Smellie	Case 83, Abortion at four months during smallpox, death	Miscarriage at four months; no marks on fetus; mother died, severe haemorrhage (Cases 170 and 171 have stillbirths.)	*Treatise on Midwifery, Volume II* (1754) (see p. 129 above)
1768	Dr William Wright	Account of a child who had the smallpox in the womb	Signs of smallpox on an infant born to a Jamaican slave who recently had the disease; infant died after 3 days; 'where pregnant women had been seized with the natural smallpox, or been by mistake inoculated, they generally miscarried in the time of, or soon after, the eruptive	*Phil. Trans*. 71 (1781), 372–3, quoted from p. 373 (communicated by John Hunter)

Table 7.5. Continued

Year	Author	Title	Content	Publication
			fever; but I never saw any signs of smallpox on any of their bodies' except on this child	
1776	John Hunter	Account of a woman who had the smallpox during pregnancy, and who seemed to have communicated the same disease to the foetus	Case of Mrs Ford related by Messers Grant and Wastall; infant born dead, covered with smallpox; mother survived disease; 'the child had caught the smallpox in the womb' from its mother; detailed discussion	*Phil. Trans.* 70 (1780), 128–42
1790	John Hunter	Case of smallpox before birth	Hannah Gower 7–8 months pregnant, inoculated; stillborn fetus with signs of smallpox; mother fully recovered	*Cases and Observations*, No. 50
1760s, 1770s	Dr John Leake	'Nature and treatment of smallpox'	Several cases of maternal smallpox, some from the Westminster Lying-in Hospital	*Practical Observations on the Childbed Fever, Volume II* (1792), 400–23
1795	Charles Kite	Cases of several women who had the smallpox during pregnancy; with an account of the manner in which the children appeared to have been affected	List of 32 cases (also tabulated) in which 15 are said to involve infection with smallpox *in utero* and 17 involved no signs on the infant at birth; 3 of the 17 from Kite (several of the individual cases appear in this table)	*Memoirs* 4 (1795), 295–320
1807	William Forbes	Cases of smallpox in the foetus	'[T]his case proves, independently of all reasoning, that the *foetus in utero* is liable to the smallpox from the influence of surrounding infection, although the mother have not the disease'	*Edin. Med.* 3 (7) (1807), 307–8
1805	Dr James Laird	Case of smallpox occurring in the foetus	Fetus born dead after six month with signs of smallpox; mother survived; 'foetus participates in many of the diseases of its parent'; syphilis also mentioned	*Edin. Med.* 3 (10) (1807), 155–7

Table 7.5. Continued

Year	Author	Title	Content	Publication
1804	Dr Edward Jenner	Two cases of smallpox infection communicated to the foetus *in utero* under peculiar circumstances	'[O]bvious infection of the foetus before birth communicated through the mother, herself being already secure from any visible occurrence of the disorder'; mentions Mead	*Med.-Chir.* 1 (1809), 269–75
1837	Dr William Davidson	Smallpox *in utero*	Mother recovered from smallpox, had live birth, but infant difficult to vaccinate successfully, 'child having been affected with the virus of smallpox while *in utero*'	*Lancet* 2 (1837–8), 628
1874	Henry Robinson	Occurrence of confluent smallpox at the seventh month of pregnancy	Case in which 'insusceptibility to vaccination may clearly be traced to the fact of the child having had smallpox in the uterus'	*BMJ* 1 (1877), 163
1870s	George Rigden	Influence of maternal smallpox on the foetus	7 cases of mothers vaccinated in infancy who had smallpox during pregnancy; all produced live-born infants at term who were successfully vaccinated at 3–5 months	*BMJ* 1 (1877), 229–30
1902–4	Dr James M. Cowie and Dr Duncan Forbes	Intrauterine infection of the fetus in smallpox	5 cases tending to support the view that the 'liability of the fetus to smallpox appears to increase directly with its age'	*BMJ* 1 (1904), 1485

Note: The following journals and case books have been used: *British Medical Journal; Edinburgh Medical and Surgical Journal; Lancet; Memoirs: Medical Society of London; Medico-chirurgical Transactions; Philosophical Transactions of the Royal Society*. The case books of John Hunter, John Leake, Richard Mead, François Mauriceau, William Smellie, and Sarah Stone and are also mentioned.

format. The paper by the distinguished surgeon, anatomist, and natural scientist John Hunter, which was published in the *Philosophical Transactions of the Royal Society of London* (1780), is something of an exception.[61] His account focuses

[61] Hunter, 'Account of a woman who had the smallpox during pregnancy, and who seemed to have communicated the same disease to the foetus', *Philosophical Transactions of the Royal Society*, 70 (1780), 128–42. This is an important paper, which has been neglected by Hunter's biographers. See, however, Elizabeth Allen, John L. Turk, and Reginald Murley (eds.), *The Case Books of John*

on the case of Mrs Ford, a primipara aged 22 who had contracted smallpox on arriving in London from the country and had subsequently been delivered of a stillborn child of about seven months. A panel of experts was formed to examine the fetus, including Hunter himself, his brother, Dr William Hunter, and Dr John Leake, the author of *Introduction to the Theory and Practice of Midwifery*.[62] All agreed that the fetus showed external signs of smallpox. John Hunter performed a post-mortem on the fetus to see if he could discover other internal signs of the presence of the disease, but in this he drew a blank. Only the skin displayed clear marks. Hunter speculated on the mode of communication of smallpox to the fetus in the womb. In Mrs Ford's case the infection came directly from the mother, who had herself contracted the disease, but Hunter also thought it possible that a mother might be capable of communicating the virus without becoming infected herself. Hunter appears sceptical about the second method of infection. He used as his authorities Gerard van Swieten, who cited the first two cases listed in Table 7.5, and Richard Mead, who provided examples of both routes of infection in his text on smallpox.[63] In concluding his paper Hunter made some telling points:

Since then we see that it is very probable, that the smallpox may be caught from the mother when she is infected, it may be asked, why does not this happen oftener? In answer to this we may suppose, that this is not so ready a way as when the child is exposed to catch it after the birth, as we find too that a difference can be produced after birth; *viz*. inoculation is a much readier way of catching it than what is called the natural way. It may likewise be said, that many women who are with child, and have the smallpox during pregnancy, do not recover; therefore both mother and child die before the disease can have time to produce eruptions upon the child. Finally in many of those cases, where the mother recovers, there is sometimes produced a miscarriage, which also hinders the infection from taking place in the child. However, many women go through the whole disease, and the child shows no marks of the smallpox.[64]

Hunter, FRS (London: Royal Society of Medicine, 1993), which does give Hunter on smallpox full measure.

[62] Leake (1729–92) gave lectures on midwifery in London during the 1760s and 1770s and was instrumental in founding the Westminster Lying-in Hospital from 1765. His publications include: *A Lecture Introductory to the Theory and Practice of Midwifery* (London: Printed for R. Baldwin, in Paternoster Row, fourth edition corrected with additions 1782); *Introduction to the Theory and Practice of Medicine* (London: Printed for R. Baldwin, Paternoster Row; and A. Murray, Fleet Street, 1787); *Medical Instructions towards the Prevention and Cure of Chronic Diseases peculiar to Women, Volume I* (London: Printed for R. Baldwin, Paternoster Row; and H. Payne, Pall Mall, second edition 1777, fifth edition with additions 1781); *Practical Observations on the Childbed Fever, and Acute Diseases most Fatal to Women during the State of Pregnancy, Volume II* (London: Printed for Baldwin, Paternoster Row; Murray, Fleet Street; and Egerton, Charing Cross, 1787, seventh edition 1792).

[63] Gerard van Swieten (1700–72) was the author of several pieces on smallpox, including *The Advantages and Disadvantages of Inoculation with respect to Individuals, and the Public, Impartially Considered* (London: Printed for W. Griffin, 1772). *De variolis et morbillis liber* (1747), by Dr Richard Mead (1673–1754) was translated as *A Discourse on the Smallpox and Measles* (London: Printed for John Brindley, 1748). Chapter 4, p. 337 deals with cases of smallpox in pregnancy.

[64] Hunter, 'Account of a woman', pp. 141–2.

Clearly Hunter and the medical establishment in 1770s London had come to believe that the risk of intrauterine death could be increased by maternal infection with smallpox, but they were uncertain why death did not occur in all cases. Hunter's question brings us to the second possibility outlined above. The statistical evidence available for eighteenth-century England, and especially London, may be capable of suggesting ways in which the decline of smallpox had a bearing on the outcome of pregnancy.

There are two possible lines of approach here. The first uses evidence intended to inform the debate over the efficacy of smallpox inoculation and the second uses the annual number of smallpox deaths reported in the London Bills of Mortality. In the early 1720s a leading London physician, James Jurin, undertook surveys of the numbers of smallpox cases, of persons inoculated, and of those supposed to have died as a result of the inoculation.[65] His purpose was to answer two questions: Does inoculation confer immunity? Is inoculation less dangerous than natural smallpox? By pooling the statistics supplied to him by correspondents round the country, Jurin concluded that the case-fatality rate for natural smallpox was about 1 in 6 (17 per cent) and that less than 2 per cent died as a direct result of smallpox inoculation. He published a short series of annual reports in which inoculation returns distinguished by age-group were set out in the format illustrated by Table 7.6.[66]

Table 7.6. Jurin's surveys of smallpox inoculation: England, 1721–6

Age-group	Persons inoculated	Had smallpox by inoculation	Had an imperfect smallpox by inoculation	No effect	Supposed to have died of inoculation
0	19	19	—	—	—
1–4	209	203	—	6	6
5–9	219	211	3	5	3
10–14	122	113	1	8	1
15–19	98	89	3	6	2
20–49	98	82	5	11	2
Total	765	717	12	36	14

Note: The returns for 1721–3, 1724, 1725, and 1726 have been combined.
Source: Jurin, *Account of Success* (1724, 1725, 1726, 1727).

[65] See Andrea A. Rusnock (ed.), *The Correspondence of James Jurin (1684–1750): Physician and Secretary to the Royal Society* (Amsterdam: Rodopi, 1996). Edward Huth, 'Quantitative evidence for judgments on the efficacy of inoculation for the prevention of smallpox: England and New England in the 1700s', *Journal of the Royal Society of Medicine*, 99 (2006), 262–6 discusses Jurin's work and its predecessors.

[66] James Jurin, *An Account of the Success of Inoculating the Smallpox in Great Britain for the Year 1724* (London: Printed for J. Peele, at Locke's Head in Paternoster-Row, 1725), with reports for 1725 and 1726 published in 1726 and 1727, and for 1721–3 combined in 1724.

One of Jurin's informants was the Revd Joseph Wasse, Rector of Aynho, Northamptonshire. Wasse provided Jurin with information about 132 cases of natural smallpox, which occurred in his parish during a 15-month period in 1723–4. Table 7.7 shows this age-disaggregated material alongside Dr John Haygarth's record of the number of smallpox deaths in Chester in the years 1772, 1773, and 1774.[67] If the former represents rural England in the early years of smallpox inoculation, the latter may be typical of non-metropolitan urban England during the later years. There were no smallpox deaths among adults in Chester, and thus no pregnant woman succumbed, but in Aynho the case-fatality rate among adults was rather high, about 25 per cent—as high as

Table 7.7. Smallpox cases and deaths by age-group: Aynho, Northamptonshire, 1723–4, and Chester, 1772–4

	Aynho, 1723–4			Chester smallpox deaths		
Age-group	Smallpox cases	Smallpox deaths	Case-fatality rate (%)	1772	1773	1774
0	—	—	—	4	—	51
1–4	13	3	23	10	1	120
5–9	15	1	7	2	—	22
10–14	33	3	9	—	—	—
15–19	14	1	7	—	—	—
20–9	25	6	24	—	—	—
30–9	12	3	25	—	—	—
40–9	10	4	40	—	—	—
50 and over	10	4	40	—	—	—
Total	132	25	19	16	1	202

Note: The population of Aynho was about 700; that of Chester in 1774 was 14 713. The total numbers of deaths in Chester were 372 in 1772, 352 in 1773, and 546 in 1774. In the epidemic year 1774 the percentage of all deaths due to smallpox was 37. For 1772–3 it was 2 per cent.

Source: Aynho: Creighton, *History of Epidemics*, ii (1965), p. 520; Chester: Haygarth, 'Observations' (1774, 1775, 1778).

[67] Wasse's data are reproduced from Creighton, *Epidemics in Britain, ii*. 520. Jurin reported the aggregate totals in his *Account of Success* for 1725. John Haygarth was a physician and statistician. He campaigned for smallpox inoculation and for the isolation of infected cases. His most important work is probably *An Inquiry How to Prevent the Smallpox* (Chester: Printed by J. Monk for J. Johnson, No. 72, St Paul's Churchyard, London, and P. Broster, Chester, 1784). See Christopher Booth, *John Haygarth, FRS (1740–1827): A Physician of the Enlightenment*, Memoirs of the American Philosophical Society, 254 (Philadelphia, Pa.: American Philosophical Society, 2005). Haygarth published three papers in the *Philosophical Transactions of the Royal Society*: 64 (1774), pp. 67–78; 65 (1775), pp. 85–90; and 68 (1778), pp. 131–54, which reported his observations on the Chester Bills of Mortality, including age and cause-of-death data. These are used in Table 7.7. Chris Galley, *The Demography of Early Modern Towns: York in the Sixteenth and Seventeenth Centuries* (Liverpool: Liverpool University Press, 1998), p. 105, table 4.10 also shows that in York nearly 90 per cent of smallpox deaths occurred to infants and children under age 5 between 1770 and 1812.

that in early childhood. Some of the adult victims may have been pregnant; we do not know.

The evidence presented in Tables 7.6 and 7.7 helps to tell an interesting story about the importance of smallpox, the potential role of inoculation, and the possibility that the risks faced by pregnant women could have changed during the eighteenth century. The case-fatality rate for smallpox may have varied from around 15 per cent in towns to 24 per cent in the countryside; Aynho fits into this range. Children were the principal victims, because a higher proportion was infected. Infants and children were also the principal targets for inoculation, which, whilst not without its dangers, does appear to have been effective in establishing a mortality rate below that for natural smallpox. Although there is no direct evidence for the effect of smallpox in pregnancy, it may be supposed that women did die from the disease; that even if they survived they were at risk of higher levels of miscarriage and stillbirth; and that inoculation in childhood may have provided some protection in later life, and have reduced the exposure of the unborn. If England were closer to the experience of Aynho in the 1720s and to Chester in the 1770s, then it would be reasonable to expect normal conditions to have improved for women who were pregnant.[68] During the nineteenth century vaccination in childhood meant that far fewer children and adults died. Non-vaccinated pregnant women may have faced higher case fatality, but fewer were infected or reinfected.[69] The potential effects on fetal and maternal mortality were very much reduced.

The second possibility is that we may be able to use the numbers of smallpox deaths reported in the Bills of Mortality for London. The percentage of all deaths attributed to smallpox provides a simple way of charting the changing importance of the disease. It is much inferior to an age- and cause-specific mortality rate, like those shown in Table 7.4 for Sweden, but it is the best index possible where population censuses and full vital-registration data are not available.[70] Figure 7.5 shows how the smallpox percentage fluctuated wildly from year to year, but

[68] Many pregnant women may have survived smallpox, but had miscarriages or stillbirths. It is also possible that smallpox itself changed during the eighteenth century, independent of the effects of inoculation. Autonomous changes in the disease environment are very difficult to prove conclusively, yet it is known that diseases like scarlet fever became less virulent in the late nineteenth century and suspected that tuberculosis also followed this pattern (see Woods, *Demography* (2000)).

[69] The statistics of smallpox vaccination and deaths are described in the following papers, which relate to the Royal Commission on Vaccination of 1896: Noel A. Humphreys, 'English vaccination and smallpox statistics; with special reference to the report of the Royal Commission, and to recent smallpox epidemics', *Journal of the Royal Statistical Society*, 60 (3) (1897), 503–51, and Alfred Milnes, 'Statistics of smallpox and vaccination, with special reference to age-incidence, sex-incidence, and sanitation', *Journal of the Royal Statistical Society*, 60 (3) (1897), 552–612. Unfortunately, neither deals with smallpox in pregnancy.

[70] William A. Guy, 'Two hundred and fifty years of smallpox in London', *Journal of the Statistical Society*, 45 (3) (1882), 399–433 discusses the origins of smallpox and measles statistics for London, and their reliability. Susan Scott and Christopher J. Duncan, *Human Demography and Disease* (Cambridge: Cambridge University Press, 1998), especially pp. 169–88 on the dynamics of smallpox in London, illustrates the changing periodicity of epidemics as well as the role of vaccination.

during the eighteenth century it averaged 8–12, with signs of decline from the 1760s—when it is believed smallpox inoculation became more effective, less dangerous, and more widespread—and obvious reduction after 1800.[71] By the 1830s less than 4 per cent of deaths in London were linked to smallpox. Figure 7.5 also illustrates the estimated late-fetal mortality rate (SBR per 1000 total births) and the childbed-mortality rate (equivalent to maternal mortality (MMR) per 10 000 births).[72] The smallpox percentage has been averaged out to allow comparison using a nine-year moving mean. During the second half of the eighteenth century smallpox became less important, and stillbirth and maternal mortality declined in London. This may have been a coincidence, but a causal association is also possible. Smallpox affected fewer pregnant Londoners, their life chances improved, and the likelihood of having a miscarriage or a stillborn child declined. We only have circumstantial evidence, although it does point in the right direction.

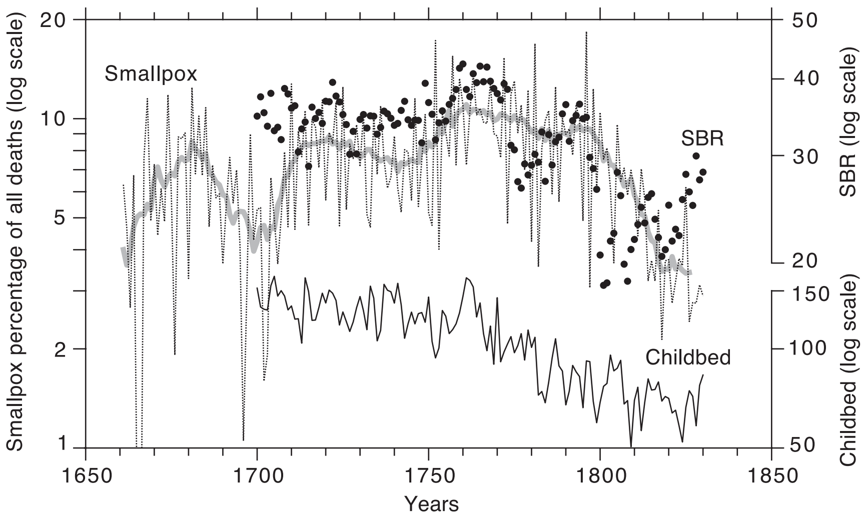


Fig. 7.5: Late-fetal mortality (SBR), childbed mortality, and percentage of burials due to smallpox: London. (A nine-year moving mean has been plotted through the annual variations in the percentage of burials due to smallpox.)

Source: Derived from the London Bills of Mortality.

[71] See Creighton, *History of Epidemics*, ii. 498 on the work of Daniel Sutton and others between the 1760s and 1790s, and J. R. Smith, *The Speckled Monster: Smallpox in England, 1670–1970, With Special Reference to Essex* (Chelmsford: Essex Record Office, 1987), 68–91.

[72] See Table 4.4, on p. 95, and Robert Woods, 'Mortality in eighteenth-century London: a new look at the Bills', *Local Population Studies*, 77 (2006), 12–23.

One final way of looking at London smallpox trends is shown in Figure 7.6. Here London is compared with Sweden using maternal mortality (MMR, with childbed mortality for London), late-fetal mortality (SBR), and the smallpox percentage of all deaths (nine-year moving mean for London). There is a remarkable correspondence between the three series for London and Sweden. Smallpox deaths declined even more rapidly in Sweden after the introduction of vaccination. Before 1800 they contributed roughly the same proportion as in London. Figure 7.5 helps to emphasize the point that, despite important geographical differences, London and Sweden may have experienced certain demographic similarities, especially in terms of maternal and fetal mortality,

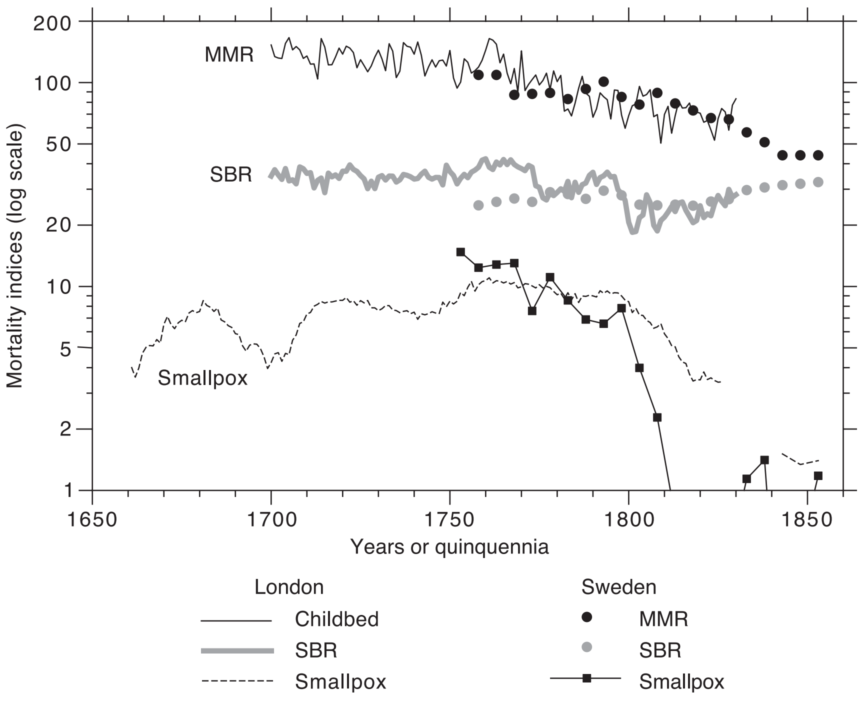


Fig. 7.6: Maternal mortality (MMR), late-fetal mortality (SBR), and percentage of burials or deaths due to smallpox: London and Sweden. (The London series have been derived from annual data in the Bills of Mortality to which a nine-year moving mean has been applied. The Swedish series are for quinquennia. Childbed mortality and MMR are per 10 000 deliveries or births, while SBR is per 1000 total births.)

Source: London, Fig. 7.3; Sweden, Fig. 7.2, and Hendricks, 'Vital statistics' (1862), p. 174, table Z.

which reflected their common experience of a particularly significant infectious disease—one that became increasingly subject to human intervention.[73]

The third approach draws on the power of modelling. Some of the most able mathematical minds of the eighteenth century were concerned with the impact of smallpox inoculation. For example, Daniel Bernoulli (1700–82), a Professor of Mathematics at the University of Basle, contributed his *Essai d'une nouvelle analyse de la mortalité causé par la petite vérole, & des avantages de l'inoculation pour la prévenir* to the French Royal Academy of Sciences in 1760.[74] Bernoulli estimated that smallpox inoculation could extend the average length of life of a five-year-old by 4.5 years and of a newly born infant by 3 years and 1 month. However, his theoretical life-table models only covered the ages 0–25 years, when inoculation was thought most likely to occur.[75] In 1806 Emmanuel-Etienne Duvillard (1755–1832) published a new analysis based on smallpox data principally for Geneva, Berlin, and The Hague, but also using the evidence assembled by Jurin and Haygarth, among others.[76] Although more empirically grounded than Bernoulli's work, Duvillard was still mainly interested in the effect of reduced child mortality on life expectancy, since there appeared to be relatively few smallpox deaths over the age of 20. Recent research on the historical epidemiology of smallpox has tended to focus on time-series analysis, on the frequency of epidemics, and the population required for epidemics to become regular and for the disease to become endemic. For example, it has been confirmed that smallpox became endemic in Chester with two-yearly epidemics superimposed, and that rural migrants to London who had escaped smallpox in childhood became ready victims in the metropolis.[77]

[73] It is also possible that the Swedish vital-registration system in its early decades and the London Bills of Mortality were equally deficient. Indeed, the fact that MMR and SBR were similar would strongly suggest that maternal and late-fetal deaths were underregistered in Sweden (see Frederick Hendricks, 'On the vital statistics of Sweden, from 1749 to 1855', *Journal of the Statistical Society*, 25 (2) (1862), 111–74).

[74] See Leslie Bradley, *Smallpox Inoculation: An Eighteenth Century Mathematical Controversy* (Nottingham: University of Nottingham, 1971) for a translation of Bernoulli's essay.

[75] Bernoulli's contribution to mathematical and epidemiological modelling is discussed in detail in Klaus Dietz and J. A. P. Heesterbeek, 'Daniel Bernoulli's epidemiological model revisited', *Mathematical Biosciences*, 180 (2002), 1–21.

[76] Duvillard, *Analyse et tableaux de l'influence de la petite vérole sur la mortalité à chaque âge, et de celle qu'un préservatif tel que la vaccine peut avoir sur la population et de la longévité* (Paris: L'Imprimerie Impériale, 1806). Duvillard used his own life table for pre-1789 France, in which $e(0)$ was 28.8 and $e(5)$ was 43.4 years, as a hypothetical population upon which the effect of child lives saved could be tested. The excessively high level of child mortality in his table (42 per cent of live-born infants died before reaching the age of 5) probably distorted his results. See also Rutten, *'De vreselijkste aller harpijen'*, pp. 63–7, which also uses burial data for The Hague, 1755–73 to model the impact of smallpox.

[77] Scott and Duncan, *Human Demography and Disease* (1998), pp. 190–7 and 185–8. The link between the economic forces driving rural migration to London and additional smallpox epidemics was suggested in John Landers, *Death and the Metropolis: Studies in the Demographic History of London, 1670–1830* (Cambridge: Cambridge University Press, 1993), 194.

Despite being important in their own right, none of these examples of attempts to model impact deals explicitly with smallpox in pregnancy. This gap has now been partly filled by Hiroshi Nishiura with his work on maternal outcomes.[78] He concludes that where pregnancy had been complicated by smallpox, the case-fatality rate was likely to be 34.3 per cent and the proportion of miscarriages or premature births 39.9 per cent. Vaccination before pregnancy could reduce the risk of maternal loss by providing partial protection, but vaccination may not prevent miscarriage and premature birth. These estimates were found by pooling results from 16 studies reporting case fatality and 15 reporting miscarriage or premature birth; the two could not be separated. All studies dated from the nineteenth and twentieth centuries, with Rao's *Smallpox* (1972) the most recent example. However, it is clear that there is considerable variation among the available studies, and it is to be suspected that 'miscarriage and premature birth' are very imprecise categories that will have been employed in different ways by the researchers involved.

These averages, with other estimates already discussed, can be used to inform a simple model of smallpox's potential impact on maternal and fetal mortality. Ideally, the model should have the following form and be applied separately to women with no smallpox immunity and those who had acquired some immunity by natural infection, immunization, or vaccination.[79]

Female population in the reproductive age-group (W)
  risk of being pregnant (p)
Pregnant population (PW)
  risk of smallpox infection (s)
Pregnant population with smallpox (PWS)
  risk of death during pregnancy ($m1$)
  risk of death after labour ($m2$)
Maternal deaths (PWSd)
Population of fetuses whose mothers have smallpox (FS)
  risk of miscarriage ($f1$)
  risk of stillbirth ($f2$)
Fetal deaths (Fd)
  chance of live birth (l)
Population of infants born to mothers who have or have had smallpox
  risk of neonatal death (n)

The risk factor $m2$ is part of maternal mortality (MMR) while $f2$ contributes to late-fetal mortality (SBR). If death occurs during pregnancy ($m1$), then either

[78] Nishiura, 'Smallpox during pregnancy and maternal outcomes', *Emerging Infectious Diseases*, 12 (7) (2006), 1119–21, and two associated web-based appendices.

[79] Smith, *Speckled Monster*, p. 66 proposes a model in which, prior to general smallpox inoculation, 50 out of 100 children failed to reach adulthood, and, of the 50, 14 deaths were due to smallpox. After general inoculation, 57 out of 100 reached adulthood, but other childhood diseases now caused 7 out of the 14 deaths. The chances of survival to adulthood improved by 14 per cent due to general inoculation in the second half of the eighteenth century, according to Smith.

miscarriage ($f1$) or stillbirth ($f2$) will automatically occur. In England the chances of being pregnant (p), equivalent to the proportion of the female population aged 15–45 who were pregnant, was around 0.15 in the early eighteenth century, rising to 0.19 in the early nineteenth century, and declining again to 0.16 by the 1850s.[80] This would mean that there were perhaps 23 pregnant women in Aynho in 1723–4, with a total population in the 15–44 age-group of 310 and 56 smallpox cases. In Chester in 1774 about 500 women may have been pregnant, with around 6600 persons in the 15–44 age-group. Here no smallpox deaths were recorded, although there may have been infected cases. The risk of smallpox infection (s) among pregnant women is difficult to judge, yet crucial to the model. For the total population of Aynho aged 15–44 it was around 0.18, with a case-fatality rate of 21 per cent. Of the 23 possible pregnant women, 7 at most are likely to have had smallpox and 2 to have died as a result. At least 2 of the women with smallpox would have experienced a fetal death.

Table 7.8 uses the model to illustrate what might have happened to hypothetical populations of women as they experienced different combinations of risks. Two contrasting periods are illustrated: 1720–60, when inoculation was in its early phase (A), and the mid-nineteenth century, by which time vaccination had become reasonably effective (B). In A the stillbirth rate was 60 per 1000 total births and in B it was 40. Starting in each of the four examples with 10 000 females in the reproductive age-group, p has been applied to establish the number of pregnant women. The number of pregnant women with smallpox is then found by assuming different values of s, the risk of smallpox infection during pregnancy.

Table 7.8. Hypothetical model of the effects of smallpox in pregnancy

	A1	A2	B1	B2
Women aged 15–44	10 000	10 000	10 000	10 000
Pregnant women (p)	(0.15) 1500	(0.15) 1500	(0.16) 1600	(0.16) 1600
Pregnant women with smallpox (s)	(0.20) 300	(0.10) 150	(0.05) 80	(0.02) 32
Maternal deaths from smallpox (m)	(0.34) 102	(0.10) 15	(0.38) 30	(0.10) 3
Stillbirths related to smallpox ($f2$)	(0.20) 60	(0.20) 30	(0.20) 16	(0.20) 6
Live births (l)	(0.60) 180	(0.60) 90	(0.60) 48	(0.60) 19
Stillbirths not related to smallpox	25	55	45	55
SBR	60	60	40	40

Note: The symbols and figures in brackets represent the probability of events occurring. A relates to the early phase of inoculation, 1720–60, and B to the mid-nineteenth century, when vaccination was fully organized, although not universal.

[80] Allowing 12 months for each pregnancy and 30 years for the reproductive life span, if the average woman produced 4.5 live births in those 30 years, then she would have been pregnant 15 per cent of the time. This is a very rough guide which uses all women aged 15–44 regardless of their marital status, fecundity, or coital frequency. Married women would have been pregnant for 30 or more per cent of their marriage-to-menopause lives.

Various case-fatality rates (*m*) are then used to derive the number of maternal deaths associated with smallpox. Finally, the numbers of stillbirths associated with smallpox are found using $f2$ and the numbers of live births are derived using l. The numbers of miscarriages are not shown, although $f1$, $f2$, and l must sum to 1. In Table 7.8, $f2$ and l are taken from Rao's Madras data shown in Table 7.2. They are assumed to remain unchanged in each of the examples, so that the smallpox stillbirth rate should be around 250. Table 7.8 also has estimates of the numbers of stillbirths occurring in those pregnancies not affected by smallpox. These are found by subtracting the smallpox stillbirths from the total numbers of stillbirths one might expect in 1500 or 1600 pregnancies with SBRs of 60 or 40.[81]

The first of the four examples, A1, is unrealistic. Too many of the stillbirths are produced by the women with smallpox because *s* has been placed at a high level, although it is consistent with what is likely to have happened in Aynho. In A2 *s* has been reduced to 0.10, so the number of pregnant women with smallpox is much lower, but these pregnancies contribute more than a third of all late-fetal deaths. Without these deaths the stillbirth rate would have been just less than 40. However, the value given to *m* in A2 is probably too low, so that in comparison with A1 there are too few maternal deaths as a result of smallpox infection. In B1 the values assigned to *m* and $f2$ are again raised to high levels, in keeping with claims that smallpox became more virulent in the late nineteenth century, especially among adults. But *s* is again reduced; even fewer pregnant women become infected. More than a quarter of stillbirths relate to smallpox pregnancies. In B2 *s* is placed at a very low level and *m* is fixed at its A2 level. Smallpox pregnancies now contribute only 10 per cent of stillbirths. Additional examples could, of course, be added to Table 7.8, allowing for further reductions in *s* and *m* while permitting $f2$ to vary, but this would not greatly enhance the value of the exercise. Comparison of A2 and B2 helps to illustrate the potentially very important point that smallpox infection in pregnancy could have substantially increased late-fetal mortality in the eighteenth century, and that the effects of inoculation and vaccination should have reduced the risk to mothers both of infection and of death once infected. It is possible for these changes to have occurred even though the risk of miscarriage and stillbirth in smallpox pregnancies remained high and constant.

It must be emphasized that this has been a hypothetical exercise. There is no concrete and unassailable proof that smallpox in pregnancy had a marked impact in heightening both maternal and fetal mortality, and that medical intervention via inoculation and then vaccination reduced the level of exposure. However, it is possible and it does seem likely.

Smallpox has been considered as a particular example of a maternal infection. It had direct effects via morbidity and mortality, but it may also have had indirect

[81] This is a very rough-and-ready approximation. However, it does suggest how the components of late-fetal deaths may have varied.

consequences for the subsequent health of those infected in childhood. There has, for example, been a lively debate on the relationship between smallpox and nutritional status. Whether smallpox was capable of adversely affecting physical-growth patterns, as indicated by historical height data, has been the point for dispute.[82] In this regard, smallpox has been linked with other infectious diseases of childhood, especially measles and whooping cough. It is possible that the nutritional status of young women in general, and mothers in particular, may have been affected not only by the quality of their diet while children, but also by the diseases that they suffered during those formative years. Food consumption alone will not have been responsible for maternal physique; the prevailing disease environment will have played its part too.[83]

Maternal syphilis

The effects of venereal disease in pregnancy have already been mentioned on several occasions in Chapters 5 and 6. Smellie, Whitehead, Ballantyne, Holland, and others reported cases, and in the early twentieth century syphilis came to be regarded as one of the most important causes of fetal deaths.[84] Its contribution to intrauterine-growth restriction, premature birth, and cases of congenital syphilis, as well as influence on premature sterility, should also be noted.[85] In the eighteenth century the picture was less clear. For example, John Hunter in *A Treatise on the Venereal Disease* (1786) was initially uncertain whether a syphilitic mother could infect her unborn infant.[86] He reports the following case:

A woman, aged twenty-five, came into St George's Hospital, August 21, 1782, with sores on her legs and blotches over her body. Her husband was a soldier. He gave her the venereal disease, December 1781. Her symptoms then were a discharge from her vagina,

[82] See, for example, Markus Heintel and Joerg Baten, 'Smallpox and nutritional status in England, 1770–1873: on the difficulties of estimating historical heights', *Economic History Review*, 51 (2) (1998), 360–71, and Komlos, 'Secular trend'.

[83] The interplay between food consumption, disease, and physiological consequences for pregnancy outcomes, including rickets and pelvic deformity, remains a very complicated area. Historians can only speculate on the possible effects and how they changed.

[84] Stuart M. Berman, 'Maternal syphilis: pathophysiology and treatment', *Bulletin of the World Health Organization*, 82 (6) (2004), 433–8 outlines current understanding of fetal transmission.

[85] It is now believed that more than half of pregnant women with untreated, active syphilis will pass it on to their unborn infants, and that about half will die before or shortly after birth. However, the incidence of syphilis among pregnant women varies considerably. Recent work has shown 0.5 per cent in a Chinese hospital study, 3.0 in a Nigerian, and 19.0 in a Tanzanian. Among those women with active syphilis in the Tanzanian study the SBR was 247, which suggests a relative-risk ratio (RR) of 9 compared with the treated cases. At the Edinburgh Royal Maternity Hospital in 1921 it was 12 (see P. Lambiganon et al., 'The epidemiology of syphilis in pregnancy', *International Journal of STD and AIDS*, 13 (7) (2002), 486–94, and Haroon Saloojee et al., 'The prevention and management of congenital syphilis: an overview and recommendations', *Bulletin of the World Health Organization*, 82 (6) (2004), 424–30).

[86] John Hunter, *A Treatise on the Venereal Disease* (London: Sold at No. 13 Castle Street, Leicester Square, 1786).

and a small swelling of the glands of the groin, which were painful. She had taken some pills, supposed to be mercurial, to the number of thirty. February 1782, about three months after being infected, the discharge stopped, but the swelling, which had been gradually increasing ever since its first appearance, had now suppurated. She applied some ointment to it which was bought her by her husband, and in two months it got well, that is, in April 1782. After the bubo got well, a discharge from the vagina came on, for which she took more of the same pills she had taken before, to the number thirty. After this time blotches came out over her whole body; some of which about her legs, under her arms, and upon her nipples, ulcerated.

Twins, which she bore at eight months, in March 1782, at the time the bubo was healing, had blotches upon them at their birth, and died soon after.

Another girl, about two years old, whom she suckled, was also covered with blotches when she came to the hospital.[87]

Hunter was able to 'conceive the bare possibility' that 'a foetus in the womb of a pocky mother maybe infected and have the disease from her'.[88] However, he found it difficult to accept that a child infected by its mother *in utero* could then 'contaminate the breasts of a clean woman' while being nursed by that woman. His work on the diagnosis and treatment of venereal diseases made Hunter cautious on the former and sceptical of the long-term efficacy of the latter. The mother and child mentioned in the case note above were admitted to the salivation ward at St George's on 21 October 1782, although Hunter records that the child was not given mercury. The soldier's wife appears not to have fared well; infected by her husband, uncured by harmful medicines, experimented on by Hunter, mother to dead twins whose lives her disease cut short.

Although Hunter may have had some lingering doubts, many of his contemporaries and certainly his Victorian successors were completely convinced that venereal disease was a significant contributor to miscarriages and stillbirths. What we must establish, however, is the prevalence of venereal disease in the past, and especially maternal syphilis, since the first reliable surveys, conducted in the early twentieth century, established that while the disease may be extremely damaging to mother and fetus, it was far from widespread.[89]

Hospital records offer one way of assessing the extent of venereal diseases. For instance, in 1774 the Chester Infirmary, the hospital in which Dr John Haygarth was a physician, admitted 10 per cent of its patients as 'venereal' cases. But in the

[87] Ibid. 294.

[88] Ibid. 291. In the second edition of the *Treatise* (London: Sherwood, Neely and Jones, 1818) Dr John Adams noted (p. 399) that Hunter did accept the possibility of fetal infection, just as he had acknowledged in his 1780 paper that the mother could communicate smallpox.

[89] David I. Kertzer, *Amalia's Tale: A Poor Peasant, an Ambitious Attorney, and a Fight for Justice* (Boston: Houghton Mifflin, 2008) tells the story of a wet-nurse who contracted syphilis from a foundling infant and sought compensation from the Bologna Foundling Hospital. Her case was not uncommon in rural Italy in the late nineteenth century. Husbands and the wet nurses' own children were in turn affected, and the risk of stillbirth was increased. It would be interesting to know exactly how important this infection route was in societies that prohibited unmarried mothers from looking after their own children.

Table 7.9. Incidence of venereal disease: Chester, 1774

	Hospital admissions		Total population	
Age-group	Male	Female	Male	Female
15–19	27.0 (10/27)	23.3 (7/30)	1.4 (10/719)	1.1 (7/649)
20–4	33.3 (13/39)	37.5 (15/40)	2.0 (13/657)	2.5 (15/608)

Note: There were 545 hospital admissions in 1774, 54 of which were 'venereal'. The incidence rates are given in per cent with the numerators and denominators in brackets. The total-population denominators are estimated by assuming that the population of Chester was 14 713 in 1774 (7479 males, 7234 females), that Princeton Model North level 6 applied, and that the GRR was 2.25.

Source: Chester Royal Infirmary, *Journal of Patients, 1772–8*, Cheshire County Record Office, Chester (Document HI/52).

20–4 age-group a third or more of cases were so described. Table 7.9 illustrates the point more fully. It shows that nearly all of the venereal patients were young persons aged 15–24 and that the sexes were roughly equally represented. Given these figures one can appreciate why the physicians and surgeons who treated such cases, Hunter and Haygarth included, would have overemphasized the importance of venereal disease. It represented a significant element of their workload and one in which they claimed a very high success rate.[90] However, what is important about Table 7.9 is the estimate it provides of the incidence of venereal disease in the population of Chester. Among females in the 20–4 age-group, 2.5 per cent may have been affected. The prevalence of the disease is more difficult to gauge. The 54 patients stated that before entering hospital they had been ill for a total of 1566 weeks, an average of 29 weeks each, although for many it was no more than 12 weeks. Delays in treatment, its uncertain effectiveness, and the youth of those infected meant that a rather small group could have had a substantial impact. Yet the proportions are small, and there are no accounts of syphilis affecting substantial numbers of pregnant women.

Chester is certainly an isolated example. It was a garrison town and venereal cases were prominent among its hospital patients, but syphilis would need to have been far more widespread among the female population for it to have had a major influence on fetal mortality in the eighteenth century. Evidence relating to the first half of the nineteenth century is equally patchy. What we have for Glasgow suggests that the ratio of new venereal-disease cases among women to the total population was around 1 in 600, and after 1851 it was substantially lower.[91] The same ratio for Chester in 1774 was 1 in 588, which suggests that the incidence of syphilis was roughly the same and at a rather low level.

[90] In Chester, 50 of the 54 'venereal' cases were said to have been 'cured' on discharge.

[91] Alexander Patterson, 'Statistics of Glasgow Lock Hospital since its foundation in 1805: with remarks on the Contagious Diseases Acts, and on syphilis', *Glasgow Medical Journal*, 18 (6) (1882), 401–18, esp. p. 406, table II. The Lock Hospitals catered for female patients with symptoms of venereal disease. In 1841, for example, there were 412 admissions and the census gave the

Glasgow data also show a similar age distribution of cases to Chester with an average among females of 18–20 years and a range of from 15–30. It is most likely, therefore, that although venereal disease, syphilis especially, destroyed the reproductive capacities of many of those who were infected, particularly if it reached an advanced stage, an insufficiently large proportion was affected to give the disease substantial demographic consequence. Claims that one could use the stillbirth rate as a guide to venereal infections would have been equally as unfounded in the eighteenth and nineteenth centuries as they proved to be in the early twentieth.[92]

COMBINED CAUSES

Table 7.1 set out a very simple way of looking at the ultimate or background causes of fetal and neonatal mortality. If we begin by focusing on the rows rather than the columns and put to one side genetic influences, we can sketch the following explanation for long-term changes in fetal mortality, especially in England.

It is likely that maternal infections communicated to the fetus *in utero* were particularly important causes of death before the availability of effective antibiotics in the late 1930s and 1940s. Smallpox in particular could have had a marked effect in the early modern period. During the eighteenth century either inoculation had a beneficial impact or the disease itself changed or both contributed to make smallpox principally a disease of childhood, unlikely to affect pregnant women and the unborn in a critical fashion. During the nineteenth century compulsory vaccination schemes protected adults to an even greater extent and smallpox lost its demographic significance. Other diseases could also have contributed to the pool of maternal infections, but it is not possible to be specific about their impact on pregnancy in England.

The nutritional status of women before and during pregnancy is known to affect fetal-growth patterns and in adverse conditions to lead to growth restriction (IUGR), premature birth, and fetal demise. Exactly how these mechanisms work is not fully understood. Must the mother be starving or have had her own growth restricted or is it the composition of her diet that is most influential (alcohol and tobacco consumption included)? Although the debate on the biological standard of living continues, there is little firm evidence to support the view that the physical health of women improved dramatically before the twentieth century. There is no good reason to believe that the chances of fetal-growth restriction, at least the part affected by maternal nutrition, changed to any considerable

population of Glasgow as 255 650. The ratio used by Patterson is not ideal, but it does give a rough indication of the incidence.

[92] See p. 161, and the work of the early-twentieth-century fetal pathologists in general.

extent during the seventeenth, eighteenth, and nineteenth centuries. Indeed, the urbanization of female labour may have made women more prone to rickets and pelvic deformities in the nineteenth century than they were when England was predominantly rural, agricultural, and domestic. The reproductive health of women would have been affected by their fertility, and this certainly did vary in the eighteenth and nineteenth centuries, both in and out of marriage, but the secular decline in fertility had its origins in the 1870s and became most obvious by the 1930s. There were far fewer high-parity births, and relatively few women became pregnant in their late thirties and forties. While maternal nutrition and reproductive competence are not irrelevant factors, there are no strong arguments for positive contributions to fetal health and mortality due to their significant improvement before the twentieth century. It might even be speculated that their failure to improve during the nineteenth century helped to keep maternal and fetal mortality at a roughly constant level in England.

Obstetric care was enhanced during the eighteenth century, and this is likely to have had beneficial consequences for the survival chances of both pregnant women and the unborn. Even in England midwifery was a more professional business in 1800 than it had been in 1700. More midwives were skilled because they had attended courses or they had been apprenticed to other midwives, and some physicians and surgeons made obstetrics a specialism. Of course the skill level should not be exaggerated, but for the 10–20 per cent of deliveries which were not normal there was a greater likelihood that safe procedures could be adopted, perhaps with the use of instruments to facilitate a successful outcome. The new lying-in hospitals were, of course, dangerous for mothers, but they helped to train midwives and manage domiciliary services, and they were probably not much more dangerous for the unborn. Although there were improvements, England was still far behind Scandinavia in the training of women-midwives, their licensing by the state, and their use to promote the health of mother and infant, partly via their role in the registration process. This corps of professionals readily adopted the new thinking on antisepsis, and in the late nineteenth century helped to establish even lower levels of maternal and stillbirth mortality in the 'advanced states'. In the 'lagging states', Britain and the USA for example, the relatively poor quality of obstetric care was recognized in the 1920s and 1930s. In Britain the Medical Research Council's Child Life Investigations kept up the pressure to reform and improve training. The 1936 Midwives Act, which established a national service of salaried midwives, just happened to coincide with the introduction of Prontocil in 1938. Skilled and professionalized birth attendants plus antibiotics made a powerful combination, with positive and immediate benefits for patient outcomes. Other initiatives and innovations followed; mortality rates continued to fall encouraged by better living standards and controlled fertility. A pioneer like Sir Dugald Baird saw these developments take place during his lifetime, but his work in social obstetrics built on that of Ballantyne, Priestley, Whitehead, Simpson, Crosse, Hamilton, Smellie, Stone, and many others. The pace of change was far from continuous, the nineteenth and early twentieth centuries in Britain being distinctly anomalous, yet there do seem to have been some marked improvements even before the 1940s downturn.

What we cannot yet state, and may never be able to, is the extent to which the decline of late-fetal mortality in the eighteenth century was due more to a reduction in maternal infections (especially smallpox) and had a strong autonomous element, or to obstetric care and was one of the first positive, without being spectacular, examples of improved medical interventions. Intrapartum stillbirths now represent less than 10 per cent of all late-fetal deaths where the mortality rate is very low (4–6 per 1000 total births), but where and when it is or was high (30–60 or so) they contribute perhaps 40–50 per cent. Given that the stillbirth rate in England declined from around 60 to 40 during the eighteenth century it seems most likely that both intrapartum and antepartum stillbirths were reduced. Midwifery and reduced exposure both helped.[93]

[93] On page 185 of his *Medical Memoirs* for 1774 Dr John Coakley Lettsom, physician to the General Dispensary in London, reflected on the improvements in medicine he had recently observed (Lettsom, *Medical Memoirs of the General Dispensary in London, for part of the Years 1773 and 1774* (London: Printed for Edward and Charles Dilly, 1774)). He singled out the mode of treating lying-in women and the inoculation against smallpox, since 'by these two circumstances alone, incredible numbers are rescued from the grave'. What is there that is new?

8

Induced abortion and the fetus as patient: a continuing paradox

Although it is clear that a number of important issues remain unresolved in relation to the causes of fetal mortality, especially prior to the twentieth century, the last chapter demonstrated that several changes could have combined to reduce the risk of stillbirths. This, the final chapter, explores the ways in which the unborn gained patient status separate from their mothers whilst, in recent decades, forfeiting rights because induced abortion has been legalized. There exists in many developed countries a sharp and obvious paradox between the fetus as patient, the beneficiary of the most advanced medical care, and the fetus as victim of maternal rejection, with social, legal, and medical support. The gestational age at which viability is fixed forms a crucial dividing line. The life of the previable fetus may be terminated under particular circumstances; that of the viable, or live-born, may not. Yet viability is difficult to define, as we have seen repeatedly; medical, legal, and statistical conventions change and vary. The terms 'therapeutic abortion' and 'criminal abortion' were used in the past to refer to the medical termination of a pregnancy in order to save the life of the mother and the bringing on of premature delivery in order to end the life of a fetus by unregistered persons, including mothers themselves, professional abortionists, midwives, and apothecaries. The World Health Organization now prefers to use the expression 'unsafe abortion', which is applied especially to developing countries where many unintended pregnancies are terminated by 'unskilled and untrained abortion providers', including traditional birth attendants, irrespective of legality. Unsafe abortion is defined as a procedure for terminating an unintended pregnancy carried out either by persons lacking the necessary skills or in an environment that does not conform to minimal medical standards, or both. The WHO has estimated that in the year 2000 approximately 10 per cent of pregnancies ended in an unsafe abortion; that is, 1 unsafe abortion in 7 live births.[1] At the same

[1] WHO, *Unsafe Abortion: Global and Regional Estimates of the Incidence of Unsafe Abortion and Associated Mortality in 2000*, 4th edn. (Geneva: World Health Organization, 2004), 1 and 9. Gilda Sedgh et al.,'Induced abortion: estimated rates and trends worldwide', *Lancet*, 370 (2007), 1338–45 offers estimates of abortion indices for 2003. The United Nations has produced a helpful review of international variations in policy: UN, *Abortion Policies: A Global Review*, United Nations, Population Division (New York: United Nations, 2003).

time in England and Wales there was approximately 1 legal abortion in 3.5 live births.

The chapter is divided into two parts. The first considers induced abortion, both unsafe and legal. It speculates on the extent of illegal and unsafe abortions in the past, and it reviews the current position, especially in England and Wales. The second turns to the other aspect of the paradox: how in medically advanced countries fetal health has been improved and mortality has been reduced to extremely low levels, especially during the last fifty years, and how the phrase 'the fetus as patient' might be used to symbolize that improvement in life chances.

It has often been argued that the incidence of induced abortion in a population reflects the extent of contraception failure. Where there is a balance between actual fertility and desired number of children either because both are high or because both are low and contraception is fully effective, induced abortion is unlikely to be widespread. But where there are large numbers of unintended pregnancies because contraception is unavailable or ineffective or not used for some reason, and the desired number of births is in decline, then there will be resort to induced abortion, which may be medically unsafe for women or may be legal and safe.[2] Induced abortion can be legal and unsafe in a society that lacks access to good-quality obstetric care, but it is also likely to be unsafe where induced abortion is illegal even though the medical knowledge and technology are present. Four different cases can be distinguished, therefore. In (A) demand for children equals or exceeds supply, there is little resort to contraception, and early-age mortality is at a high level anyway making child survival precarious. One would not expect to find anything other than rare, isolated examples in such historical societies. In (B) the fertility transition is under way, the ideal family size has been reduced, supply of children exceeds demand (child survival may also have improved), contraception is ineffective, and the number of unwanted pregnancies is substantial leading to increased demand for abortion, usually unsafe because illegal. In (C) many of the same conditions as (B) apply, but contraception is inaccessible and induced abortion is normally unsafe for medical reasons. In case (D) abortion is both safe and legal, unintended pregnancies are substantial in number either because access to effective contraception is restricted or because induced abortion has itself become an acceptable method of fertility limitation. England in the seventeenth and eighteenth centuries provides an example of (A). One would expect instances of induced abortion to be rare and inherently unsafe, related to out-of-wedlock conceptions where the pregnancy could not be legitimized by subsequent marriage either before or after birth. Case (B) applies to the English, and most other western-European populations, between the mid-nineteenth century and the legalization of abortion in the 1960s.

[2] This argument has been developed fully in John Bongaarts and Charles E. Westoff, 'The potential role of contraception in reducing abortion', *Studies in Family Planning*, 31 (3) (2000), 193–202.

Significant numbers of pregnancy terminations may have been carried out during this period, but, since the overwhelming majority were illegal, the number is very difficult to determine. Once induced abortion was legalized it became both medically and legally safe. In eastern Europe, where access to effective contraception was restricted, abortion came to be used as the most popular method of fertility control. In other developed countries resort to abortion reflects failure to use contraception effectively, especially among those under 25. Britain is now an example of (D). Most developing countries illustrate (C). Here unintended pregnancies are widespread partly because effective modern methods of contraception are not available and traditional methods are unreliable, but also because the desired number of children has been in decline. Unsafe abortion practices are common and maternal mortality is kept at an avoidably high level in consequence, as recent WHO reports continue to demonstrate.

During the last four centuries Britain has moved from (A) to (B) to (D), therefore. A higher proportion of pregnancies are now terminated by induced abortion than has been the case at any time in the past. Table 8.1 illustrates the current position of England and Wales, and the consequences of the legalization of abortion in 1967.[3] It gives the annual averages for the number of legal

Table 8.1. Average number of legal abortions, stillbirths, live births, and early-neonatal deaths registered per year, together with associated abortion and mortality indices: England and Wales, 1971–2005

Five-year periods	Legal abortions	Still-births	Live births	Early-neonatal deaths	Spontaneous pregnancy losses	Abortion ratio	Abortion rate	SBR	ENMR
1971–5	105 874	8021	685 576	6560	147 703	154.4	10.9	11.6	9.6
1976–80	113 196	5224	590 642	4341	129 448	191.6	11.0	8.8	7.3
1981–5	132 400	3813	636 558	3026	140 552	208.0	12.0	6.0	4.8
1986–90	163 294	3369	685 994	2644	151 338	238.0	14.4	4.9	3.9
1991–5	159 315	3493	675 041	2223	150 940	236.0	14.6	5.1	3.3
1996–2000	173 035	3381	630 960	1887	143 496	274.2	16.7	5.3	3.0
2001–5	181 201	3462	619 556	1673	142 031	292.5	17.4	5.6	2.7

Note: The estimated number of spontaneous pregnancy losses (including spontaneous abortions (miscarriages) and stillbirths) is derived as follows: ((live births × 0.2) + (legal abortions × 0.1)). The abortion ratio is the ratio of legal induced abortions to 1000 live births. The abortion rate is the number of legal abortions to resident females per 1000 resident females aged 15–44. SBR is the stillbirth rate: stillbirths per 1000 total births. ENMR is the early-neonatal mortality rate: deaths aged 0–6 days per 1000 live births.

Source: Derived from Office of National Statistics, *Birth Statistics* and *Mortality Statistics*, various series, and Department of Health, *Statistical Bulletin: Abortion Statistics, England and Wales, 2006* (London: Department of Health, 2007), table 1.

[3] The Abortion Act 1967 came into force on 27 April 1968. It allows for the termination of pregnancy by a registered practitioner (endorsed by two medical practitioners) under certain very specific conditions including 'injury to the physical or mental health of the pregnant woman'

abortions, stillbirths, live births, and early-neonatal deaths registered in five-year periods from 1971–5 to 2001–5, as well as abortion indices and mortality rates. Late-fetal and early-neonatal mortality are expressed in the normal way, but induced abortion must be measured by a variety of means that are far from straightforward. The age-specific abortion rate gives the number of legal abortions to females resident in England and Wales per 1000 females aged 15–44. It has increased from 11 to more than 17 during the last 35 years. The ratio of abortions to live births is often used; it shows an increase from 1 in 6.5 to 1 in 3.5. While conventional, this ratio does not reflect the contribution of induced abortion to all fetal losses. It would also be possible to relate legal abortions to conceptions, which could be derived simply by doubling the number of live births on the assumption that the ratio of conceptions to live births is likely to be 2 to 1.[4] This way of looking at induced abortions suggests that there was a two-fold increase in their contribution to fetal deaths. Finally, Table 8.1 has an estimate of spontaneous pregnancy losses (SPL); that is, miscarriages plus stillbirths, or spontaneous intrauterine deaths. Here SPL is derived by combining 20 per cent of live births with 10 per cent of legal induced abortions.[5] The number of pregnancies will be less than the number of conceptions because of losses during the first days after fertilization. Table 8.1 indicates that since the late 1980s the number of legal abortions may well have exceeded the number of spontaneous pregnancy losses.

(ground C). On 1 April 1991 the terms of the Human Fertilisation and Embryology Act 1990 were implemented. They placed a limit of 24 weeks' gestation, rather than 28 weeks' (the definition of stillbirths was changed from 28 to 24 weeks on 1 October 1992), on 2 of the 5 grounds for an abortion (including C). Less than 10 per cent of terminations now take place after 13 weeks and only 0.1 per cent after 24 weeks. The Department of Health took over responsibility for abortion statistics from the Office of National Statistics in 2002. In Scotland, the Department of Health is also responsible for recording legal abortions. There are now more than 13 000 legal abortions in Scotland per year, and the ratio of abortions to live births is 1 in 2. In England and Wales the number of registered legal abortions undergone by resident women has reached 200 000 a year.

[4] See Ch. 3, pp. 41–52.

[5] This method of deriving SPL was suggested in Sedgh et al., 'Induced abortion', pp. 1340–1. It is said to use research reported in Henri Leridon, *Human Fertility: The Basic Components* (Chicago, Ill.: University of Chicago Press, 1977), and follows 'a model-based approach derived from clinical studies of pregnancy by gestational age'. Table 5.4, on p. 148, gave Sir William Priestley's estimate of the abortion ratio (i.e. total abortions per 1000 live births) as equivalent to 300 in the 1880s. Table 8.1 shows an induced-abortion ratio approaching 300. John F. Osborn, Maria Sofia Cattaruzza, and Angela Spinelli, 'Risk of spontaneous abortion in Italy, 1978–1995, and the effect of maternal age, gravidity, marital status, and education', *American Journal of Epidemiology*, 151 (1) (2000), 98–105 uses the Italian spontaneous-abortion registers to trace the changing split between induced and spontaneous abortions. The spontaneous-abortion ratio for 1995 (notified hospital and domiciliary miscarriages) was 122 per 1000 live births. Danish data for 1978–92 reported in Anne-Marie Nybo Andersen et al., 'Maternal age and fetal loss: population-based register linkage study', *British Medical Journal*, 320 (2000), 1708–12 indicate an induced-abortion ratio of 352, a spontaneous abortion ratio of 126, and that the ratio of fetal deaths to live births was 1 to 2. These examples demonstrate again how difficult it has proved to get a clear and accurate idea of the extent of fetal mortality, and the distribution of deaths among the different categories: unrecognized pregnancy losses; recognized pregnancies; spontaneous and induced abortions; stillbirths.

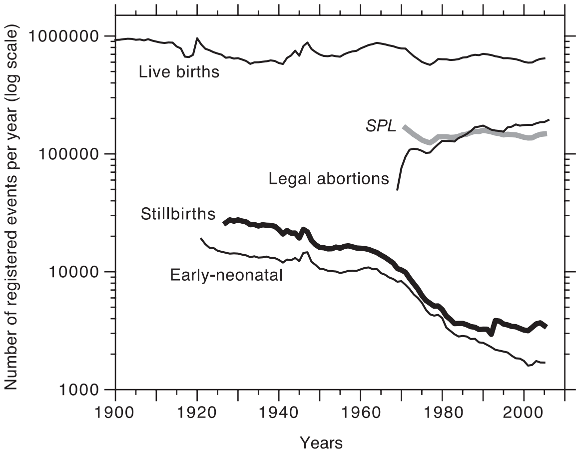


Fig. 8.1: Number of live births, legal abortions, stillbirths, and early-neonatal deaths registered per year, and estimated number of spontaneous pregnancy losses (SPL): England and Wales. (SPLs have been estimated from [(live births × 0.2) + (legal abortions × 0.1)]. They include spontaneous abortions (miscarriages) and stillbirths.)

Source: See Table 8.1.

Figure 8.1 places the recent experience of England and Wales in a wider context. It shows the number of registered live births, stillbirths, and early-neonatal deaths per year, as well as the number of legal abortions to females resident in England and Wales, and the estimated number of spontaneous pregnancy losses since the legalization of abortion. The decline of late-fetal and early-neonatal deaths will be familiar by now, but increase in legal abortions and their apparent effect on the number of spontaneous pregnancy losses, chiefly miscarriages, needs to be emphasized.

Table 8.1 and Figure 8.1 raise some interesting questions concerning the extent of illegal induced abortion prior to the 1960s, which are very difficult to answer. Given the argument outlined above, that the extent of induced abortion reflects ineffective contraception, one might expect there to have been high levels of abortion or attempted unsafe abortion during the first half of the twentieth century. Fertility was in decline despite limited access to appliance methods of birth control, and it may be assumed that a considerable number of pregnancies were unplanned or unwanted.[6] In these circumstances, resort to induced abortion

[6] Irvine Loudon, *Death in Childbirth: An International Study of Maternal Care and Maternal Mortality, 1800–1950* (Oxford: Clarendon, 1992), 107–29 notes: 'Although it is extremely difficult to estimate the incidence of induced abortion before the Second World War, it seems likely that the incidence and death rate from abortion began to rise in the second half of the nineteenth century and continued to reach a peak in the 1930s' (p. 109). This is consistent with contemporary opinions like the one expressed in L. A. Parry, *Criminal Abortion* (London: Bale, Sons & Danielsson, 1932),

was probably common, but how common? Official reports in the 1920s and 1930s estimated that 40 per cent of all abortions were illegally procured. Loudon has used this evidence to suggest that 5.9 per cent of pregnancies may have been terminated by induced abortion in England and Wales in 1936, for example.[7] However, this would also mean that more than 80 per cent of pregnancies ended in a live birth, an unrealistically high figure. His calculations are illustrated in Table 8.2. Other, potentially more sophisticated, studies used either hospital-based data on women being treated for the effects of an abortion or retrospective surveys requiring women to recall their pregnancy histories. In the first case, one must be able to identify the clinical consequences of induced abortions without additional evidence from the patient, and be willing to assume that the ratio of spontaneous to induced abortions among hospital patients also applies in the

Table 8.2. Categories of pregnancy loss: England and Wales, 1936

Live births (registered)	605 292
Stillbirths (registered)	25 045
Total abortions (estimated)	110 000
Spontaneous abortions (miscarriages)	66 000
Induced (illegal) abortions	44 000
Total pregnancies (estimated)	740 337
Stillbirth rate per 1000 total births	39.7
Percentage of pregnancies terminated by:	
Miscarriage	8.9
Induced abortion	5.9
Stillbirth	3.4

Note: The total number of pregnancies has been found by summing live births, stillbirths and abortions.
Source: Loudon, *Death in Childbirth* (1992), p. 114.

but figures for 'natural abortion' (e.g. 1 in 7) are the only ones cited (p. 2). Kate Fisher, *Birth Control, Sex and Marriage in Britain, 1918–1960* (Oxford: Oxford University Press, 2006) uses oral histories to analyse variations and changes in fertility control, but finds very little reference to abortion.

7 Loudon, *Death in Childbirth*, p. 114. See also Malcolm Potts, Peter Diggory, and John Peel, *Abortion* (Cambridge: Cambridge University Press, 1977), p. 84. This material comes from Ministry of Health, *Interim Report of Inter-departmental Committee on Maternal Mortality and Morbidity* (London: Ministry of Health, 1930), and *Report of the Inter-departmental Committee on Abortion* (London: Ministry of Health, 1939). James Thomas and A. Susan Williams, 'Women and abortion in 1930s Britain: a survey and its data', *Social History of Medicine*, 11 (2) (1998), 283–309 discusses a survey carried out by the Joint Council on Midwifery involving 3300 questionnaires intended to establish the extent of induced and spontaneous abortion in late-1930s Britain. Although the JCM survey failed to meet this objective, Thomas and Williams assert that it supports 'the theory that many women attempted abortion on a regular basis' (p. 306). Tania McIntosh, ' "An abortionist city": maternal mortality, abortion, and birth control in Sheffield, 1920–1940', *Medical History*, 44 (2000), 75–96 argues that there were some abortion 'hot spots', Sheffield and Bolton included, and that in Sheffield in 1934, 39 per cent of total maternal deaths were related to abortions.

wider population of pregnant women. In the second case, the vagaries of memory and unwillingness to admit illegal practices can impose severe limitations.[8] There is, however, the more general problem of how to assess the extent of total pregnancy loss—all fetal deaths, both spontaneous and induced. What evidence there is from diverse sources suggests that in developed countries during the first half of the twentieth century (i.e. category B) from perhaps 25 to 60 per cent of all abortions were induced—usually illegal and potentially unsafe.[9]

This broad span may also be appropriate for the late nineteenth century, when the number of examples towards the upper end of the range is likely to have increased. However, the evidence on which to base this assertion is fragmentary and potentially unreliable, to say the least.[10] Official concern over induced abortion certainly increased, although, like syphilis, its incidence may have been exaggerated.

Angus McLaren's account of abortion in France between 1800 and 1914 illustrates the way in which historians have tackled the problem.[11] He focuses on attitudes to, rather than the extent of, abortion: the shift from association with unwanted pregnancies among spinsters and widows to abortion as a means of family planning used by married women, especially as a 'back-up method' among the bourgeoisie; the role of midwives (*les sages-femmes*) as abortionists and their denunciation by doctors; the increasing engagement of women in the urban-industrial workforce; the rise of feminism; and the legal connection between abortion and infanticide. What McLaren says of France has, in broad

[8] Potts, Diggory, and Peel, *Abortion*, pp. 64–131 reviews these studies for Britain and several other countries including the USA where one survey of white married women indicated that 60 per cent of all abortions were induced in the 1930s and 30 per cent in the 1950s (p. 88, table 6). See also Henry P. David, 'Abortion in Europe, 1920–91: a public-health perspective', *Studies in Family Planning*, 23 (1) (1992), 1–22.

[9] Sølvi Sogner, 'Abortion, birth control, and contraception: fertility decline in Norway', *Journal of Interdisciplinary History*, 34 (2) (2003), 209–34 reports estimates for Norway in 1933 which show that the ratio of total abortions to live births was 1 in 4.9, and that induced abortions represented 54 per cent of all abortions (46 per cent among married and 85 per cent among unmarried women), so that the ratio of induced abortions to live births was 1 in 9.1 (p. 230, table 6,). Had there been no induced abortions, the number of live births would have increased by up to 10 per cent.

[10] The survey by Potts, Diggory, and Peel, *Abortion*, relies heavily on Whitehead's data (see Ch. 5, pp. 142–7) and a number of anecdotal accounts dealing with the supply of abortifacients. R. Sauer, 'Infanticide and abortion in nineteenth-century Britain', *Population Studies*, 32 (1) (1978), 81–93 also considers the available material, but is careful not to quantify. See also Robert Woods, *The Demography of Victorian England and Wales* (Cambridge: Cambridge University Press, 2000), 123, on debates over the contribution of induced abortion to fertility decline.

[11] McLaren, 'Abortion in France: women and the regulation of family size, 1800–1914', *French Historical Studies*, 10 (1978), 461–85. The most authoritative work on this subject, Ambroise Tardieu, *Étude médico-légale sur l'avortement: suivie d'une note sur l'obligation de déclarer a l'état civil les foetus mort-nés et d'observations et recherches pour servir å l'histoire médico-légale des grossesses fausses et simulées*, 3rd edn. (Paris: Baillière, 1868), linked induced abortion with the need to register stillbirths. Jean-Yves Le Naour and Catherine Valenti, *Histoire de l'avortement, XIXe–XXe siècle* (Paris: Seuil, 2003) also discusses developments in France, but has little to add in terms of the extent of induced abortion.

terms, also been said of other European populations.[12] If official concern reflects popular practice, the resort to induced abortion was increasing during the late nineteenth century.

There are a number of populations in which legal induced abortion has been used as a substitute for contraception. The countries of Eastern Europe are usually held up as examples, especially Romania, Russia, and the Czech Republic, but not Poland.[13] However, the case of Japan is of special interest because spontaneous fetal deaths at over 12 weeks' gestation were registered throughout the twentieth century and because the Eugenic Protection Law of 1948 dramatically increased the availability of medically safe legal abortions at a time when other methods of contraception were not available—the oral contraceptive pill was not licensed until 1999—and there was a growing desire to restrict family size. Figure 8.2

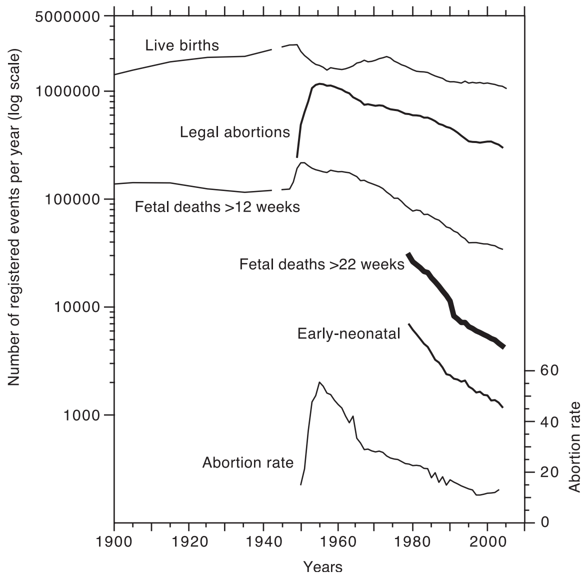


Fig. 8.2: Number of live births, fetal deaths over 12 and over 22 weeks' gestation, legal abortions, and early-neonatal deaths registered per year, and abortion rate: Japan. (The age-specific abortion rate expresses the number of legal abortions per 1000 women aged 15–44.)

Source: National Institute of Population and Social Security, Tokyo, *Population Statistics of Japan*, 2006, tables 4.17, 4.18, and 5.4.

[12] Sauer, 'Infanticide and abortion' is, likewise, strong on anecdotal evidence and weak on general experience.

[13] Elwood Carlson, Jan M. Hoem, and Jitka Rychtarikova, 'Trajectories of fetal loss in the Czech Republic', *Demography*, 36 (3) (1999), 327–37 is one of the best-documented studies. Potts, Diggory, and Peel, *Abortion* (1977) provides other Eastern European examples, as does David, 'Abortion in Europe', pp. 12–15.

illustrates the Japanese registration data for live births, spontaneous fetal deaths over 12 and 22 completed weeks' gestation, legal induced abortions, and early-neonatal deaths. It also shows the age-specific abortion rate.[14] Unfortunately, it is likely that both spontaneous and induced abortions were underreported, perhaps substantially, by pregnant women and medical professionals. Irene B. Taeuber has made some observations on the likely extent of under- and misreporting in the 1940s and 1950s.[15] She derived 'reported conceptions' by combining the numbers of induced abortions within 3 months of conception with fetal deaths after 12 weeks and live births. She then looked at the ratio of total induced abortions to reported conceptions, which was 35.4 per cent for Japan in 1953 (the range among prefectures was 50–20 per cent), a minimal figure in her view. Taeuber also made some significant remarks on fetal mortality in general, and on induced abortion in Japan even before 1948:

> It is improbable that the resort to abortion in Japan could have attained its present magnitude without a cultural base in which post-conception limitation of fertility was accepted and practiced . . . The change in reported stillbirths [fetal deaths over 12 weeks' gestation] in the years from 1947 to the present [1958] is consistent with the assumption that substantial numbers of induced abortions have always been included with the stillbirth statistics, and that fluctuations in the ratio of stillbirths to live births continue to reflect changes in induced abortions.[16]

Despite their limitations, the various series in Figure 8.2 help to demonstrate how important it can be to distinguish among fetal deaths between spontaneous miscarriages and induced abortions, and how difficult that division of previable losses is even when there is a requirement to register second- and third-trimester deaths.

Most of those societies that fall into category (A)—Japan may have been an exception—are likely to have experienced rather low levels of induced abortion. The overwhelming majority of fetal deaths would have been spontaneous and

[14] Aya Goto et al. 'Abortion trends in Japan, 1975–95', *Studies in Family Planning* 31 (4) (2000), 301–8; Sachiko Baba, Satoshi Tsujita, and Kanehisa Morimoto, 'The analysis of trends in induced abortion in Japan: an increasing consequence among adolescents', *Environmental Health and Preventive Medicine*, 10 (1) (2005), 9–15; and Ryuzaburo Sato and Miho Iwasawa, 'Contraceptive use and induced abortion: how is it so unique among developed countries?', *Japanese Journal of Population*, 4 (1) (2006), 33–54 analyse the induced abortion trends, but they do not consider the spontaneous abortions reported as fetal deaths.

[15] Taeuber, *The Population of Japan* (Princeton, NJ: Princeton University Press, 1958), 275–83. See also Minoru Muramatsu, 'Effect of induced abortion on the reduction of births in Japan', *Milbank Memorial Fund Quarterly*, 38 (2) (1960), 153–66.

[16] Taeuber, *Population of Japan*, p. 278. Taeuber uses the fetal-death ratio (FDR), which was mentioned in relation to American fetal mortality in Chapter 4, pp. 74–6, and illustrated for the USA in Figure 4.11. The Japanese word *mabiki*, meaning thinning, has been applied to infanticide and abortion. More recent research, for example Tiana Norgren, *Abortion Before Birth Control: The Politics of Reproduction in Postwar Japan* (Princeton, NJ: Princeton University Press, 2001), has tended to support Taeuber in her view that abortion/infanticide has a long and significant history in Japan.

only a small number were self-induced or assisted. For example, Laura Gowing has explored the legal evidence for abortion, or induced miscarriage, among unmarried women in seventeenth-century England.[17] The relevant legislation included an Act of 1624, which was intended to outlaw infanticide—murder after live birth—but also related to induced abortion after 'quickening'.[18] There developed a presumption that if an unmarried woman had a stillborn child then the death must be associated with some deliberate act on the mother's part. This reflected a long-standing suspicion of miscarriages among unmarried women and the extent to which they were instances of natural fetal wastage. Lord Ellenborough's Act of 1803 made the procurement of an abortion a statutory crime.[19] Social and cultural historians have been, to say the least, imaginative in their use of court records to reflect immoral behaviour as defined at the time. There certainly are instances of such behaviour, and knowledge of herbal abortifacients (especially savin and pennyroyal) did exist, although quite how effective it was and who had access to it remains obscured.[20] Peter Laslett has argued that there existed a 'bastardy-prone sub-society' to which might be added the notion that some women were also, in a sense, 'abortion aware', knowing what to do if they became pregnant. But neither idea holds up well against comparison with the English evidence. Indeed, the rather high level of illegitimate fertility, especially when associated with high levels of bridal pregnancy, would seem to indicate that many young women fell pregnant before marriage. It was not a 'sub-society' and effective knowledge of or willingness to use abortion methods

[17] Gowing, *Common Bodies: Women, Touch and Power in Seventeenth-century England* (New Haven, Conn.: Yale University Press, 2003).

[18] Quickening marks the time at which fetal movements are first felt by the mother. This is usually said to be 12–16 weeks LMP, but some sources mention 16–20 weeks or the mid-point of pregnancy. Keith Wrightson, 'Infanticide in earlier seventeenth-century England', *Local Population Studies*, 15 (1975), 10–22 provides an estimate for bastard infanticide of 2 per cent in rural Essex. The crime was, as he says, infrequent, but prior to 1929 it was not illegal to kill fetuses during difficult births.

[19] Gowing, *Common Bodies*, esp. pp. 121 and 142, has several interesting examples of young women being brought to court on suspicion of having by some means procured an abortion. The evidence was often hearsay, and unconvincing, a reflection of moral indignation against those unfortunate enough to have conceived out of wedlock. See also Angus McLaren, *Reproductive Rituals: The Perception of Fertility in England from the Sixteenth Century to the Nineteenth Century* (London: Methuen, 1984), 89–144, and David Cressy, *Birth, Marriage and Death: Ritual, Religion, and the Life Cycle in Tudor and Stuart England* (Oxford: Oxford University Press, 1997), 47–50. William Hunter, 'On the uncertainty of signs of murder in the case of bastard children', *Medical Observations and Enquiries*, 6 (1784), 206–90 demonstrated long ago how difficult it was to establish the truth in such cases. His work was taken up in the early nineteenth century in William Cummin, *The Proofs of Infanticide Considered* (London: Longman, Rees, Orme, Brown, Green and Longman, 1836).

[20] McLaren, *Reproductive Rituals*, p. 107 notes that 'the vast range of references to herbal abortifacients is chiefly of interest because of the light it casts, not on the rate of successful induction of abortions, but on the reality of a widespread tradition of women seeking to limit births by herbal means'. However, Gigi Santow's review of John M. Riddle, *Eve's Herbs* (*Population and Development Review*, 24 (4) (1998), 869–75), is highly critical of the claims made for the effectiveness of many herbal abortifacients.

was not widespread.[21] It would be quite safe to suppose that, as far as England is concerned, the vast majority of fetal deaths were spontaneous prior to, perhaps, the middle of the nineteenth century. Thereafter, the balance shifted, with induced abortions responsible for a growing share of fetal deaths.

The history of induced abortion is a shadowy one, therefore, even when it has been decriminalized. Suspicions exist, and there are isolated, documented examples, but there is no clear picture of level and only speculation concerning trend before the 1960s.

The second part of this chapter considers the other aspect of the paradox: the fetus as patient. That is, how the health and survival chances of the unborn have improved, and late-fetal mortality reduced to extremely low levels, partly because both mother and fetus have become patients in their own separate rights.

The *Oxford English Dictionary* tells us that the noun 'patient' relates to 'a person receiving or registered to receive medical treatment, especially at a particular establishment or from a particular practitioner; a person staying in a hospital for medical treatment', and that its use dates from at least the late fourteenth century.[22] However, it has been a point of debate whether midwives have patients, since they are not medical practitioners, and pregnant women are not 'ill' and are not receiving treatment. Sarah Stone, in her *A Complete Practice of Midwifery* (1737), only used the word once. In Observation VI she recalled how she was thanked by a physician for helping his patient by successfully delivering the placenta after a miscarriage. Of course the textbooks and case notes written by physicians and surgeons often referred to the problems their patients faced, as well as the treatment given. When it was necessary to extract a dead fetus, this was regarded as an operation requiring a surgeon or specialist man-midwife, but the use of any form of instrument was also thought to justify the term, even manual manipulation of the position of the fetus *in utero*. Most women-midwives deferred to male operators when circumstances arose and where they were available. The men wrote prescriptions, carried out surgery, and offered treatment to the undelivered and delivered alike once they became unwell, the labour had stalled, or postnatal recovery was not progressing. The women-midwives dealt with natural childbirths where there were no complications; they had clients. Again, Mrs Stone was an exception, since she acted as a consulting midwife performing the procedures necessary to delivery, but lacking access to forceps. Women-midwives were specialist nurses who often performed general nursing duties when required, including the laying out of dead bodies prior to interment. Only men provided treatment in the centuries before women were allowed to qualify and join the medical profession as physicians and surgeons.

[21] Laslett, *Family Life and Illicit Love in Earlier Generations* (Cambridge: Cambridge University Press, 1977), 102–55.

[22] The physician in Chaucer's *Canterbury Tales* 'kepte his pacient a ful greet deel In houres by his magik natureel' (*Prologue*, l. 415).

But in certain circumstances that treatment could be given to the unborn via their mothers, and it was certainly the case that all midwives provided some level of care for the pregnant, recently delivered, and their offspring. Although the treatment was often unsuccessful in the case of a fetus, it might still be claimed that regarding fetuses as potential patients has a history as long as that of midwifery itself. What changed were the forms of treatment available and their likely level of success.

The delivery of unnatural presentations using instruments, deliveries restricted by pelvic deformities, and, in extreme instances, the use of Caesarean section all provide examples where 'patient' and 'treatment' may reasonably be applied. In the eighteenth century there was considerable ill-tempered debate over the use of obstetric instruments. The operators, Smellie in particular, were attacked for their too-ready use of crotchets and forceps; but towards the end of the eighteenth century there was also criticism of some men-midwives for being overcautious and not acting soon enough to avoid protracted labours, which would be dangerous for both mother and fetus if haemorrhage set in. In the nineteenth century it is clear, from the standard midwifery textbooks, as well as the specialist studies, that there continued to be minor improvements in instrument design and the procedures adopted for obstetric operations. The use of chloroform in some natural and most instrumental deliveries became standard practice after the 1840s, and this would certainly have eased the pain of giving birth and may even have speeded up the process, thereby saving mother and infant. However, the apparently slow adoption of antiseptic practices in midwifery and obstetrics from the 1870s continued to pose a threat to survival chances.

Chloroform was first used in midwifery practice in 1847. In 1849 Dr John Denham, a physician working at the Dublin Lying-in Hospital, reported cases in which chloroform had been used.[23] He noted four distinct sets: natural labours where chloroform was used to relieve pain and quieten the patient; in preternatural cases where the fetus needed to be turned prior to delivery; in cases where the crotchet was used to deliver a dead-born fetus; and where forceps were used to deliver what was usually a live-born infant. Case 46 comes from the fourth set and illustrates some of the benefits, but also the limitations:

> Case 46.—Bridget Nowlan, aged 30; first pregnancy. A twin case: the first, a footling, of which she was delivered while in a state of anaesthesia. The child was large, for a twin, and great difficulty was experienced in getting away the head; it was born alive, however. The second a head presentation; the pains were so weak that ergot was administered, but with little effect; she was then delivered by the forceps, chloroform having been administered. The child was stillborn; no haemorrhage, but recovery slow, as there was some sloughing of the vagina. She did not leave the hospital until the twenty-ninth day [eight days was usual].[24]

[23] Denham, 'A report upon the use of chloroform in fifty-six cases of labour occurring in the Dublin Lying-in Hospital', *Dublin Quarterly Journal of Medical Science*, 8 (15) (1849), 107–42.

[24] Denham, 'Report', p. 131. Ergot alkaloids were used for uterine contraction and to reduce the risk of haemorrhage.

Case 32 is taken from the third set:

Case 32.—Maria Byrne, aged 28; first pregnancy; tedious labour; delay in second stage from inertia. She was put under the influence of chloroform, which neither increased nor diminished the uterine action. Ergot was then given, when the pains increased considerably, both in frequency and force, but without any advance in the labour. The foetal heart soon ceased to beat, and she was then delivered by the crotchet. She had a good recovery, and went home on the ninth day.[25]

It suggests that the woman's health was probably preserved by the use of chloroform to ease the delivery, although the fetus was stillborn.

Even among its enthusiastic advocates, it was recognized that chloroform was not a panacea. At best it proved an effective substitute for opiates, and certainly it made childbirth less painful, but there were also benefits for the health of the fetus, which could be delivered more quickly and with less damage if turning or forceps were needed. Dr Mathew, whom we met in Chapter 1, confirmed that by the 1890s chloroform was used in all his forceps delivery cases and that although there were no maternal deaths, nearly 7 per cent of fetuses were born dead.[26] Chloroform undoubtedly helped, but it was not sufficient on its own to have a dramatic impact on either fetal or maternal mortality.

Caesarean section offers another set of possibilities in which the unborn might be considered patients. However, it is important to distinguish between three different circumstances in which the operation was conducted. Post-mortem Caesarean sections were performed when the mother was already dead, or beyond saving, and where it was thought that the fetus was both viable and still alive. What might be called medical or emergency Caesarean sections are attempted when there is good reason to believe the lives of the mother and/or the fetus are in danger if delivery does not take place rapidly, perhaps because the pelvis is found to be unusually narrow or haemorrhage has begun or labour has become protracted and asphyxia is feared. Abnormal presentations, such as breech and transverse, are now routinely delivered by Caesarean section in developed countries. In the third case the Caesarean section is elective; it is the delivery method chosen by the mother and agreed to by the obstetrician. The increase in popularity of elective Caesarean sections largely explains the dramatic rise in the incidence of the operation, so that in the UK more than 20 per cent of births are now by Caesarean section and in Australia and the USA the figure exceeds 30 per cent, with some states having more than a third. In developing countries rates are lower, around 10 per cent, but in Brazil about 35 per cent of infants are born this way.

In the first two categories the fetus had become a patient, the operation was conducted in order to save its life. Medical Caesarean sections were not successful

[25] Denham, 'Report', 127.

[26] George Porter Mathew, *Clinical Observations on 2000 Obstetric Cases* (London: Simpkin, Marshall, Hamilton, Kent, 1898).

for mother and infant before the 1880s, and then it was usual for a hysterectomy to be performed, thereby removing the possibility of future pregnancies. The success rate in emergency Caesarean sections improved in response to the following developments: anaesthesia (from the 1840s), asepsis (1870s), blood transfusion (1930s), antibiotics (1940s), electronic fetal monitoring during labour (1970s), and routine ultrasound screening (1980s).[27] Dugald Baird reviewed the use of Caesarean section in 1955, post-antibiotics but pre-ultrasound.[28] He was particularly interested in first pregnancies and postmaturity, after 41 weeks' gestation, but especially the use of Caesarean section as a way of saving the fetus in cases of prolonged labour. In Aberdeen the continued decline in the stillbirth rate could partly be associated with the increasing resort to Caesarean section among elderly primigravidae.[29] For those women aged 35 and over the Caesarean-section rate increased from 4 per cent in 1938–42 to 27 per cent in 1951–4. Emergency Caesarean section helped to save the lives of both mothers and babies, but its timely use was even more beneficial for the latter than the former. Baird remarked that improvements in the targeting of 'at risk' cases and the use of Caesarean section had 'completely altered the graph of stillbirth rates by maternal age, which no longer rises sharply'.[30]

Post-mortem Caesarean sections have a long history dating back to ancient times. The purpose has usually been said to be the desire to deliver a live-born infant after the mother has died, but it is also clear that in many cases there was also an imperative to christen the fetus before it too expired. In *Secrets of Women* (2006) Katharine Park provides examples of this practice drawn principally from late-medieval Italy.[31] There the Church set special store by the need to baptize whenever possible, even if there had been a maternal death. These 'Caesarean births', as they have been called, may only have lived long enough to allow emergency baptism. The medical justification was overridden by the religious.[32]

[27] See Samuel Lurie and Marek Glezerman, 'The history of cesarean technique', *American Journal of Obstetrics and Gynecology*, 189 (6) (2003), 1803–6, and Donald Todman, 'A history of caesarean section: from ancient world to the modern era', *Australian and New Zealand Journal of Obstetrics and Gynaecology*, 47 (2007), 357–61.

[28] Baird, 'Caesarean section, its use in difficult labour in primigravidae', *British Medical Journal*, 2 (1955), 1159–63.

[29] Figure 6.2, on p. 172, shows the stillbirth rate for Aberdeen 1931–51. The SBR was below 20 by 1954.

[30] Baird, 'Caesarean section', p. 1161.

[31] Park, *Secrets of Women: Gender, Generation, and the Origins of Human Dissection* (New York: Zone, 2006). The desire to perform this operation for both religious and medical reasons has led Park to discuss the origins of human dissection, as well as the operators' backgrounds, whether lay persons, women-midwives, physicians, or surgeons. The case described in Katharine Park, 'The death of Isabella Della Volpe: four eyewitness accounts of a postmortem caesarean section in 1545', *Bulletin of the History of Medicine*, 82 (1) (2008), 169–87 also illustrates the potential financial significance, since post-mortem Caesarean section demonstrated the existence of living issue, thereby avoiding the need to return a dowry. Here, two women-midwives, a surgeon, and a barber were involved.

[32] Monica H. Green, *Making Women's Medicine Masculine: The Rise of Male Authority in Pre-modern Gynaecology* (Oxford: Oxford University Press, 2008), 103. Green's account considers

As we saw in Chapter 4, on pages 77–82, emergency baptism was also important in other areas of Catholic Europe during the early modern period, but in France, for example, the rite could be performed on the fetus *in utero* without the need for Caesarean section.

In northern Europe, where the imperative to baptize appears to have been less strong, post-mortem Caesarean sections were performed for the sake of preserving life, if possible. Dr Smellie, as might be expected, has a discussion of the operation in his great *Treatise* (1751) and provides some case notes. He is to the point concerning procedures, objectives, and ethics:

When a woman cannot be delivered by any of the methods hitherto described and recommended in laborious and preternatural labours, on account of the narrowness or distortion of the pelvis, into which it is sometimes impossible to introduce the hand; or from large excrescences and glandular swellings, that fill up the vagina, and cannot be removed; or from large cicatrices and adhesions in that part and at the os uteri, which cannot be separated; in such emergencies, if the woman is strong and of a good habit of body, the Caesarean operation is certainly advisable, and ought to be performed; because the mother and child have no other chance to be saved, and it is better to have recourse to an operation which hath sometimes succeeded, than leave them both to inevitable death. Nevertheless, if the woman is weak, exhausted with fruitless labour, violent floodings, or any other evacuation which renders her recovery doubtful, even if she were delivered in the natural way; in these circumstances it would be rashness and presumption to attempt an operation of this kind, which ought to be delayed until the woman expires, and then immediately performed with a view to save the child.[33]

Smellie went on to describe the operation in some detail and to give sources for readers to consult if they required more practical information. In *A Collection of Preternatural Cases* (1764), published after his death, Smellie gave three examples of cases in which he had conducted post-mortem Caesarean sections, but in none was the child born alive:

Case 430. *A Case of Flooding from Placental presentation; the Woman died suddenly, and was opened immediately to save the Child, which proved to be Dead*

many familiar areas of gender conflict: male operator/female patient, woman-midwife for natural childbirth/man-midwife for complicated procedures. Her demonstration that these tensions predated the eighteenth century by several hundred years is important. For example, it helps to counter the view that '[i]n winning their own professional and social respectability[,] the man-midwives helped to depress the status and opportunities of their female counterparts' (Barbara Brandon Schnorrenberg, 'Is childbirth any place for a woman? The decline of midwifery in eighteenth-century England', *Studies in Eighteenth-century Culture*, 10 (1981), 400).

[33] William Smellie, *Smellie's Treatise on the Theory and Practice of Midwifery*, ed. Alfred H. McClintock (London: New Sydenham Society, 1876), i. 362. McClintock has a long note on the Caesarean section (p. 365) which reflects the uncertain status of the operation in the 1870s. Fleetwood Churchill, *Researches in Operative Midwifery, etc.* (Dublin: Keene, 1841), 185–234, 'On the Caesarean section', provides summary statistics from various sources. For example, in 40 British cases 29 women died, and in 37 cases 15 fetuses died. Churchill was even more optimistic than usual about the value of these data.

In the year 1747, I was called by a midwife to a woman who was attacked with a violent flooding; but she being unwilling that I should examine, and the discharge being stopped before I reached the house, I ordered a mixture of the *Tinctura Rosarum*, and liquid laudanum, to be given as there should be occasion; and desired them to send for me if it should again return.

She was within a fortnight of her full time; the discharge was sudden, in a large quantity, and soon stopped; she continued free all that day, till towards the evening; the flooding continued all night; and I was not called till next morning, when I found her excessively weak and low. Although she had no signs of labour, yet the os uteri was soft, and a little open, and something like either a coagulum of blood or the placenta presenting. Before I had time to put her in a supine position for the delivery, she fainted away, was thrown into convulsions, and died instantly.

As there were none other than the husband and nurse present, I immediately sent for an apothecary, who lived next door. All the bystanders being fully convinced of her death, I immediately made a large opening in the abdomen, with a view to save the child. Though the woman was pretty fat, yet the parietes of the abdomen were thinner than I expected, from the large distension of the uterus. I then made a large opening in the uterus also, which was not a quarter of an inch thick. A large quantity of water was immediately discharged into basins, in all about two quarts. I then extracted the child, which was large and plump, but had no signs of life, and seemed to have been dead several hours by the stiffness of the joints. I now leisurely examined the uterus and secundines. The uterus and the woman's body seemed to be quite destitute of blood; for scarce one drop appeared on opening the parts.[34]

Smellie further speculated that the placenta had ruptured leading to haemorrhage, that the fetus had been in a normal position, and that if he had been called earlier both might have been saved.

In the other two cases the women were similarly multiparae and suffered from violent haemorrhage. Case 432 gave Smellie the opportunity to mention some of the precautions he took once the woman had died and if the fetus appeared stillborn:

In order to prevent reflections, and ascertain that the woman was really dead, I sent for the apothecary, and immediately opened the abdomen and uterus. Then I extracted the child; but felt no pulsation in the arteries of the funis umbilicalis [umbilical cord]; neither was there any pulsation felt at the heart. I rubbed the child's head with spirits, slapped the nates [buttocks], and shook the body to give pain and make it shriek. A nisus of this kind, operating on the nerves, sometimes stimulates the heart to contraction; and affords an easy admission of the air to rush into the lungs. I then tried to inflate the lungs, by blowing in at the child's mouth; but all these efforts were to no purpose; though made in less than four minutes after the mother expired. The child was plump and full grown: the scrotum and lips were not livid: but the joints were a little rigid; a circumstance which denoted that it had been dead some hours.[35]

There is no record that Smellie ever attempted a Caesarean section on a living woman, or, indeed, that he was ever successful in delivering a living infant by

34 Smellie, *Smellie's Treatise*, ed. McClintock, iii. 220. 35 Ibid. 225.

this method, but there are many cases in which he was able to save the life of the mother by removing a dead fetus, occasionally by craniotomy.[36] There is every indication that Smellie was always anxious to do his best for his patients; that he agonized over when to declare mother or fetus dead and what the implications would be for the one who remained alive; and that the incompetence of others made him angry, especially when it affected life chances. In Case 432 the fetus was just as much a patient as its mother.

Despite the work of the eighteenth- and nineteenth-century obstetricians, particularly their desire to provide effective care for mother and unborn in difficult circumstances and to improve the reliability of anatomical atlases by using scientific dissection plus accurate recording, it is often claimed that the fetus became a patient because of ultrasound. Obstetric ultrasound (US) imaging 'has provided eyes for physicians that enable them to look at the fetus as a patient. Thus, it is recognized that the diagnosis and management of fetal problems could not have occurred without US'.[37] Ultrasound imaging was first used in obstetrics in the late 1950s, when Professor Ian Donald, of the Royal Maternity Hospital, Glasgow, used an early and fairly rudimentary device.[38] During the last fifty years ultrasound technology has made enormous advances, including the development of real-time and three-dimensional imaging during the 1980s and four-dimensional imaging more recently, but the equipment has also become more accurate, cheaper, and thus more commonly available, so that routine fetal screening using ultrasound became possible in developed countries during the 1980s. One specialist expressed the prevailing view in that decade as follows:

> I think we are progressing further and further into the field of fetal evaluation to make the nine months which the fetus spends *in utero* a much safer, healthier time and to aid in the recognition of fetal anomalies. By the use of this instrumentation we have brought the fetus from a point where it hides beneath our fingertips and the necessity for the obstetrician to spend a lot of time guessing what is going on to a point where we actually feel the fetus is an active part in the management of pregnancy. We can observe it. We can visualise motion, breathing, activity, and bring reassurance to the mother.[39]

The contribution of ultrasound to fetal medicine over the last twenty years cannot be overemphasized. First, it has provided the means to establish accurate and differentiated fetal-growth patterns related to gestational age without having to use pathological data.[40] Advances in fetal biometry, 'fetometry' as it has

[36] These cases were discussed in Chapter 5, pp. 126–9.

[37] Barry B. Goldberg, 'Obstetric US imaging: the past 40 years', *Radiology*, 215 (2000), 628.

[38] I. Donald, J. MacVicar, and T. G. Brown, 'Investigation of abdominal masses by pulsed ultrasound', *Lancet*, 1 (1958), 1188–95.

[39] Margaret B. McNay and John E. E. Fleming, 'Forty years of obstetric ultrasound, 1957–1997: from A-scope to three dimensions', *Ultrasound in Medicine and Biology*, 25 (1) (1999), 39.

[40] Ultrasound has, of course, also made new advances in fetal pathology possible (Enid Gilbert-Barness and Diane Debich-Spicer, *Embryo and Fetal Pathology: Color Atlas with Ultrasound Correlation* (Cambridge: Cambridge University Press, 2004)). R. M. Pitkin, 'Fetal death: diagnosis

been called, have been substantial since the days of Ballantyne, but much of the progress has been very recent and driven by developments in ultrasound. It is now possible to create customized expected-growth curves focusing on fetal weight or length and to establish due dates on the basis of standardized growth patterns.[41] This ability also makes possible the identification of cases of intrauterine-growth restriction (IUGR) and 'small for dates'. This is particularly important in research on the causes of antepartum stillbirths, many of which cannot be assigned to a causal category but are thought to relate to growth restriction in some way.[42] Second, fetal-development abnormalities can be detected at an early stage and advice on the termination of pregnancy provided, if necessary. This is an important advance, which has coincided with the legalization of induced abortion in many countries. However, it should be added that abortion for strictly medical reasons now forms only a small minority of all induced abortions. Third, it is now possible to recognize multiple pregnancies with ease. This is especially important because these fetuses are at high risk and because IVF treatment has made such pregnancies more likely in recent years. Fourth, ultrasound greatly assists the process of prenatal diagnosis, which may be beneficial to both mother and fetus. Intrauterine therapy has led at its most extreme to the development of fetal surgery. Professor Michael Harrison of the University of California, San Francisco, was the first to pioneer human open fetal surgery in 1981. From this he and his team developed a 'fetal treatment program' that relies heavily on ultrasound-guided invasive therapy, surgery included.[43] Fifth, the adoption of routine ultrasound screening (for dating in the first trimester and to detect abnormalities at 18–20 weeks LMP) has, in most cases, made pregnancy feel safer by providing valuable psychological support, particularly to the mother.

There is one area, however, in which the availability of ultrasound must be regarded as a mixed blessing: fetal sexing. There is convincing evidence that in those societies in which a strong preference for sons prevails ultrasound screening is being used to target female fetuses for abortion. The result is a clear distortion in the sex ratio at birth, favouring males. In China, the one-child-family policy combined with son preference and ready access to induced

and management', *American Journal of Obstetrics and Gynecology*, 157 (1987), 583–9 also illustrates the use of ultrasound in the identification of fetal death before delivery.

[41] See Figure 6.1, on p. 156, which combines a fetal-growth curve generalized from ultrasound measurements and Ballantyne's data derived from fetal necropsy. An example of the new work is provided in Frank P. Hadlock, Ronald B. Harrist, and Juan Martinez-Poyer, 'In utero analysis of fetal growth: a sonographic weight standard', *Radiology*, 181 (1991), 129–33.

[42] See Chapter 6, pp. 178–88, on fetal-death nosologies.

[43] Michael R. Harrison, Mitchell S. Golbus, and Roy A. Filly, *The Unborn Patient: Prenatal Diagnosis and Treatment* (New York: Grune and Stratton, 1984; Philadelphia, Pa.: Saunders, 2001) and Michael R. Harrison, *Atlas of Fetal Surgery* (New York: Chapman & Hall, 1996) summarize this approach. See also Raul A. Cortes and Diana L. Farmer, 'Recent advances in fetal surgery', *Seminars in Perinatology*, 28 (3) (2004), 199–211 for an optimistic review of progress in this field. John C. Hobbins, *Obstetric Ultrasound: Artistry in Practice* (Oxford: Blackwell, 2008) describes the state of the interpretive art today.

abortion has encouraged this behaviour. In northern India it is also obvious that sex-selective abortion is being used, despite the illegal nature of the practice. Even in South Korea, the country with the lowest recorded stillbirth rate in the early twenty-first century, there appears to be evidence for a sex bias in the resort to induced abortion.[44] In certain particular circumstances ultrasound, rather than conferring patient status on the unborn because they can be 'envisioned', has actually exposed them to the danger of feticide.

In the future it is most likely that advances in medical technology will allow fetal mortality to be reduced even further in developed countries. But many of the old tensions and ethical dilemmas will remain. Home or hospital, midwife or obstetrician, vaginal or Caesarean, these are some of the choices that sit alongside IVF treatment and induced abortion.[45] New research on the causes of fetal-growth restrictions and prematurity may prove fruitful, and this would certainly lead to a reduction in risk. It would also contribute to improvements in cause-of-death classifications and a resolution for both the how and why questions. In developing countries, where early-age mortality remains high, improved access to skilled birth attendants would certainly assist the reduction of maternal and stillbirth mortality, as would the control of unsafe abortions accompanied by better access to effective contraception. At the moment it is difficult to believe that those countries with the worst levels of fetal and infant mortality will be able to join the advanced, low-mortality states in the near future. Too much remains to be done and the task appears daunting, but then so might the gap between Scandinavia, on the one hand, and Britain and the USA, on the other, have appeared in 1900 had it been appreciated and properly described.[46]

[44] Junhong Chu, 'Prenatal sex determination and sex-selective abortion in rural central China', *Population and Development Review*, 27 (2) (2001), 259–81; Fred Arnold, Sunita Kishor, and T. K. Roy, 'Sex-selective abortions in India', *Population and Development Review*, 28 (4) (2002), 759–85; and Doo-Sub Kim, 'Missing girls in South Korea: trends, levels and regional variation', *Population-E*, 59 (6) (2004), 865–78 provide the evidence. The availability of ultrasound plays a part in each case, although it is noted that female infanticide has declined. Sylvie Dubuc and David Coleman, 'An increase in the sex ratio of births to India-born mothers in England and Wales: evidence for sex-selective abortion', *Population and Development Review*, 33 (2) (2007), 383–400 illustrates one of the implications of daughter aversion.

[45] The ethical, moral, and legal dilemmas are likely to become even more intense as the fetus, viable and previable, is given more rights and a political position in the pro-life versus pro-choice contest (see Sue Ruddick, 'At the horizons of the subject: neo-liberalism, neo-conservatism and the rights of the child, pt. I: From "knowing fetus" to "confused" child', and 'pt. II: Parent, caregiver, state', *Gender, Place and Culture* 14 (5) (2007), 513–26, and 14 (6) (2007), 627–40.

[46] Two reports published in 2008 illustrate the different perspectives in developed and developing countries. The first, Healthcare Commission, *Towards Better Births: A Review of Maternity Services in England* (London: Commission for Healthcare Audit and Inspection, 2008), is preoccupied with the continuing debate over place of delivery and whether there is greater risk to mother and infant in a home labour, while the second, WHO, *Closing the Gap in a Generation: Health Equity through Action on the Social Determinants of Health*, Commission on Social Determinants of Health, Final Report (Geneva: World Health Organization, 2008), addresses the problem of persistent health inequalities, but especially their social and economic dimensions. It only considers life after birth.

Bibliography

BOOKS ORIGINALLY PUBLISHED BEFORE 1800

Albini, Bernard Siegfried, *Icones Ossium Foetus Humani* (Leiden: Johan and Herman Verbeek, 1737).

Burton, John, *An Essay Towards a Complete New System of Midwifery, Theoretical and Practical. Together with the Descriptions, Causes, and Methods of Removing, or Relieving, the Disorders peculiar to Pregnant and Lying-in Women, and New-born Infants. Interspersed with Several New Improvements; Whereby Women may be delivered, in most dangerous Cases, with Ease, Safety, and Expedition, than by any other Method heretofore practiced: Part of which has been laid before the Royal Society at London, and the Medical Society, at Edinburgh; after having been perused by Many of the most Eminent of their Profession, both in Great Britain and Ireland; by whom they were greatly approved of. All Drawn up and Illustrated with Several Curious Observations, and Eighteen Copper-Plates* (London: Printed for James Hodges, at the Looking-Glass, facing St Magnus' Church, London Bridge, 1751).

—— *A Letter to William Smellie, MD, Containing Critical and Practical Remarks upon His* Treatise on the Theory and Practice of Midwifery (London: Printed for W. Owen, 1753).

Chapman, Edmund, *A Treatise on the Improvement of Midwifery, Chiefly with regard to the Operation. To which are added Fifty-seven cases, selected from upwards of Twenty-seven years practice*, 2nd edn. (London: Printed for John Brindley, at the King's Arms in New Bond Street; John Clarke, under the Royal Exchange; and Charles Corbett, at Addison's Head against St Dunstan's Church in Fleet Street, 1735).

Cowper, William, *The Anatomy of Humane Bodies* (Oxford: Printed at the Theater, Samuel Smith and Benjamin Walford, Printers to the Royal Society, at the Prince's Arms in St Paul's Churchyard, London, 1698).

Culpeper, Nicholas, *A Directory for Midwives: or a Guide for Women, in their Conception, Bearing; and Suckling their Children* (London: Printed for H. Sawbridge at the Sign of the Bible on Ludgate Hill, 1675, 1684).

Dawkes, Thomas, *The Midwife Rightly Instructed: Or, The Way, Which all Women desirous to learn, should take, to acquire the True Knowledge and be Successful in the Practice of, the Art of Midwifery. Written principally for the Use of Women* (London: Printed for J. Oswald, at the Rose and Crown in Poultry, near Stocks Market, 1736).

Denman, Thomas, *An Introduction to the Practice of Midwifery, in Two Volumes* (London: Printed for J. Johnson, No. 72, St Paul's Churchyard, 1794–5).

Deventer, Hendrik van, *The Art of Midwifery Improv'd. Fully and plainly laying down Whatever Instructions are requisite to make a Compleat Midwife, and the many Errors in all the Books hitherto written upon the Subject clearly refuted. Illustrated with thirty-eight cuts curiously Engraven on Copper Plates, representing in their due Proportion the several Positions of a Foetus. Written in Latin by Henry à Daventer. Made English. To which is added, a Preface giving some Account of this Work, by an Eminent Physician* (London: Printed for E. Curll at the Dial and Bible, J. Pemberton at the Buck and Sun, both against St Dunstan's Church in Fleet Street, and W. Taylor at the Ship in Paternoster Row, 1716).

Douglas, John, *A Short Account of the State of Midwifery in London, Westminster, &c.* (London: Printed for and sold only by the Author in Lad Lane near Guildhall, 1736).

Giffard, William, *Cases in Midwifery*, Revised and published by Edward Hody, MD, FRS (London: Printed for B. Motte, T. Wotton, and L. Gilliver, in Fleet Street; and J. Nourse, without Temple Bar, 1734).

Hamilton, Alexander, *Elements of the Practice of Midwifery* (London: Printed for J. Murray, No. 32, Opposite St Dunstan's Church, Fleet Street, 1775).

——*A Treatise of Midwifery, Comprehending the Management of Female Complaints, and the Treatment of Children in Early Infancy. To which are added Prescriptions for Women and Children, and Directions for Preparing a Variety of Food and Drinks, Adapted to the Circumstances of Lying-in Women. Divested of Technical Terms and Abstruse Theories* (London: Printed for J. Murray, No. 32, Opposite St Dunstan's Church, Fleet Street; J. Dickson, W. Creech, and C. Elliot, at Edinburgh, 1781).

—— *Outlines of the Theory and Practice of Midwifery* (Edinburgh: Printed for C. Elliot, Edinburgh; and G. Robinson, London, 1784).

Harrison, John, *A Short Comparative View of the Practice of Surgery in French Hospitals* (London: Printed for Jacob Robinson, at the Golden Lion, in Ludgate Street, 1750).

Haygarth, John, *An Inquiry How to Prevent the Smallpox* (Chester: Printed by J. Monk for J. Johnson, No. 72, St Paul's Churchyard, London, and P. Broster, Chester, 1784).

Heberden, William, *Observations on the Increase and Decrease of Different Diseases, and Particularly of the Plague* (London: Printed for T. Payne, at the Mews Gate, 1801).

Hunter, John, *A Treatise on the Venereal Disease* (London: Sold at No. 13 Castle Street, Leicester Square, 1786; second edition, Sherwood, Neely and Jones, 1818).

Hunter, William, *The Anatomy of the Human Gravid Uterus Exhibited in Figures* (Birmingham: Printed by John Baskerville; Sold in London by S. Baker and G. Leigh, in York Street; T. Cadell, in the Strand; D. Wilson and G. Nicol, opposite York Buildings; and J. Murray, in Fleet Street, 1774).

Janson, Samuel, *Korte en Bondige Verhandeling, van de Voortteeling en 't Kinderbaren* (Amsterdam: Timotheus ten Hoorn, 1711).

Johnstone, Charles, and Hart, Emily J. (eds.), *The Register of the Parish of Hackness, 1557–1783*, Publications of the Yorkshire Parish Register Society, 25 (Leeds: Yorkshire Parish Register Society, 1906).

Jurin, James, *An Account of the Success of Inoculating the Smallpox in Great Britain for the Year 1724* (London: Printed for J. Peele, at Locke's Head in Paternoster Row, 1725).

La Motte, Guillaume Mauquest de, *Traité complet des accouchements naturels, non naturels, et contre nature, expliqué dans un grand nombre d'observations et de réflexions sur l'art d'accoucher* (Paris: rue de la Harpe, chez Laurent d'Houry, Imprimeur-Libraire, vis-à-vis la rue S. Severin, au St. Esprit, 1722).

——*A General Treatise of Midwifery: Illustrated with upwards of Four Hundred Curious Observations and Reflexions Concerning that Art. By Lamotte, Sworn surgeon and man-midwife at Valognes,* Translated into English by Thomas Tomkyns, Surgeon (London: Printed for James Waugh at the Turk's Head, in Gracechurch Street, 1746).

Leake, John, *Medical Instructions towards the Prevention and Cure of Chronic Diseases peculiar to Women, Volume I* (London: Printed for R. Baldwin, Paternoster Row; and H. Payne, Pall Mall, second edition 1777, fifth edition with additions 1781).

——*A Lecture Introductory to the Theory and Practice of Midwifery* (London: Printed for R. Baldwin, in Paternoster Row, fourth edition corrected with additions 1782).

——*Introduction to the Theory and Practice of Medicine* (London: Printed for R. Baldwin, Paternoster Row; and A. Murray, Fleet Street, 1787).

——*Practical Observations on the Childbed Fever, and Acute Diseases most Fatal to Women during the State of Pregnancy, Volume II* (London: Printed for Baldwin, Paternoster Row; Murray, Fleet Street; and Egerton, Charing Cross, 1787, seventh edition 1792).

Lettsom, John Coakley, *Medical Memoirs of the General Dispensary in London, for part of the Years 1773 and 1774* (London: Printed for Edward and Charles Dilly, 1774).

Levret, André, *Observations sur les causes et les accidens de plusieurs accouchements laborieux* (Paris: Osmont, 1747).

Mauriceau, François, *Traité des maladies des femmes grosses, et de celles qui sont nouvellement accouchées*, 2nd edn. (Paris: Chez l'Auteur, au milieu de la rue de Petits-Champs S. Honoré, à l'Enseigne du bon Medecin, 1675).

——*Aphorisms touchant la grossesse, l'accouchement, les maladies, et autres dispositions des femmes* (Paris: Chez Laurent d'Houry, rue Saint Jacques, devant la Fontaine S. Severin, au Saint Esprit, 1694).

—— *Observations sur la grossesse et l'accouchement des femmes, et sur leurs maladies et celles des enfants nouveau-nez* (Paris: Chez Jean Anisson, Directeur de l'Imprimerie Royale, rue S. Jacques, à la Fleur de Lis de Florence, 1694).

—— *The Diseases of Women with Child, and in Child-bed: As also best Means of helping them in Natural and Unnatural Labours. With fit Remedies for the several Indispositions of New-born Babes. To which is prefix'd an* Anatomical Treatise. *All illustrated with divers fair Figures, correctly engraven in Copper. A Work much more perfect than any now extant in* English; *and very necessary for Chirurgeons and Midwives practising this Art. Written by Francis Mauriceau, Translated by Hugh Chamberlen MD* (London: Printed for Andrew Bell at the Cross Keys and Bible in Cornhill, near Stocks Market, third corrected edition, 1697).

——*Dernières observations sur les maladies des femmes rosses et accouchées* (Paris: Chez Laurent d'Houry, rue S. Severin; au Saint Esprit, vis-à-vis la rue Zacharie, 1708).

——*Aphorisms relating to the Pregnancy, Delivery, and Diseases of Women, Translated from the French by Thomas Jones, Surgeon* (London: Printed for the author [translator]; and sold by Mr Samuel Birt; and William Chase, in Norwich, 1739).

Mead, Richard, *De variolis et morbillis liber* (1747), translated as *A Discourse on the Smallpox and Measles* (London: Printed for John Brindley, 1748).

Mesnard, Jacques, *Le guide des accoucheurs, ou, le maistre dans l'art d'accoucher les femmes* (Paris: Chez de Bure, Le Breton, Durand, 1743).

Monro, Donald, 'The dissection of a woman with child; and remarks on *gravid uteri'*, *Essays and Observations, Physical and Literary, Read before a [Philosophical] Society in Edinburgh and published by them, Volume I, Article XVII* (Edinburgh, 1754), pp. 403–25.

Nihell, Elizabeth, *A Treatise on the Art of Midwifery* (London: Printed for A. Morley, at Gay's Head, near Beaufort Buildings, in the Strand, 1760).

Noortwyk, Wilhelm, *Uteri Humani Gravidi Anatomi et Hisoria* (Leiden: Johan and Herman Verbeek, 1743).

Ould, Fielding, *A Treatise of Midwifery. In Three Parts* (London: Printed for J. Buckland, at the Buck, in Paternoster Row, 1748).

Raulin, Joseph, *De la conservation des enfans, ou les moyens de les fortifier, de les preserver et quérir des maladies jusqu'à l'âge de puberté*, 2 vols. (Paris: Merlin, 1768 and 1769).

Rösslin, Eucharius, *When Midwifery Became the Male Physician's Province: The Sixteenth Century Handbook* The Rose Garden for Pregnant Women and Midwives, *Newly Englished*, Translated from the German and with an Introduction by Wendy Arons (Jefferson, NC: McFarland & Co., 1994).

Saxtorph, Matthias, *Nyeste Udtog af Fødsels-Videnskaben til Brug for Jordemødrene* (Copenhagen: Schubothes, 1790).

Sharp, Jane, *The Midwives Book. Or the whole Art of Midwifery Discovered* (London: Printed for Simon Miller, at the Star at the West End of St Pauls, 1671), ed. Elaine Hobby (New York: Oxford University Press, 1999).

Siegemund, Justine, *The Court Midwife* [1690], trans. and ed. Lynne Tatlock (Chicago, Ill.: University of Chicago Press, 2005).

Smellie, William, *A Treatise on the Theory and Practice of Midwifery* (London: Printed for D. Wilson, at Plato's Head, near Round Court, in the Strand, first edition 1751, dated 1752).

——*A Collection of Cases and Observations in Midwifery. By William Smellie MD, To Illustrate His former Treatise, or First Volume, on that Subject* (London: Printed for D. Wilson and T. Durham, at Plato's Head, in the Strand, 1754).

——*A Sett of Anatomical Tables, With Explanations, and an Abridgement of the Practice of Midwifery; with a view to illustrate a Treatise on that Subject, and Collection of Cases* (London: [no printer or bookseller named, printed by subscription], first large folio edition 1754, second, corrected, edition 1761).

——*A Collection of Preternatural Cases and Observations in Midwifery. By William Smellie MD, Completing the Design of Illustrating his First Volume, on that Subject* (London: Printed for D. Wilson and T. Durham, in the Strand, 1764).

——*Anatomical Tables, With Explanations, and an Abridgment of the Practice of Midwifery; With a view to illustrate a Treatise on that Subject, and Collection of Cases* (Edinburgh: Printed for William Creech, 1787).

——*Smellie's Treatise on the Theory and Practice of Midwifery*, 3 vols. ed. and annot. Alfred H. McClintock, (London: New Sydenham Society, 1876–8).

Sterne, Laurence, *The Life and Opinions of Tristram Shandy, Gentleman* ([1759–67]Oxford: Oxford University Press, 1998).

Stone, Sarah, *A Complete Practice of Midwifery. Consisting of Upwards of Forty Cases or Observations in the valuable Art, selected from Others, in the Course of a very Extensive Practice. And Interspersed with many necessary Cautions and useful Instructions, proper to be observed in the most Dangerous and Critical Exigencies, as well when the Delivery is difficult in its own Nature, as when it becomes so by the Rashness or Ignorance of Unexperienced Pretenders. Recommended to All Female Practitioners in an Art so important to the Lives and Well-Being of the Sex* (London: Printed for T. Cooper, at the Globe, Paternoster Row, 1737).

Swieten, Gerard van, *The Advantages and Disadvantages of Inoculation with respect to Individuals, and the Public, Impartially Considered* (London: Printed for W. Griffin, 1772).

TC, ID, MS, and TB, *The Compleat Midwifes Practice* (London: Printed for Nathaniel Brooke at the Angell in Cornhill, 1656).

Torriano, Nathaneal, *Compendium Obstetricii: or, A Small Tract on the Formation of the Foetus, and the Practice of Midwifery* (London: Printed for E. Comyns, under the Royal Exchange; and J. Robinson, in Ludgate Street, 1753).

Willughby, Percival, *Observations in Midwifery* [*c*.1672], Edited from the original MS by Henry Blenkinsop (1863) with a new Introduction by John L. Thornton (Wakefield: S. R. Publishers, 1972).

OTHER PUBLICATIONS

Adappa, R., et al., 'Perinatal and infant autopsy', *Archives of Disease in Childhood: Fetal and Neonatal Edition*, 92 (2007), F49–F50.

Allen, Elizabeth, Turk, John L., and Murley, Reginald (eds.), *The Case Books of John Hunter, FRS* (London: Royal Society of Medicine, 1993).

Allport, W. H., 'Tristram Shandy and obstetrics', *American Journal of Obstetrics*, 65 (1912), 612–17.

Alter, George, 'Infant and child mortality in the United States and Canada', in Alain Bideau, Bertrand Desjardins, and Héctor Pérez Brignoli (eds.), *Infant and Child Mortality in the Past* (Oxford: Clarendon, 1997), 91–108.

Andersen, Anne-Marie Nybo, et al., 'Maternal age and fetal loss: population-based register linkage study', *British Medical Journal*, 320 (2000), 1708–12.

Andersson, T., Högberg, U., and Bergström, S., 'Community-based prevention of perinatal deaths: lessons from nineteenth-century Sweden', *International Journal of Epidemiology*, 29 (2000), 542–8.

Anon., 'Hommage à Jean Bourgeois-Pichat', *Population*, 45 (4–5) (1990), 731–72.

Arnold, Fred, Kishor, Sunita, and Roy, T. K., 'Sex-selective abortions in India', *Population and Development Review*, 28(4) (2002), 759–85.

Aveling, James Hobson, *English Midwives, Their History and Prospects* (London: Churchill, 1872).

Baba, Sachiko, Tsujita, Satoshi, and Morimoto, Kanehisa, 'The analysis of trends in induced abortion in Japan: an increasing consequence among adolescents', *Environmental Health and Preventive Medicine*, 10 (1) (2005), 9–15.

Backer, Julie E., 'Population statistics and population registration in Norway, I. The vital statistics of Norway: an historical review', *Population Studies*, 1 (2) (1947), 212–26.

Baines, Paul, and Rogers, Pat, *Edmund Curll, Bookseller* (Oxford: Oxford University Press, 2007).

Baird, Dugald, *The Urinary Tract in Pregnancy and the Puerperium*, MD thesis (University of Glasgow, 1934).

—— 'Maternal mortality in hospital: a review of 999 fatal cases in the Glasgow Royal Maternity and Women's Hospital during ten years, 1925–34', *Lancet*, 1 (1936), 295–8.

—— 'The influence of social and economic factors on stillbirths and neonatal deaths', *Journal of Obstetrics and Gynaecology of the British Empire*, 52 (1945), 217–34, 339–66.

—— 'Social class and foetal mortality', *Lancet*, 2 (1947), 531–5.

—— 'Preventive medicine in obstetrics', *New England Journal of Medicine*, 246 (15) (1952), 561–68.

—— 'Social and economic factors affecting the mother and child', *American Journal of Public Health*, 42 (1952), 516–20.

Baird, Dugald, 'Caesarean section, its use in difficult labour in primigravidae', *British Medical Journal*, 2 (1955), 1159–63.

—— 'The evolution of modern obstetrics', *Lancet*, 2 (1960), pp. 557–64, 609–14.

—— 'Environmental and obstetrical factors in prematurity, with special reference to experience in Aberdeen', *Bulletin of the World Health Organization*, 26 (1962), 291–5.

—— 'The epidemiology of prematurity', *Journal of Pediatrics* 65 (6) (1964), 909–24.

—— 'The obstetrician and society', *American Journal of Public Health*, 60 (4) (1970), 628–40.

—— 'Epidemiology of congenital malformations of the central nervous system in (a) Aberdeen and (b) Scotland', *Journal of Biosocial Science*, 6 (1974), 113–37.

—— 'The epidemiology of low birth weight: changes in incidence in Aberdeen, 1948–72', *Journal of Biosocial Science*, 6 (1974), 323–41.

—— 'The interplay of changes in society, reproductive habits, and obstetric practice in Scotland between 1922 and 1972', *British Journal of Preventive and Social Medicine*, 29 (1975), 135–46.

—— 'The perinatal mortality rate as a measure of the efficiency of the maternity services', *Health Bulletin*, 35 (5) (1977), 234–42.

—— 'Environment and reproduction', *British Journal of Obstetrics and Gynaecology*, 87 (1980), 1057–67.

—— 'Changing problems and priorities in obstetrics', *British Journal of Obstetrics and Gynaecology*, 92 (1985), 115–21.

—— 'Interview', Aberdeen University Oral History Archive, transcript, University of Aberdeen Library, Special Collections, MS 3620/1/21, 22 (1985).

—— and Thomson, A. M., 'The effects of obstetric and environmental factors on perinatal mortality by clinico-pathological causes', in Neville R. Butler and Eva. D. Alberman (eds.), *Perinatal Problems: The Second Report of the 1958 British Perinatal Mortality Survey* (Edinburgh: Livingstone, 1969), 211–26.

—— and —— 'General factors underlying perinatal mortality rates', in Neville R. Butler and Eva D. Alberman (eds.), *Perinatal Problems. Second Report of the 1958 British Perinatal Mortality Survey* (Edinburgh: Livingstone, 1969), 16–35.

—— and ——, 'Reduction of perinatal mortality by improving standards of obstetric care', in Neville R. Butler and Eva. D. Alberman (eds.), *Perinatal Problems: The Second Report of the 1958 British Perinatal Mortality Survey* (Edinburgh:. Livingstone, 1969), 255–82.

—— and —— 'The survey perinatal deaths re-classified by special clinico-pathological assessment', in Neville R. Butler and Eva. D. Alberman (eds.), *Perinatal Problems: The Second Report of the 1958 British Perinatal Mortality Survey* (Edinburgh: Livingstone, 1969), 200–10.

—— and Wyper, James F. B., 'High stillbirth and neonatal mortalities', *Lancet*, 2 (1941), 657–9.

—— Thomson, A. M., and. Duncan, Ethel H. L, 'The causes and prevention of stillbirths and first-week deaths, pt. II: Evidence from Aberdeen clinical records', *Journal of Obstetrics and Gynaecology of the British Empire*, 60 (1953), 17–30.

—— Walker, J., and Thomson, A. M., 'The causes and prevention of stillbirths and first-week deaths, pt. III: A classification of deaths by clinical cause: the effect of age, parity and length of gestation on death rates by cause', 61 (1954), 433–48.

Bakketeig, Leiv S., Seigel, Daniel G., and Sternthal, Phyllis M., 'A fetal-infant life table based on single births in Norway, 1967–73', *American Journal of Epidemiology*, 107 (3) (1978), 216–25.

Ballantyne, J. W., *Certain Anatomical and Pathological Conditions in the Foetus and New-Born Infant in their Relation to Obstetrics*, MD thesis (University of Edinburgh, 1889).

—— *An Introduction to the Diseases of Infancy* (Edinburgh: Oliver & Boyd, 1891).

—— *The Diseases and Deformities of the Foetus: An Attempt Towards a System of Natal Pathology*, i (Edinburgh: Oliver & Boyd, 1892).

—— *The Diseases and Deformities of the Foetus: An Attempt Towards a System of Ante-natal Pathology, ii. Congenital Diseases of the Subcutaneous Tissue and Skin* (Edinburgh: Oliver & Boyd, 1895).

—— *Manual of Antenatal Pathology and Hygiene, i. The Foetus* (1902)/*ii. The Embryo* (1904) (Edinburgh: Green, 1902/1904).

—— *Essentials of Obstetrics* (Edinburgh: Green, 1904).

—— *Essentials of Gynecology* (Edinburgh: Green, 1905).

—— *Expectant Motherhood: Its Supervision and Hygiene* (London: Cassell, 1914).

—— (ed.), *Teratologia: A Quarterly Journal of Ante-natal Pathology* (London: Williams and Northgate, 1894–5).

—— 'Intra-uterine rickets', *Edinburgh Medical Journal*, 35 (12) (1890), 1111–21.

—— 'The pathology of antenatal life', *Glasgow Medical Journal*, 49 (1898), 241–58.

—— 'A problem of antenatal pathology: recurrent monstriparity', *American Journal of Obstetrics*, 41 (1900), 577–86.

—— 'The problem of the postmature infant', *Journal of Obstetrics and Gynaecology of the British Empire*, 2 (6) (1902), 36–54.

—— 'The "Byrth of Mankynde"', *Journal of Obstetrics and Gynaecology of the British Empire*, 10 (4) (1906), 297–325; 12 (3) (1907), 175–94; 12 (4) (1907), 255–74.

—— 'Pre-maternity hospital practice: a series of thirty cases of morbid pregnancy treated in the Royal Maternity Hospital, Edinburgh, during the Autumn Quarter of 1908', *Journal of Obstetrics and Gynaecology of the British Empire*, 15 (2) (1909), 93–107; 15 (3) (1909), 169–86.

—— 'The treatment of eclampsia: a resumé of eighteen months' experience', *Journal of Obstetrics and Gynaecology of the British Empire*, 18 (6) (1910), 378–83.

—— 'Still-births' registration', *Journal of Obstetrics and Gynaecology of the British Empire*, 25(3) (1914), 132–49.

—— 'Ante-natal, intra-natal, and post-natal death: causes, pathology, and prevention, with special reference to ante-natal death', *British Medical Journal*, 2 (1922), 583–8.

Barfield, Wanda D., et al., 'Contribution of late fetal deaths to US perinatal mortality rates, 1995–1998', *Seminars in Perinatology*, 26 (1) (2002), 17–24.

Barnes, Robert, unpublished casebook, 1857–68, Archives, Royal College of Obstetricians and Gynaecologists, London.

Baskett, Thomas F., *Essential Management of Obstetric Emergencies*, 4th edn. (Bristol: Clinical, 2004).

Bell, Charles, 'Remarks on abortion in the early months of pregnancy', *Edinburgh Medical Journal* 11 (2) (1865), 120–33.

Berman, Stuart M., 'Maternal syphilis: pathophysiology and treatment', *Bulletin of the World Health Organization* 82 (6) (2004), 433–8.

Bertillon, Jacques, ‘Mort-né’, *Dictionnaire Encyclopédique des Sciences Médicales*, x (Paris: Masson/Libraire de l’Académie de Médecine, 1876), 2–28.

Bickerton, Thomas H., *A Medical History of Liverpool from the Earliest Days to the Year 1920* (London: Murray, 1936).

Bideau, Alain, ‘Accouchement “naturel” et accouchement à “haut risque” ’, *Annales de Démographie Historique* (1981), 49–66.

—— Desjardins, Bertrand, and Brignoli, Héctor Pérez (eds.), *Infant and Child Mortality in the Past* (Oxford: Clarendon, 1997).

Black, Malcolm, ‘Antiseptic midwifery’, *Glasgow Medical Journal*, 50 (1898), 12–22.

Bland, Robert, ‘Some calculations of the number of accidents or deaths which happen in consequence of parturition; &c.’, *Philosophical Transactions of the Royal Society*, 71 (1781), 355–71.

Boklage, Charles E., ‘Survival probability of human conceptions to term’, *International Journal of Fertility*, 35 (2) (1990), 75–94.

—— ‘The epigenetic environment: secondary sex ratio depends on differential survival in embryogenesis’, *Human Reproduction*, 20 (3) (2005), 583–7.

Bongaarts, John, and Robert G. Potter, *Fertility, Biology, and Behavior: An Analysis of the Proximate Determinants* (New York: Academic, 1983).

—— and Westoff, Charles E., ‘The potential role of contraception in reducing abortion’, *Studies in Family Planning*, 31 (3) (2000), 193–202.

Booth, Christopher, *John Haygarth, FRS (1740–1827): A Physician of the Enlightenment*, Memoirs of the American Philosophical Society, 254 (Philadelphia, Pa.: American Philosophical Society, 2005).

Bound, J. P., Butler, N. R., and Spector, W. G., ‘Classification and causes of perinatal mortality’, *British Medical Journal*, 2 (1956), 1191–6, 1260–5.

Bourgeois-Pichat, Jean, ‘De la mesure de la mortalité infantile’, *Population*, 1 (1946), 53–68.

—— ‘Analyse de la mortalité infantile’, *Revue de l’Institut International de Statistique*, 1–2 (1950), 45–68.

—— ‘La mesure de la mortalité infantile’, *Population*, 6 (1951), 233–48, 459–80.

—— ‘An analysis of infant mortality’, *Population Bulletin of the United Nations*, 2 (1952), 1–14.

Bradley, Leslie, *Smallpox Inoculation: An Eighteenth Century Mathematical Controversy* (Nottingham: University of Nottingham, 1971).

Brockbank, W., and Kenworthy, F. (eds.), *The Diary of Richard Kay, 1716–51, of Baldingstone, near Bury: A Lancashire Doctor*, Chetham Society, Remains Historical and Literary, 3rd ser., 16 (Manchester: Manchester University Press, 1968).

Brody, Steven A., ‘The life and times of Sir Fielding Ould: man-midwife and master physician’, *Bulletin of the History of Medicine*, 52 (2) (1978), 228–50.

Browne, Francis J., ‘Still-birth: its cause, pathology, and prevention’, *Edinburgh Medical Journal*, 27 (1921), 153–66, 199–211, 286–96.

Brunton, Deborah, ‘Smallpox inoculation and demographic trends in eighteenth-century Scotland’, *Medical History*, 36 (1992), 403–29.

Butler, Neville R., and Bonham, Dennis G. (eds.), *Perinatal Mortality: The First Report of the 1958 British Perinatal Mortality Survey* (Edinburgh: Livingstone, 1963.)

—— and Alberman, Eva D. (eds.), *Perinatal Problems: The Second Report of the 1958 British Perinatal Mortality Survey* (Edinburgh: Livingstone, 1969).

Bynum, W. F., and Porter R. (eds.), *William Hunter and the Eighteenth-century Medical World* (Cambridge: Cambridge University Press, 1985).

Campbell, Stuart, *Watch Me Grow!* (London: Carroll & Brown, 2004).

Carlson, Elwood, Hoem, Jan M., and Rychtarikova, Jitka, 'Trajectories of fetal loss in the Czech Republic', *Demography*, 36 (3) (1999), 327–37.

Carpentier, Louis Arthur Alphonse, *De l'influence des divers traitements sur les accès éclamptiques* (Paris: Parent, 1872).

—— *Traité practique des accouchements* (Paris: Baillière, 1880).

Cartlidge, Patrick H. T., et al. 'Value and quality of perinatal and infant postmortem examinations: an analysis of 400 consecutive deaths', *British Medical Journal*, 310 (1995), 155–58.

Cazeaux, Pierre, *Traité théoretique et pratique de l'art des accouchements: Comprenant l'histoire des maladies qui peuvent se manifester pendant la grossesse et le travail et l'indication des soins à donner à l'enfant nouveau-né* (Paris: Méquignon-Marvis Fils, 1841).

CEMACH, *Perinatal Mortality, 2005: England, Wales and Northern Ireland* (London: Confidential Enquiry into Maternal and Child Health, 2007).

CEMACH, *Perinatal Mortality, 2006: England, Wales and Northern Ireland* (London: Confidential Enquiry into Maternal and Child Health, 2008).

Chan, A., et al., 'Classification of perinatal deaths: development of the Australian and New Zealand classifications', *Journal of Paediatrics and Child Health*, 40 (2004), 340–7.

Chase, Helen C., *International Comparison of Perinatal and Infant Mortality*, US National Center for Health Statistics, 3rd ser., 6 (Washington, DC: US Government Printing Office, 1967), 14–17.

Chu, Junhong, 'Prenatal sex determination and sex-selective abortion in rural central China', *Population and Development Review*, 27 (2) (2001), 259–81.

Churchill, Fleetwood, *Researches on Operative Midwifery, etc* (Dublin: Keene, 1841).

—— *On the Theory and Practice of Midwifery* (London: Renshaw, 1st edn. 1842, 6th edn. 1872).

Cnattingius, Sven, and Stephansson, Olof, 'The epidemiology of stillbirth', *Seminars in Perinatology*, 26 (1) (2002), 25–30.

Coale, Ansley J., and Demeny, Paul, *Regional Model Life Tables and Stable Populations* (Princeton, NJ: Princeton University Press, 1966).

Cody, Lisa Forman, *Birthing the Nation: Sex, Science, and the Conception of Eighteenth-century Britons* (Oxford: Oxford University Press, 2005).

—— 'The politics of reproduction: from midwives' alternative public sphere to the public spectacle of man-midwifery', *Eighteenth-century Studies*, 32 (4) (1999), 477–95.

—— 'Living and dying in Georgian London's lying-in hospitals', *Bulletin of the History of Medicine*, 78 (2004), 309–48.

Cole, S. K., Hey, E. N., and Thomson, A. M., 'Classifying perinatal death: an obstetric approach', *British Journal of Obstetrics and Gynaecology*, 93 (1986), 1204–12.

Collins, Robert, *A Practical Treatise on Midwifery, Containing the Result of Sixteen Thousand Six Hundred and Fifty-four Births, Occurring in the Dublin Lying-in Hospital, During a Period of Seven Years Commencing November 1826* (London: Longman, Rees, Orme, Browne, Green, and Longman, 1835).

Collins, Robert, 'Observations on the periodicity of births, &c.', *Dublin Journal of Medical Science*, 10 (29) (1836), 197–204.

Constantin, Carolyn M., et al., 'Smallpox: a disease of the past? Consideration for midwives', *Journal of Midwifery and Women's Health*, 48 (4) (2003), 258–67.

—— et al., 'Smallpox: an update for nurses', *Biological Research for Nursing*, 4 (4) (2003), 282–94.

Copeman, Edward (ed.), *Cases in Midwifery, By the Late John Green Crosse, MD, FRS, Arranged (with an Introduction and Remarks)* (London: Churchill, 1851).

Cortes, Raul A., and Farmer, Diana L., 'Recent advances in fetal surgery', *Seminars in Perinatology*, 28 (3) (2004), 199–211.

Coster, Will, 'Tokens of innocence: infant baptism, death and burial in early modern England', in Bruce Gordon and Peter Marshall (eds.), *The Place of the Dead: Death and Remembrance in Late Medieval and Early Modern Europe* (Cambridge: Cambridge University Press, 2000), 266–87.

Creighton, Charles, *A History of Epidemics in Britain, ii. From the Extinction of the Plague to the Present Time* (Cambridge: Cambridge University Press, 1894; London: Cass, 1965).

Cressy, David, *Birth, Marriage and Death: Ritual, Religion, and the Life Cycle in Tudor and Stuart England* (Oxford: Oxford University Press, 1997).

Crosse, V. Mary, *A Surgeon in the Early Nineteenth Century: The Life and Times of John Green Crosse, 1790–1850* (Edinburgh: Livingstone, 1968).

—— 'The premature baby', *Journal of Obstetrics and Gynaecology of the British Empire*, 53 (1) (1946), 72–83.

Crowther, M. Anne, and Dupree, Marguerite W., *Medical Lives in the Age of Surgical Revolution* (Cambridge: Cambridge University Press, 2007).

Cruickshank, J. N., *Maternal Syphilis as a Cause of Death of the Foetus and of the New-born Child*, Medical Research Council, 82 (London: HMSO, 1924).

—— *The Causes of Neonatal Death*, Medical Research Council, special report series, 145 (London: HMSO, 1930).

—— et al., *The Estimation of Foetal Age, the Weight and Length of Normal Foetuses and the Weights of Foetal Organs*, Medical Research Council, special report series, 86 (London: HMSO, 1924).

Cummin, William, *The Proofs of Infanticide Considered* (London: Longman, Rees, Orme, Brown, Green and Longman, 1836).

Curtis, Stephen, 'Midwives and their role in the reduction of direct obstetric deaths during the late nineteenth century: the Sundsvall region of Sweden (1860–1890)', *Medical History*, 49 (2005), 321–50.

Cutts, F. T., et al., 'Control of rubella and congenital rubella syndrome (CRS) in developing countries, pt. I. burden of disease from CRS', *Bulletin of the World Health Organization*, 75 (1) (1997), pp. 55–68.

David, Henry P., 'Abortion in Europe, 1920–91: a public-health perspective', *Studies in Family Planning*, 23 (1) (1992), 1–22.

Davis, David D., *Elements of Operative Midwifery: Comprising a Description of Certain New and Improved Powers for Assisting Difficult and Dangerous Labour, Illustrated by Plates, With Cautionary Strictures on Improper use of Instruments* (London: Hurst, Robinson, 1825).

Davis, Gayle, 'Stillbirth registration and perceptions of infant death, 1900–1960: the Scottish case in national context', *Economic History Review*, 62 (2009).

—— and Davidson, Roger '"A fifth freedom" or "hideous atheistic expediency"? The medical community and abortion law reform in Scotland, *c*.1960–1975', *Medical History*, 50 (2006), 29–48.

De Lacy, Margaret, 'Puerperal fever in eighteenth-century Britain', *Bulletin of the History of Medicine*, 63 (1989), 521–56.

Del Panta, Lorenzo, 'Infant and child mortality in Italy, eighteenth to twentieth century: long-term trends and territorial differences', in Alain Bideau, Bertrand Desjardins, and Héctor Pérez Brignoli (eds.), *Infant and Child Mortality in the Past* (Oxford: Clarendon, 1997), 7–21.

Denham, John, 'A report upon the use of chloroform in fifty-six cases of labour occurring in the Dublin Lying-in Hospital', *Dublin Quarterly Journal of Medical Science*, 8 (15) (1849), 107–42.

Dietz, Klaus, and Heesterbeek, J. A. P., 'Daniel Bernoulli's epidemiological model revisited', *Mathematical Biosciences*, 180 (2002), 1–21.

Dixon, C. W., *Smallpox* (London: Churchill, 1962).

Dobson, Mary J., *Contours of Death and Disease in Early Modern England* (Cambridge: Cambridge University Press, 1997).

Donald, I., MacVicar, J., and Brown, T. G., 'Investigation of abdominal masses by pulsed ultrasound', *Lancet*, 1 (1958), 1188–95.

Donnison, Jean, *Midwives and Medical Men: A History of the Struggle for the Control of Childbirth* (London: Heinemann, 1977).

Doran, Alban, 'Burton ('Dr Slop'): his forceps and his foes', *Journal of Obstetrics and Gynaecology of the British Empire*, 23 (1913), 3–24, 65–86.

Douglas, Charlotte A., *Infant and Perinatal Mortality in Scotland*, US National Center for Health Statistics, 3rd ser., 5 (Washington, DC: US Government Printing Office, 1966).

Drake, Michael, *Population and Society in Norway, 1735–1865* (Cambridge: Cambridge University Press, 1969).

Dubuc, Sylvie, and Coleman, David, 'An increase in the sex ratio of births to India-born mothers in England and Wales: evidence for sex-selective abortion', *Population and Development Review*, 33 (2) (2007), 383–400.

Dudfield, Reginald, 'Still-births in relation to infantile mortality', *Journal of the Royal Statistical Society*, 76 (1) (1912), 1–57.

—— 'Stillbirths: the case for their compulsory registration and their definition', *Proceedings of the Royal Society of Medicine: Section of Epidemiology and State Medicine*, 17 (1914), 81–106.

Duncan, Ethel H. L., Baird, Dugald, and Thomson, A. M., 'The causes and prevention of stillbirths and first week deaths, pt. I: The evidence of vital statistics', *Journal of Obstetrics and Gynaecology of the British Empire*, 59 (1952), 183–96.

Dunham, Ethel C., et al., 'Problem of the causes of stillbirth', *American Journal of Public Health*, 28 (4) (1938), 491–8.

Dupâquier, Jacques, 'For a history of prematurity', in Alain Bideau, Bertrand Desjardins, and Héctor Pérez Brignoli (eds.), *Infant and Child Mortality in the Past* (Oxford: Clarendon, 1997), 188–202.

Duvillard, Emmanuel-Etienne, *Analyse et tableaux de l'influence de la petite vérole sur la mortalité à chaque âge, et de celle qu'un préservatif tel que la vaccine peut avoir sur la population et de la longévité* (Paris: L'Imprimerie Impériale, 1806).

Eccles, Audrey, *Obstetrics and Gynaecology in Tudor and Stuart England* (London: Croom Helm, 1982).

Eriksson, Aldur W., and Fellman, Johan, 'Factors influencing the stillbirth rates in single and multiple births in Sweden, 1869 to 1967', *Twin Research and Human Genetics*, 9 (4) (2006), 591–6.

Farr, William, *Vital Statistics*, ed. Noel A. Humphreys (London: Sanitary Institute of Great Britain, 1885).

Fasbender, Heinrich, *Geschichte der Geburtshülfe* (Jena: Fischer, 1906).

Feldman, W. M., *The Principles of Ante-natal and Post-natal Child Care* (London: Bale, Sons, and Danielsson, 1927).

Fellman, Johan, and Eriksson, Aldur W., 'Stillbirth rates in singletons, twins and triplets in Sweden, 1869 to 2001', *Twin Research and Human Genetics*, 9 (2) (2006), 260–5.

Fenner, Frank, et al., *Smallpox and its Eradication* (Geneva: World Health Organization, 1988).

Fife, Ernelle, 'Gender and professionalism in eighteenth-century midwifery', *Women's Writing*, 11 (2) (2004), 185–200.

Finlay, Roger, 'Distance to church and registration experience', *Local Population Studies*, 24 (1980), 26–40.

Finster, Mieczyslaw, and Wood, 'The Apgar score has survived the test of time', *Anesthesiology*, 102 (4) (2005), 855–7.

Fisher, Kate, *Birth Control, Sex and Marriage in Britain, 1918–1960* (Oxford: Oxford University Press, 2006).

Fissell, Mary E., *Vernacular Bodies: The Politics of Reproduction in Early Modern England* (Oxford: Oxford University Press, 2004).

Fogel, Robert W., *The Escape from Hunger and Premature Death, 1700–2100* (Cambridge: Cambridge University Press, 2004).

Forbes, Thomas R., 'The regulation of English midwives in the eighteenth and nineteenth centuries', *Medical History*, 15 (4) (1971), 352–62.

Fraser, Malcolm, 'New Zealand—infant mortality rates and stillbirths', *Journal of the Royal Statistical Society*, 92 (3) (1929), 428–44.

French, Fern E., and Bierman, Jessie M., 'Probabilities of fetal mortality', *Public Health Reports*, 77 (10) (1962), 835–47.

Galley, Chris, *The Demography of Early Modern Towns: York in the Sixteenth and Seventeenth Centuries* (Liverpool: Liverpool University Press, 1998).

—— ' "One face, one voice, one heart, and two persons!" The survival of twins in early modern society', *Local Population Studies*, 51 (1993), 73–6.

—— 'On the stillbirth rate in early modern England', *Local Population Studies*, 81 (2008), 75–83.

—— and Robert Woods, 'On the distribution of deaths during the first year of life', *Population: An English Selection*, 11 (1999), 35–60.

Gardarsdottir, Olöf, *Saving the Child: Regional, Cultural and Social Aspects of the Infant Mortality Decline in Iceland, 1770–1920*, demographic database, Umeå University, report 19 (Umeå: Umeå University, 2002).

Gardosi, Jason, et al., 'An adjustable fetal weight standard', *Ultrasound Obstetrics and Gynecology*, 6 (1995), 168–74.

—— et al., 'Analysis of birthweight and gestational age in antepartum stillbirths', *British Journal of Obstetrics and Gynaecology*, 105 (1998), 524–30.

——'Classification of stillbirth by relevant condition at death (ReCoDe): population-based cohort study', *British Medical Journal*, 331 (2005), 1113–17.

Garrett, Eilidh, et al., (eds.), *Infant Mortality: A Continuing Social Problem* (London: Ashgate, 2006).

Geertruyden, Jean-Pierre van, et al., 'The contribution of malaria in pregnancy to perinatal mortality', *American Journal of Tropical Medicine and Hygiene*, 2nd ser., 71 (2004), 35–40.

Gélis, Jacques, *Les enfants des limbes: mort-nés et parents dans l'Europe chrétienne* (Paris: Audibert, 2006).

——'Miracle et médecine aux siècles classiques: le corps médical et le retour temporaire à la vie des mort-nés', *Historical Reflections,* 9 (1982), 85–101.

George, M. Dorothy, 'Some causes of the increase of population in the eighteenth century as illustrated by London', *Economic Journal*, 32 (1922), 325–52.

Gilbert-Barness, Enid, and Debich-Spicer, Diane, *Embryo and Fetal Pathology: Color Atlas with Ultrasound Correlation* (Cambridge: Cambridge University Press, 2004).

Glaister, John, *Dr William Smellie and His Contemporaries: A Contribution to the History of Midwifery in the Eighteenth Century* (Glasgow: Maclehose, 1894).

Goldberg, Barry B., 'Obstetric US imaging: the past 40 years', *Radiology*, 215 (2000), 622–9.

Goldenberg, Robert L., Kirby, R., and Culhane, J. F., 'Stillbirth: a review', *Journal of Maternal-Fetal and Neonatal Medicine*, 16 (2) (2004), 79–94.

Goldenberg, Robert L., and Thompson, Cortney, 'The infectious origins of stillbirth', *American Journal of Obstetrics and Gynecology*, 189 (3) (2003), 861–73.

Goto, Aya, et al., 'Abortion trends in Japan, 1975–95', *Studies in Family Planning*, 31 (4) (2000), 301–08.

Gourbin, C., and Masuy-Stroobant, G., 'Registration of vital data: are live births and stillbirths comparable all over Europe?', *Bulletin of the World Health Organization*, 73 (4) (1995), 449–60.

Gowing, Laura, *Common Bodies: Women, Touch and Power in Seventeenth-century England* (New Haven, Conn.: Yale University Press, 2003).

Graetzer, Jonas, *Die Krankheiten des Foetus* (Breslau: Aderholz, 1837).

Granville, Augustus Bozzi, *A Report of the Practice of Midwifery, at the Westminster General Dispensary, During 1818* (London: Burgess and Hill, 1819).

——*Graphic Illustrations of Abortion and the Diseases of Menstruation* (London: Woodfall, 1833).

——'On certain phenomena, facts, and calculations, incidental to or connected with the power and act of propagation in females of the industrial classes in the metropolis; derived from the experience of two lying-in institutions, embracing a period of eleven years, during which upwards of 12,000 cases were carefully observed', *Transactions of the Obstetrical Society of London*, 2 (1860), 139–96.

Green, Monica H., *Making Women's Medicine Masculine: The Rise of Male Authority in Pre-modern Gynaecology* (Oxford: Oxford University Press, 2008).

Grove, Robert D., and Hetzel, Alan M., *Vital Statistics Rates in the United States, 1940–1960*, US National Center for Health Statistics (Washington, DC: US Government Printing Office, 1968).

Gruenwald, Peter, 'Growth of the human fetus: I. Normal growth and its variation; II. Abnormal growth in twins and infants of mothers with diabetes, hypertension, or isoimmunization', *American Journal of Obstetrics and Gynecology*, 94 (1966), 1112–32.

—— 'Influence of environmental factors on foetal growth in man', *Lancet*, 1 (1967), 1026–28.

Grundy, Isobel, 'Sarah Stone: enlightenment midwife', in Roy Porter (ed.), *Medicine in the Enlightenment* (Amsterdam: Rodopi, 1995), 128–44.

—— 'Stone [née Holmes], Sarah (*fl.* 1701–1737), midwife', *Oxford Dictionary of National Biography* (Oxford: Oxford University Press, 2004).

Gunn, Alistair L., 'The inevitable William and the accidental John', *Transactions of the Hunterian Society*, (1968), 87–103.

Gutierrez, Hector, and Houdaille, Jacques, 'La mortalité maternelle en France au XVIIIe siècle', *Population*, 38 (1983), 974–94.

Guy, William A., 'Two hundred and fifty years of smallpox in London', *Journal of the Statistical Society*, 45 (3) (1882), 399–433.

Haas-Posthuma, J. H. de, and Haas, J. H. de, *Infant Loss in the Netherlands*, US National Center for Health Statistics, 3rd ser., 11 (Washington, DC: US Government Printing Office, 1968).

Hadlock, Frank P., Harrist, Ronald B., and Martinez-Poyer, Juan, 'In utero analysis of fetal growth: a sonographic weight standard', *Radiology*, 181 (1991), 129–33.

Hanson, Clare, *A Cultural History of Pregnancy: Pregnancy, Medicine and Culture, 1750–2000* (London: Palgrave, 2004).

Harrison, Michael R., *Atlas of Fetal Surgery* (New York: Chapman & Hall, 1996).

—— Golbus, Mitchell S., and Filly, Roy A., *The Unborn Patient: Prenatal Diagnosis and Treatment* (New York: Grune & Stratton, 1984; Philadelphia, Pa.: Saunders, 2001).

Hart, Nicky, 'Beyond infant mortality: gender and stillbirth in reproductive mortality before the twentieth century', *Population Studies*, 52 (2) (1998), 215–22.

Hassett, Daniel E., 'Smallpox infections during pregnancy: lessons on pathogenesis from nonpregnant animal models of infection', *Journal of Reproductive Immunology*, 60 (2003), 13–24.

Hawkins, F. Bisset, *Elements of Medical Statistics*, ed. Richard Wall ([1829] London: Gregg, 1973).

Haygarth, John, 'Chester Bills of Mortality', *Philosophical Transactions of the Royal Society*, 64 (1774), 67–78; 65 (1775), 85–90; 68 (1778), 131–54.

Healthcare Commission, *Towards Better Births: A Review of Maternity Services in England* (London: Commission for Healthcare Audit and Inspection, 2008).

Heberden, William, *Observations on the Increase and Decrease of Different Diseases, and Particularly of the Plague* (London: Payne, 1801).

Heintel, Markus, and Baten, Joerg, 'Smallpox and nutritional status in England, 1770–1873: on the difficulties of estimating historical heights', *Economic History Review*, 51 (2) (1998), 360–71.

Hendricks, Frederick, 'On the vital statistics of Sweden, from 1749 to 1855', *Journal of the Statistical Society*, 25 (2) (1862), 111–74.

Henry, Louis, *Techniques d'analyse en démographie historique* (Paris: INED, 1980).

—— 'Mortalité intra-utérine et fécondabilité', *Population*, 19 (5) (1964), 899–940.

Hey, E. N., Lloyd, D. J., and Wigglesworth, J. S., 'Classifying perinatal death: fetal and neonatal factors', *British Journal of Obstetrics and Gynaecology*, 93 (1986), 1213–23.

Hibbard, Bryan, *The Obstetrician's Armamentarium: Historical Obstetric Instruments and their Inventors* (San Anselmo, Calif..: Norman, 2000).

Higgs, Edward, *Life, Death and Statistics: Civil Registration and the Work of the General Register Office, 1836–1952, Local Population Studies* supplement (Hatfield: Local Population Studies Society, 2004).

Hill, Kenneth, et al., 'Estimates of maternal mortality worldwide between 1990 and 2005: an assessment of available data', *Lancet*, 370 (2007), 1311–19.

Hinderaker, Sven G., et al., 'Avoidable stillbirths and neonatal deaths in rural Tanzania', *British Journal of Obstetrics and Gynaecology*, 110 (2003), 616–23.

Historisk Statistik för Sverige, Del 1. Befolkning, Andra Upplagan, 1720–1967 (Stockholm: Statistical Central Bureau, 1967).

Historisk Statistikk, 1978 (Oslo: Central Bureau of Statistics of Norway, 1978).

Hobbins, John C., *Obstetric Ultrasound: Artistry in Practice* (Oxford: Blackwell, 2008).

Högberg, Ulf, 'The decline in maternal mortality in Sweden: the role of community midwifery', *American Journal of Public Health*, 94 (8) (2004), 1312–20.

—— and Wall, Stig, 'Secular trends in maternal mortality in Sweden from 1750 to 1980', *Bulletin of the World Health Organization* 64 (1) (1986), 79–84.

Holland, Eardley, *The Causation of Foetal Death: Report of an Investigation into the Factors which determined Death in a Sample of Three Hundred Foetuses of Viable Age*, Ministry of Health, Reports on Public Health and Medical Subjects 7 (London: HMSO, 1922).

—— 'Causes of foetal death', *Journal of Obstetrics and Gynaecology of the British Empire* 29 (1922), pp. 549–71.

—— 'The Princess Charlotte of Wales: a triple obstetric tragedy', *Journal of Obstetrics and Gynaecology of the British Empire*, 58 (6) (1951), 905–19.

—— and Lane-Claypon, Janet E., *Child Life Investigations: A Clinical and Pathological Study of 1,673 Cases of Dead-births and Neonatal Deaths*, Medical Research Council, special report series, 109 (London: HMSO, 1926).

Hollingsworth, T. H., *The Demography of the British Peerage*, supplement to *Population Studies* 18 (2) (1964).

Holt, L. Emmett, and Babbitt, Ellen C., 'Institutional mortality of the new-born: a report on ten thousand consecutive births at the Sloane Hospital for Women, New York', *Journal of the American Medical Association*, 64 (4) (1915), 287–90.

Hoyert, D. L., *Perinatal Mortality in the United States, 1985–91*, US National Center for Health Statistics, *Vital Health Statistics* 20(26) (1995).

Hubbard, William H., 'The urban penalty: towns and mortality in nineteenth-century Norway', *Continuity and Change*, 15(2) (2000), 331–50.

Humphreys, Noel A., 'English vaccination and smallpox statistics; with special reference to the report of the Royal Commission, and to recent smallpox epidemics', *Journal of the Royal Statistical Society*, 60 (3) (1897), 503–51.

Hunter, John, 'Account of a woman who had the smallpox during pregnancy, and who seemed to have communicated the same disease to the foetus', *Philosophical Transactions of the Royal Society*, 70 (1780), 128–42.

Hunter, William, 'On the uncertainty of signs of murder in the case of bastard children', *Medical Observations and Enquiries*, 6 (1784), 206–90.

Huth, Edward, 'Quantitative evidence for judgments on the efficacy of inoculation for the prevention of smallpox: England and New England in the 1700s', *Journal of the Royal Society of Medicine*, 99 (2006), 262–66.

ISTAT, *Tendenze evolutive della mortalità infantile in Italia*, Annali di Statistica, 8th ser., 29 (Rome: ISTAT, 1975).

James, William H., 'The incidence of spontaneous abortion', *Population Studies*, 24 (2) (1970), 241–45.

Jardine, Robert, 'A year's work at the Glasgow Maternity Hospital', *Glasgow Medical Journal*, 50 (1898), 89–111.

Johansen, Hans Chr., *Danish Population History, 1600–1939* (Odense: University Press of Southern Denmark, 2002).

Johnstone, R. W., *William Smellie: The Master of British Midwifery* (Edinburgh: Livingstone, 1952).

Jordanova, Ludmilla J., 'Gender, generation and science: William Hunter's obstetrical atlas', in W. F. Bynum and Roy Porter (eds.), *William Hunter and the Eighteenth-Century Medical World* (Cambridge: Cambridge University Press, 1985), 385–412.

Keeling, J. W., et al., 'Classification of perinatal death', *Archives of Disease in Childhood*, 64 (1989), 1345–51.

Kerr, J. M. Munro, *Operative Midwifery* (London: Baillière, Tindall and Cox, 1908; fourth edn., as *Operative Obstetrics*, 1937).

—— 'The causes of stillbirth', *Glasgow Medical Journal*, 87 (1917), 283–91.

—— *Maternal Mortality and Morbidity: A Study of their Problems* (Edinburgh: Livingstone, 1933).

—— Johnstone, R. W., and Phillips, Miles H. (eds.), *Historical Review of British Obstetrics and Gynaecology, 1800–1950* (Edinburgh: Livingstone, 1954).

Kertzer, David I., *Amalia's Tale: A Poor Peasant, an Ambitious Attorney, and a Fight for Justice* (Boston: Houghton Mifflin, 2008).

Kim, Doo-Sub, 'Missing girls in South Korea: trends, levels and regional variation', *Population-E*, 59 (6) (2004), 865–78.

King, Helen, *Midwifery, Obstetrics and the Rise of Gynaecology: The Uses of a Sixteenth-century Compendium* (London: Ashgate, 2007).

King, Richard, *The Preservation of Infants in Delivery; being an exposition of the Chief Cause of Mortality in Still-born Children* (London: Churchill, 1847).

—— *The Cause of Death in the Still-born*, 2nd edn. (London: Churchill, 1858).

Kirkpatrick, T. Percy C., *The Book of the Rotunda Hospital: An Illustrated History of the Dublin Lying-in Hospital from its Foundation in 1745 to the Present Day,* ed. Henry Jellett (London: Allard, 1913).

Klein, Herbert S., *A Population History of the United States* (Cambridge: Cambridge University Press, 2004).

Kline, Jennie, Stein, Zena, and Susser, Mervyn, *Conception to Birth: Epidemiology of Prenatal Development* (New York: Oxford University Press, 1989).

Klukoff, Philip J., 'Smollett's defence of Dr Smellie in *The Critical Review*', *Medical History*, 14 (1) (1970), 31–41.

Knapp, Lewis Mansfield, *Tobias Smollett: Doctor of Men and Manner*s (Princeton, NJ: Princeton University Press, 1949).

Knodel, John E., and Kintner, Hallie,'The impact of breast feeding patterns on the biometric analysis of infant mortality', *Demography*, 14 (1977), 391–409.

Komlos, John, 'The secular trend in the biological standard of living in the United Kingdom, 1730–1860', *Economic History Review*, 46 (1) (1993), 115–44.

Korteweg, F. J., et al., 'The Tulip classification of perinatal mortality: introduction and multidisciplinary inter-rater agreement', *British Journal of Obstetrics and Gynaecology*, 113 (2006), 393–401.

Kowaleski, J., *State Definitions and Reporting Requirements for Live births, Fetal Deaths, and Induced Terminations of Pregnancy*, rev. edn. (Hyatsville, Md.: US National Center for Health Statistics, 1997).

Lachelin, Gillian C. L., *Miscarriage: The Facts*, 2nd edn. (Oxford: Oxford University Press, 1996).

Lalou, Richard, 'Endogenous mortality in New France: at the crossroads of natural and social selection', in Alain Bideau, Bertrand Desjardins, and Héctor Pérez Brignoli (eds.), *Infant and Child Mortality in the Past* (Oxford: Clarendon, 1997), 203–15.

Lambiganon, P. et al., 'The epidemiology of syphilis in pregnancy', *International Journal of STD and AIDS*, 13 (7) (2002), 486–94.

Landers, John, *Death and the Metropolis: Studies in the Demographic History of London, 1670–1830* (Cambridge: Cambridge University Press, 1993).

Lane, Joan, 'A provincial surgeon and his obstetric practice: Thomas W. Jones of Henley-in-Arden, 1764–1846', *Medical History*, 31 (1987), 333–48.

Langhoff-Roos, Jens, et al., 'Potentially avoidable perinatal deaths in Denmark, Sweden and Lithuania as classified by the Nordic–Baltic classification', *British Journal of Obstetrics and Gynaecology*, 105 (1998), 1189–94.

Laslett, Peter, *Family Life and Illicit Love in Earlier Generations* (Cambridge: Cambridge University Press, 1977).

Lawn, Joy, Shibuya, Kenji, and Stein, Claudia, 'No cry at birth: global estimates of intrapartum stillbirths and intrapartum-related neonatal deaths', *Bulletin of the World Health Organization*, 83 (6) (2005), 409–17.

Lee, Robert, *Clinical Midwifery: The Histories of Five Hundred and Forty-five Cases of Difficult, Preternatural, and Complicated Labour* (London: Churchill, 1842).

—— *Lectures on the Theory and Practice of Midwifery* (London: Longman, Brown, Green, and Longman, 1844).

—— *Three Hundred Consultations in Midwifery* (London: Churchill, 1864).

Le Fort, Léon, *Des maternités*: *Étude sur les maternités et les institutions charitables d'accouchement à domicile, dans les principaux états de l'Europe: France, Autriche, Prusse, Russie, Angleterre, Belgique, Danemark, Hollande, Etats allemands* (Paris: Masson, 1866).

Le Naour, Jean-Yves, and Valenti, Catherine, *Histoire de l'avortement, XIX–XXe siècle* (Paris: Seuil, 2003).

Leridon, Henri, *Human Fertility: The Basic Components* (Chicago, Ill.: University of Chicago Press, 1977).

Lewis, Judith Schneid, *In the Family Way: Childbearing in the British Aristocracy, 1760–1860* (New Brunswick, NJ: Rutgers University Press, 1986).

—— 'Maternal health in the English aristocracy: myths and realities, 1790–1840', *Journal of Social History*, 17 (1) (1983), 9–114.

—— '"'Tis a misfortune to be a Great Ladie": maternal mortality in the British aristocracy, 1558–1959', *Journal of British Studies*, 37 (1998), 26–53.

Lieburg, M. J. van, *Nieuw licht op Hendrik van Deventer (1651–1724*), Erasmus University Medical Historical Papers 1 (Rotterdam: Erasmus, 2002).

—— and Marland, Hilary, 'Midwifery regulation, education, and practice in the Netherlands during the nineteenth century', *Medical History*, 33 (1989), 296–317.

Lieske, Pam, (ed.), *Eighteenth-century British Midwifery*, pt. I, vols. 1–4 (2007); pt. II, vols. 5–8 (2008); pt. III, vols. 9–12 (2009) (London: Pickering and Chatto, 2007–9).

—— 'William Smellie's use of obstetric machines and the poor', *Studies in Eighteenth-century Culture*, 29 (2000), 65–86.

Linder, Forrest E., and Grove, Robert D., *Vital Statistics Rates in the United States, 1900–1940*, US National Office of Vital Statistics (Washington, DC: US Government Printing Office, 1947).

Livi Bacci, Massimo, 'Introduction', in Alain Bideau, Bertrand Desjardins, and Héctor Pérez Brignoli (eds.), *Infant and Child Mortality in the Past* (Oxford: Clarendon, 1997), 1–4.

Løkke, Anne, *Døden i barndommen: Spaedbørnsdødelighed og moderniseringsprocesser i Danmark, 1800 til 1920* (Copenhagen: Gyldendal, 1998).

—— 'No difference without a cause: infant mortality rates as a world-view generator', *Scandinavian Journal of History*, 20 (2) (1995), 75–96.

—— 'The "antiseptic" transformation of Danish midwives, 1860–1920', in Hilary Marland and Anne Marie Rafferty (eds.), *Midwives, Society and Childbirth: Debates and Controversies in the Modern Period* (London: Routledge, 1997), 102–33.

—— 'Did midwives matter? 1787–1845', in Hilde Sandvik, Kari Telste, and Gunnar Thorvaldsen (eds.), *Pathways of the Past: Essays in Honour of Sølvi Sogner*, Time and Thought 7, Department of History, University of Oslo (Oslo: Novus, 2002), 59–72.

Lopez, A. D., et al., *Life Tables for 191 Countries for 2000: Data, Methods, Results*, GPE Discussion Paper 40 (Geneva: WHO, 2001).

Loudon, Irvine, *Medical Care and the General Practitioner, 1750–1850* (Oxford: Clarendon, 1986).

—— *Death in Childbirth: An International Study of Maternal Care and Maternal Mortality, 1800–1950* (Oxford: Clarendon, 1992).

—— *The Tragedy of Childbed Fever* (Oxford: Oxford University Press, 2000).

—— 'On maternal and infant mortality, 1900–1960', *Social History of Medicine*, 4(1) (1991), 29–73.

—— 'Review essay: The making of man-midwifery', *Bulletin of the History of Medicine*, 70 (3) (1996), 507–15.

—— 'General practitioners and obstetrics: a brief history', *Journal of the Royal Society of Medicine*, 101 (2008), 531–5.

Lurie, Samuel, and Glezerman, Marek, 'The history of cesarean technique', *American Journal of Obstetrics and Gynecology*, 189 (6) (2003), 1803–6.

Lynch, Katherine A., Greenhouse, Joel B., and Brändstrom, Anders, 'Biometric modeling in the study of infant mortality: evidence from nineteenth-century Sweden', *Historical Methods*, 31 (2) (1998), 53–64.

McCalman, Janet, and Morley, Ruth, 'Mothers' health and babies' weights: the biology of poverty in the Melbourne Lying-in Hospital, 1857–83', *Social History of Medicine*, 16 (2003), 39–56.

McClure, Elizabeth M., et al., 'The global network: a prospective study of stillbirths in developing countries', *American Journal of Obstetrics and Gynecology* 197 (2007), 247–51.

McCowan, Lesley M. E., Harding, Jane E., and Stewart, Alastair W., 'Customised birthweight centiles predict SGA pregnancies with perinatal morbidity', *British Journal of Obstetrics and Gynaecology* 112 (2005), 1026–33.

Macfarlane, Alison, and Mugford, Miranda, *Birth Counts: Statistics of Pregnancy and Childbirth*, i–ii (text/tables) (London: HMSO, 2000).

Macgregor, Agnes R., 'The pathology of stillbirth and neonatal death: a review of 1053 cases', *British Medical Bulletin*, 4 (3) (1946), 174–8.

McIntosh, Tania, 'Profession, skill, or domestic duty? Midwifery in Sheffield, 1881–1936', *Social History of Medicine*, 11 (3) (1998), 403–20.

—— ' "An abortionist city": maternal mortality, abortion, and birth control in Sheffield, 1920–1940', *Medical History*, 44 (2000), 75–96.

McKeown, Thomas, *The Modern Rise of Population* (London: Edward Arnold, 1976).

—— and Brown, R. G., 'Medical evidence related to English population changes in the eighteenth century', *Population Studies* 9 (2) (1955), 119–41.

McLaren, Angus, 'Abortion in France: women and the regulation of family size, 1800–1914', *French Historical Studies*, 10 (1978), 46–85.

—— *Reproductive Rituals: The Perception of Fertility in England from the Sixteenth Century to the Nineteenth Century* (London: Methuen, 1984).

McClintock, Alfred H., and Hardy, Samuel L., *Practical Observations on Midwifery and the Diseases Incident to the Puerperal State* (Dublin: Hodges and Smith, 1848).

McNay, Margaret B., and Fleming, John E. E.,'Forty years of obstetric ultrasound, 1957–1997: from A-scope to three dimensions', *Ultrasound in Medicine and Biology*, 25 (1) (1999), 3–56.

McTavish, Lianne, 'Blame and vindication in the early modern birthing chamber', *Social History of Medicine*, 50 (2006), 447–64.

Madge, Henry, *The Diseases of the Foetus in Utero (Not Including Malformations): With an Outline of Foetal Development* (London: Renshaw, 1854).

Mahy, Mary, *Childhood Mortality in the Developing World: A Review of Evidence from the Demographic and Health Surveys*, DHS Comparative Reports 4 (Calverton, Md.: ORC Macro, 2003).

Mall, Franklin Paine, and Meyer, Arthur William, *Studies on Abortuses: A Survey of Pathologic Ova in the Carnegie Embryological Collection*, Contributions to Embryology 56 (Washington DC: Carnegie Institution of Washington (publication 275), 1921).

Marland, Hilary (ed.), *'Mother and Child Were Saved' The Memoirs (1693–1740) of the Frisian Midwife Catharina Schrader*, trans. and annot. Hilary Marland, with introductory essays by M. J. van Lieburg and G. J. Kloosterman (Amsterdam: Rodopi, 1987).

—— and Rafferty, Anne Marie (eds.), *Midwives, Society and Childbirth: Debates and Controversies in the Modern Period* (London: Routledge, 1997).

Marlow, Neil, 'Outcome following extremely preterm birth', *Current Obstetrics and Gynaecology*, 16 (3) (2006), 141–6.

Marshall, John, *Mortality of the Metropolis* (London: Treuttel, Würtz, and Richter, 1832).

Massey, Lyle, 'Pregnancy and pathology: picturing childbirth in eighteenth-century obstetric atlases', *Art Bulletin* 87 (1) (2005), 73–91.

Mathew, George Porter, *Clinical Observations on 2000 Obstetric Cases* (London: Simpkin, Marshall, Hamilton, Kent, 1898).

Matthiesen, P. C., Trolle, D., and Zachau-Christiansen, B., *Infant and Perinatal Mortality in Denmark*, US National Center for Health Statistics, 3rd ser., 9 (Washington, DC: US Government Printing Office, 1967).

Milnes, Alfred, 'Statistics of smallpox and vaccination, with special reference to age-incidence, sex-incidence, and sanitation', *Journal of the Royal Statistical Society*, 60 (3) (1897), 552–612.

Ministry of Health, *Interim Report of Inter-departmental Committee on Maternal Mortality and Morbidity* (London: Ministry of Health, 1930).

——*Report of the Inter-departmental Committee on Abortion* (London: Ministry of Health, 1939).

Mooney, Graham, 'Still-births and the measurement of urban infant mortality rates *c*.1890–1930', *Local Population Studies*, 53 (1994), 42–52.

Morris, J. N., et al., 'Social and biological factors in infant mortality', *Lancet*, 1 (1955), 343–9, 395–7, 445–8, 499–502, 554–9.

Mosley, W. Henry, and Chen, Lincoln C., 'An analytical framework for the study of child survival in developing countries', *Population and Development Review*, supplement to vol. 10 (1984), 25–45.

Mouat, F. J., 'Note on the statistics of childbirth in the lying-in wards of the workhouse infirmaries of England and Wales for the ten years, 1871–80', *Transactions of the International Medical Congress, London, 1881* (London, 1881), 392–4.

Muramatsu, Minoru, 'Effect of induced abortion on the reduction of births in Japan', *Milbank Memorial Fund Quarterly*, 38 (2) (1960), 153–66.

Murphy, Edward William, *A Report on the Obstetric Practice of University College Hospital, London* (Dublin: Hodges and Smith, 1844).

Murray, M. Bruce, *The Effect of Maternal Social Conditions and Nutrition upon Birth-weight and Birth-length*, 81 (London: HMSO, 1924).

Nankivell, P. H., 'Certificate of attendance at William Smellie's lectures, 1757', *Medical History*, 1 (1957), 279–81.

Needham, Joseph, *A History of Embryology* (Cambridge: Cambridge University Press, 1934; 2nd edn. 1959).

Newman, Karen, *Fetal Positions: Individualism, Science, Visuality* (Stanford, Calif.: Stanford University Press, 1996).

Newsholme, Arthur, *The Elements of Vital Statistics in their Bearing on Social and Public Health Problems* (London: George Allen & Unwin, 1889).

Ngoc, Nhu Thi Nguyen, et al., 'Causes of stillbirths and early neonatal deaths: data from 7,993 pregnancies in six developing countries', *Bulletin of the World Health Organization*, 84 (9) (2006), 699–705.

Nicopoullos, J. D. M., '"Midwifery is not a fit occupation for a gentleman"', *Journal of Obstetrics and Gynaecology*, 23 (6) (2003), 589–93.

Nightingale, Florence, *Introductory Notes on Lying-in Institutions* (London: Longmans, Green, 1871).

Nishiura, Hiroshi, 'Smallpox during pregnancy and maternal outcomes', *Emerging Infectious Diseases*, 12 (7) (2006), 1119–21.

Norgren, Tiana, *Abortion Before Birth Control: The Politics of Reproduction in Postwar Japan* (Princeton, NJ: Princeton University Press, 2001).

Nuttall, Alison, 'Passive trust or active application: changes in the management of difficult childbirth and the Edinburgh Royal Maternity Hospital, 1850–1890', *Medical History*, 50 (2006), 351–72.

Osborn, John F., Cattaruzza, Maria Sofia, and Spinelli, Angela, 'Risk of spontaneous abortion in Italy, 1978–1995, and the effect of maternal age, gravidity, marital status, and education', *American Journal of Epidemiology*, 151 (1) (2000), 98–105.

Packard, Randall M., *The Making of a Tropical Disease: A Short History of Malaria* (Baltimore, Md.: Johns Hopkins University Press, 2007).

Palmer, A. C., *The Cause of Foetal Death in 144 Cases*, Medical Research Council, Special Report Series 118 (London: HMSO, 1928).

Park, Katharine, *Secrets of Women: Gender, Generation, and the Origins of Human Dissection* (New York: Zone, 2006).

——'The death of Isabella Della Volpe: four eyewitness accounts of a postmortem caesarean section in 1545', *Bulletin of the History of Medicine*, 82 (1) (2008), 169–87.

Parry, L. A., *Criminal Abortion* (London: Bale, Sons & Danielsson, 1932),

Paton, Diarmid Noël, and Findlay, Leonard, *Studies of Child Life in Cities and Rural Districts of Scotland*, 101 (London: HMSO, 1926).

Patterson, Alexander, 'Statistics of Glasgow Lock Hospital since its foundation in 1805: with remarks on the Contagious Diseases Acts, and on syphilis', *Glasgow Medical Journal*, 18 (6) (1882), 401–18.

Pattinson, R. C., De Jong, G., and Theron, G. B., 'Primary causes of total perinatally related wastage at Tygerberg Hospital', *South African Medical Journal*, 75 (1989), 50–3.

Pearl, Raymond, *The Biology of Death* (Philadelphia, Pa.: Lippincott, 1922).

Pearson, Karl, 'The chances of death', in Pearson, *The Chances of Death and Other Studies in Evolution* (London: Edward Arnold, 1897), 1–41.

Peckham, C. H., 'Statistical studies on prematurity', *Journal of Pediatrics*, 13 (1938), 474–97.

Phillips, Leslie, *Pathology and Treatment of Abortion* (Birmingham: Cornish, 1887).

Phillips, Miles H., 'William Smellie and the maternal mortality problem', *Transactions of the Edinburgh Obstetrical Society*, 92 (1933), 130–56.

——'Men-midwives of the past', *Bristol Medico-chirurgical Journal*, 52 (196) (1935), 83–102.

——*Percival Willughby, Gentleman: A Man-midwife of the Seventeenth Century*, Lloyd Roberts Memorial Lecture, delivered at St Mary's Hospital, Manchester, 14 November 1952 (Manchester: St Mary's Hospital, 1952).

Pitkin, R. M., 'Fetal death: diagnosis and management', *American Journal of Obstetrics and Gynecology*, 157 (1987), 583–89.

Poppel, Frans van, 'Historical trends in mortality around birth in the Netherlands: registration practices, trends and regional differences in the nineteenth and early twentieth centuries', unpublished paper presented at the Social Science History Association conference, Baltimore, Md., November 2003.

Potter, Edith L., *Pathology of the Fetus and the Newborn* (Chicago, Ill.: Year Book, 1952).

——and Adair, Fred L., *Fetal and Neonatal Death* (Chicago, Ill.: University of Chicago Press, 1940, 2nd edn. 1949).

Potts, Malcolm, Diggory, Peter, and Peel, John, *Abortion* (Cambridge: Cambridge University Press, 1977).

Poulain, Michel, and Tabutin, Dominique, 'Mortalité aux jeunes âges en Belgique de 1840 à 1970', *Population et Famille*, 42 (3) (1977), 49–73.

Pressat, Roland, *The Dictionary of Demography*, ed. Christopher Wilson (Oxford: Blackwell, 1985),

Priestley, William O., *Lectures on the Development of the Gravid Uterus* (London: Churchill, 1860).

Priestley, William O., *The Pathology of Intra-uterine Death*, Lumleian Lectures, delivered at the Royal College of Physicians of London, March 1887 (London: Churchill, 1887).

—— 'On the treatment of cases of abortion in which the placenta and membrane are retained', *Transactions of the Obstetrical Society of London*, 3 (1861), 146–71.

Ramsbotham, Francis H., *The Principles and Practice of Obstetric Medicine and Surgery, in Reference to the Process of Parturition*, 5th edn. (London: Churchill, 1867).

Rao, A. R., *Smallpox* (Bombay: Kothari, 1972).

—— 'Haemorrhagic smallpox', *Journal of the Indian Medical Association*, 43 (1964), 224–9.

—— et al., 'Pregnancy and smallpox', *Journal of the Indian Medical Association*, 40 (1963), 353–63.

Razzell, Peter, *The Conquest of Smallpox* (Firle: Caliban, 1977).

—— 'Population change in eighteenth-century England a reinterpretation', *Economic History Review*, 18 (2) (1965), 312–32.

—— and Spence, Christine, 'The hazards of wealth: adult mortality in pre-twentieth-century England', *Social History of Medicine*, 19 (3) (2006), 381–405.

—— and —— 'The history of infant, child and adult mortality in London, 1550–1850', *London Journal*, 32 (3) (2007), 271–92.

Reddy, Uma M., Ko, Chia-Wen, and Willinger, Marian, 'Maternal age and the risk of stillbirth throughout pregnancy in the United States', *American Journal of Obstetrics and Gynecology*, 195 (2006), 764–70.

Registrar General, *Annual Statistical Review of England and Wales for the Year 1927* (London: HMSO, 1929).

Reid, James, *Manual of Practical Midwifery: Containing a Description of Natural and Difficult Labours, with their Management. Intended Chiefly as a Book of Reference for Students and Junior Practitioners* (London: Churchill, 1836).

Reiss, H. E., 'Historical insights: John William Ballantyne 1861–1923', *Human Reproduction Update,* 5(4) (1999), 386–9.

Rentoul, Robert Reid, *The Causes and Treatment of Abortion* (Edinburgh: Pentland, 1889).

Rifkin, Benjamin A., Ackerman, Michael J., and Folkenberg, Judith, *Human Anatomy: Depicting the Body from the Renaissance to Today* (London: Thames & Hudson, 2006).

Rigby, Edward, *A System of Midwifery* (London: Whittaker, 1841).

Roberts, K. B., and Tomlinson, J. D. W., *The Fabric of the Body: European Traditions of Anatomical Illustration* (Oxford: Clarendon, 1992).

Rollet, Catherine, 'La statistique des décès des enfants et des mort-nés dans la ville de Paris et le département de la Seine au XIXe siècle', unpublished paper presented at the workshop on 'Fetal and neonatal mortality: historical perspectives on the borderline between life and death', Spanish Council for Scientific Research, Madrid, 10–11 June 2008.

Roosmalen, J. van, 'Perinatal mortality in rural Tanzania', *British Journal of Obstetrics and Gynaecology*, 96 (1989), 827–34.

Rosenberg, Margit, 'Birth weights in three Norwegian cities, 1860–1984: secular trends and influencing factors', *Annals of Biology*, 15 (1988), 275–88.

Ross, Ian Campbell, 'Midwifery', in Ross (ed.), *Public Virtue, Public Love: The Early Years of the Dublin Lying-in Hospital, The Rotunda* (Dublin: O'Brien, 1986), 125–64.

Rousseau, George S., 'Pineapples, pregnancy, pica, and *Peregrine Pickle*', in G. S. Rousseau and P. G. Boucé (eds.), *Tobias Smollett: Bicentennial Essays Presented to Lewis M. Knapp* (New York: Oxford University Press, 1971), 79–109.

Royal Commission on Venereal Diseases, *Final Report* (Cd 8189) (London: HMSO, 1916).

Royal Statistical Society, *Infantile Mortality: Report of the Special Committee Appointed by the Council of the Royal Statistical Society to Enquire into the Systems Adopted in Different Countries for the Registration of Births (Including Stillbirths) and Deaths with Reference to Infantile Mortality* (London: Royal Statistical Society, 1912).

Ruddick, Sue, 'At the horizons of the subject: neo-liberalism, neo-conservatism and the rights of the child, pt. I: From "knowing fetus" to "confused" child'; 'pt. II: Parent, caregiver, state', *Gender, Place and Culture*, 14 (5) (2007), 513–26; 14(6) (2007), 627–40.

Rusnock, Andrea, *Vital Accounts: Quantifying Health and Population in Eighteenth-century England and France* (Cambridge: Cambridge University Press, 2002).

—— (ed.), *The Correspondence of James Jurin (1684–1750): Physician and Secretary to the Royal Society* (Amsterdam: Rodopi, 1996).

Russell, Helen, *J. W. Ballantyne, MD, FRCPEdin, FRSE, 1861–1923*, Royal College of Physicians of Edinburgh publication 39 (Edinburgh: Royal College of Physicians, 1971).

Rutten, Willibrord, *'De vreselijkste aller harpijen': Pokkenepidemieen enpokkenbestrijding in Nederland in de achttiende en negentiende eeuw: een sociaal-historische en historisch-demografische studie, AAG Bijdragen*, 36 (1997).

—— 'Smallpox, subfecundity, and sterility: a case study from a nineteenth-century Dutch municipality', *Social History of Medicine*, 6 (1) (1993), 85–99.

Salihu, H. M., et al., 'Racial disparity in stillbirth among singleton, twin, and triplet gestations in the United States', *Obstetrics and Gynecology*, 104 (2004), 734–40.

Sallares, Robert, Bouwman, Abigail, and Anderung, Cecilia, 'The spread of malaria to southern Europe in antiquity: new approaches to old problems', *Medical History*, 48 (2004), 311–28.

Saloojee, Haroon, et al., 'The prevention and management of congenital syphilis: an overview and recommendations', *Bulletin of the World Health Organization*, 82 (6) (2004), 424–30.

Santow, Gigi, review of John M. Riddle, *Eve's Herbs* (*Population and Development Review*, 24 (4) (1998), 869–75.

Sato, Ryuzaburo, and Iwasawa, Miho, 'Contraceptive use and induced abortion: how is it so unique among developed countries?', *Japanese Journal of Population*, 4 (1) (2006), 33–54.

Sauer, R., 'Infanticide and abortion in nineteenth-century Britain', *Population Studies*, 32 (1) (1978), 81–93.

Schiebinger, Londa, 'Skeletons in the closet: the first illustrations of the female skeleton in eighteenth-century anatomy', *Representations*, 14 (1986), 42–81.

Schlesinger, Edward R., and Allaway, Norman, 'Trends in familial susceptibility to perinatal loss', *American Journal of Public Health* 45 (1955), 174–83.

Schnorrenberg, Barbara Brandon, 'Is childbirth any place for a woman? The decline of midwifery in eighteenth-century England', *Studies in Eighteenth-century Culture*, 10 (1981), 393–408.

Schofield, Roger, 'Perinatal mortality in Hawkshead, Lancashire, 1581–1710', *Local Population Studies*, 4 (1970), 11–16.

—— 'Did the mothers really die? Three centuries of maternal mortality in "The World We Have Lost"', in Lloyd Bonfield, Richard M. Smith, and Keith Wrightson (eds.), *The World We Have Gained* (Oxford: Blackwell, 1986), 231–60.

—— Reher, David, and Bideau, Alain (eds.), *The Decline of Mortality in Europe* (Oxford: Clarendon, 1991).

Schultz, Adolph H., 'Sex-incidence in abortions', in Franklin Paine Mall and Arthur William Meyer, *Studies on Abortuses: A Survey of Pathologic Ova in the Carnegie Embryological Collection*, Contributions to Embryology 56 (Washington DC: Carnegie Institution of Washington, (publication 275), 1921), 177–91.

Scott, Susan, and Duncan, Christopher J., *Human Demography and Disease* (Cambridge: Cambridge University Press, 1998).

Sedgh, Gilda, et al., 'Induced abortion: estimated rates and trends worldwide', *Lancet*, 370 (2007), 1338–45.

Shapiro, Sam, Jones, Ellen W., and Densen, Paul M., 'A life table of pregnancy terminations and correlates of fetal loss', *Milbank Memorial Fund Quarterly*, 40 (1962), 7–45.

—— Schlesinger, Edward R., and Nesbitt, Robert E. L., *Infant and Perinatal Mortality in the United States*, US National Center for Health Statistics, 3rd ser., 4 (Washington, DC: US Government Printing Office, 1965).

—— —— and —— *Infant, Perinatal, Maternal, and Childhood Mortality in the United States* (Cambridge, Mass.: Harvard University Press, 1968).

Shuttleton, David E., *Smallpox and the Literary Imagination, 1660–1820* (Cambridge: Cambridge University Press, 2007).

Silver, Robert M., 'Fetal death', *Obstetrics and Gynecology*, 109 (1) (2007), 153–67.

Simpson, Alexander R., 'Introduction to a discussion on intrauterine death: its pathology and preventive treatment', *British Medical Journal*, 2 (1888), 866–9.

Simpson, James Y., *Contributions to Obstetric Pathology and Practice* (Edinburgh: Sutherland and Knox, 1853).

Sköld, Peter, *The Two Faces of Smallpox: A Disease and its Prevention in Eighteenth- and Nineteenth-century Sweden*, Demographic Database, Umeå University, Report 12 (Umeå: Umeå University Press, 1996).

—— 'From inoculation to vaccination: smallpox in Sweden in the eighteenth and nineteenth centuries', *Population Studies*, 50 (1996), 247–62.

—— 'The key to success: the role of local government in the organization of smallpox vaccination in Sweden', *Medical History*, 45 (2000), 201–26.

—— 'The birth of population statistics in Sweden', *History of the Family*, 9 (1) (2004), 5–21.

Smith, Gordon C. S., and Fretts, Ruth C., 'Stillbirth', *Lancet*, 370 (2007), 1715–25.

Smith, J. R., *The Speckled Monster: Smallpox in England, 1670–1970, With Special Reference to Essex* (Chelmsford: Essex Record Office, 1987).

Smith, Richard M., and Oeppen, Jim, 'Place and status as determinants of infant mortality *c*.1550–1837', in Eilidh Garrett, et al. (eds.), *Infant Mortality: A Continuing Social Problem* (London: Ashgate, 2006), 53–78.

Smith, W. Tyler, *A Manual of Obstetrics: Theoretical and Practical* (London: Churchill, 1858).

Sogner, Sølvi, 'Abortion, birth control, and contraception: fertility decline in Norway', *Journal of Interdisciplinary History*, 34 (2) (2003), 209–34.

Spencer, Herbert R., *The History of British Midwifery from 1650 to 1800*, Fitz-Patrick Lectures for 1927, delivered before the Royal College of Physicians of London (London: Bale, Sons, & Danielsson, 1927).

Stark, J. Nigel (ed.), 'An obstetric diary of William Hunter, 1762–65', *Glasgow Medical Journal*, 70 (1908), 167–77, 241–56, 338–56.

Statisk over Folkemaengdens Bevaegelse i Aarene 1876–1880 (Kristiana: Statistiske Centralbureau, 1883).

Steckel, Richard H., 'Birth weights and stillbirths in historical perspective', *European Journal of Clinical Nutrition*, 1st ser., 52 (1998), 15–20.

Sterne, Laurence, *The Life and Opinions of Tristram Shandy, Gentleman* ([1759–67]Oxford: Oxford University Press, 1998).

Stevenson, A. C., et al., 'Observations on the results of pregnancies in women resident in Belfast', *Annals of Human Genetics*, 23 (4) (1958), 382–420.

Streeter, J. S., *Practical Observations on Abortion* (London: Sherwood, Gilbert and Piper, 1840).

Suarez, Victor R., and Hankins, Gary D. V., 'Smallpox and pregnancy: from eradicated disease to bioterrorist threat', *Obstetrics and Gynecology*, 100 (2002), 87–93.

Sutherland, Ian, *Stillbirths: Their Epidemiology and Social Significance* (London: Oxford University Press, 1949).

Taeuber, Irene B., *The Population of Japan* (Princeton, NJ: Princeton University Press, 1958), 275–83.

Tanner, J. M., *A History of the Study of Human Growth* (Cambridge: Cambridge University Press, 1981).

—— *Foetus into Man: Physical Growth from Conception to Maturity*, 2nd edn. (Ware: Castlemead, 1989).

Tardieu, Ambroise, *Étude médico-légale sur l'avortement: suivie d'une note sur l'obligation de déclarer a l'état civil les foetus mort-nés et d'observations et recherches pour servir å l'histoire médico-légale des grossesses fausses et simulées*, 3rd edn. (Paris: Baillière, 1868).

Taussig, Frederick J., *The Prevention and Treatment of Abortion* (London: Keener, 1910).

—— *Abortion: Spontaneous and Induced, Medical and Social Aspects* (London: Henry Kimpton, 1936).

Teijlingen, Edwin van, 'The man and his vision. Sir Dugald Baird: three decades of transforming work in reproductive health', in Sarah James (ed.), *Evidence and Action: A Decade of Research on Women's Health, 1995–2005* (Aberdeen: Dugald Baird Centre for Research on Women's Health, 2005), 6–9.

—— et al. (eds.), *Midwifery and the Medicalization of Childbirth: Comparative Perspectives* (New York: Nova, 2004).

Thomas, James, and Williams, A. Susan, 'Women and abortion in 1930s Britain: a survey and its data', *Social History of Medicine*, 11 (2) (1998), 283–309.

Thornton, John L., *Jan van Rymsdyk: Medical Artist of the Eighteenth Century* (Cambridge: Oleander, 1982).

—— and Want, Patricia C., 'William Hunter (1718–1783) and his contributions to obstetrics', *British Journal of Obstetrics and Gynaecology*, 90 (1983), 787–94.

Thorvaldsen, Gunnar, 'Rural infant mortality in nineteenth-century Norway', *Hygiea Internationalis*, 3 (1) (2002), 75–113.

Todman, Donald, 'A history of caesarean section: from ancient world to the modern era', *Australian and New Zealand Journal of Obstetrics and Gynaecology*, 47 (2007), 357–61.

Tomkins, Alannah (ed.), 'The registers of a provincial man-midwife, Thomas Higgins of Wem, 1781–1803', in D. C. Cox (ed.), *Shropshire Historical Documents: A Miscellany*, Shropshire Record Series 4 (Keele: University of Keele, 2000), 65–148.

Ulrich, Laurel Thatcher, ' "The living mother of a living child": midwifery and mortality in post-revolutionary New England', *William and Mary Quarterly*, 46 (1) (1989), 27–48.

——*A Midwife's Tale: The Life of Martha Ballard Based on Her Diary, 1785–1812* (New York: Knopf, 1990).

UN, *Foetal, Infant and Early Childhood Mortality, i. The Statistics; ii, Biological, Social and Economic Factors*, United Nations, Department of Social Affairs, Population Division, Population Studies 13 (New York: United Nations, 1954).

——*Abortion Policies: A Global Review*, United Nations, Population Division (New York: United Nations, 2003).

Vallgårda, Signild, 'Trends in perinatal death rates in Denmark and Sweden, 1915–1990', *Paediatric and Perinatal Epidemiology*, 9 (1995), 201–18.

——'Hospitalization of deliveries: the change of place of birth in Denmark and Sweden from the late nineteenth century to 1970', *Medical History*, 40 (1996), 173–96.

Vallin, Jacques, 'Mortality in Europe from 1720 to 1914: long-term trends and changes in patterns by age and sex', in Roger Schofield, David Reher, and Alain Bideau (eds.), *The Decline of Mortality in Europe* (Oxford: Clarendon, 1991), 38–67.

——and Meslé, France, *Tables de mortalité françaises pour les XIXe et XXe siècles et projections por le XXIe siècle* (Paris: INED, 2001).

Vandresse, Marie, 'Estimation of a structural model of the determinants of neonatal mortality in Hungary, 1984–88 and 1994–98', *Population Studies*, 62 (1) (2007), 85–111.

Vergani, Patrizia, et al., 'Identifying the causes of stillbirth: a comparison of four classification systems', *American Journal of Obstetrics and Gynecology*, 199 (3) (2008), 319–22.

Versluysen, Margaret Connor, 'Midwives, medical men and "poor women labouring of child": lying-in hospitals in eighteenth-century London', in Helen Roberts (ed.), *Women, Health and Reproduction* (London: Routledge & Kegan Paul, 1981), 18–49.

Villar, José, and Belizán, José M., 'The relative contribution of prematurity and fetal-growth retardation to low birth weight in developing and developed societies', *American Journal of Obstetrics and Gynecology*, 143 (7) (1982), 793–98.

Walle, Etienne van de, *The Female Population of France in the Nineteenth Century: A Reconstruction of 82 Départements* (Princeton, NJ: Princeton University Press, 1974).

Ward, W. Peter, *Birth Weight and Economic Growth: Women's Living Standards in the Industrializing West* (Chicago, Ill.: University of Chicago Press, 1993).

Weinberg, Eugene D., 'Pregnancy-associated depression of cell-mediated immunity', *Reviews of Infectious Diseases*, 6 (6) (1984), 814–31.

Whipple, George Chandler, *Vital Statistics: An Introduction to the Science of Demography* (New York: Wiley, 1919).

Whitehead, James, *On the Causes and Treatment of Abortion and Sterility: Being the Result of an Extended Practical Inquiry into the Physiological and Morbid Conditions* *of the Uterus, with Reference especially to Leucorrhoeal Affections and the Diseases of Menstruation* (London: Churchill, 1847).

—— *On the Transmission, from Parent to Offspring, of some Forms of Disease, and of Morbid Taints and Tendencies* (London: Churchill, 1851).

—— *The Rate of Mortality in Manchester and Other Manufacturing Towns, Compared with that of Cathedral and County Towns*, 3rd, enlarged, edn. (London: Churchill, 1864).

—— and Merei, A. Schoepf, *First Report of the Clinical Hospital for Diseases of Children, Stevenson Square, Manchester: Containing an Account of the Results of the First 530 Patients there Treated* (Manchester: Bradshaw & Blacklock, 1856).

Whitfield, C. R., et al., 'Perinatally related wastage: a proposed classification of primary obstetric factors', *British Journal of Obstetrics and Gynaecology*, 93 (1986), 694–703.

Whitty, Christopher J. M., Edmonds, Sally, and Mutabingwa, Theonest K., 'Malaria in pregnancy', *British Journal of Obstetrics and Gynaecology*, 112 (2005), 1189–95.

WHO, *Making Pregnancy Safer: The Critical Role of the Skilled Attendant. A Joint Statement by WHO, ICM and FIGO* (Geneva: World Health Organization, 2004).

—— *Maternal Mortality in 2000: Estimates Developed by WHO, UNICEF, UNFPA* (Geneva: World Health Organization, 2004).

—— *Unsafe Abortion: Global and Regional Estimates of the Incidence of Unsafe Abortion and Associated Mortality in 2000*, 4th edn. (Geneva: World Health Organization, 2004).

—— *Neonatal and Perinatal Mortality: Country, Regional and Global Estimat*es (Geneva: World Health Organization, 2006).

—— *Skilled Attendant at Birth, 2006 Updates* (Geneva: World Health Organization, 2006).

—— *Closing the Gap in a Generation: Health Equity through Action on the Social Determinants of Health*, Commission on Social Determinants of Health, Final Report (Geneva: World Health Organization, 2008).

Wigglesworth, Jonathan S., *Perinatal Pathology* (Philadelphia, Pa.: Saunders, 1984; 2nd edn. 1996).

—— 'Monitoring perinatal mortality: a pathophysiological approach', *Lancet*, 2 (1980), 684–86.

Wilcox, Allen J., and Horney, Louise F., 'Accuracy of spontaneous abortion recall', *American Journal of Epidemiology*, 120 (5) (1984), 727–33.

—— et al., 'Incidence of early loss of pregnancy', *New England Journal of Medicine*, 319 (4) (1988), 189–94.

Williams, J. Whitridge, 'The limitation and possibilities of pre-natal care', *Journal of the American Medical Association*, 64 (1915), 75–82.

Williamson, Paul, and Woods, Robert, 'A note on the fetal-infant mortality problem', *Journal of Biosocial Science*, 35 (2003), 201–12.

Wilson, Adrian, *The Making of Man-midwifery: Childbirth in England, 1660–1770* (Cambridge, Mass.: Harvard University Press, 1995).

—— 'William Hunter and the varieties of man-midwifery', in W. F. Bynum and Roy Porter (eds.), *William Hunter and the Eighteenth-century Medical World* (Cambridge: Cambridge University Press, 1985), 343–69.

Wood, James W., *Dynamics of Human Reproduction: Biology, Biometry, Demography* (New York: de Gruyter, 1994).

Woods, Robert, *The Demography of Victorian England and Wales* (Cambridge: Cambridge University Press, 2000).

Woods, Robert, *Children Remembered: Responses to Untimely Death in the Past* (Liverpool: Liverpool University Press, 2006).

—— 'The measurement of historical trends in fetal mortality in England and Wales', *Population Studies*, 59 (2) (2005), 147–62.

—— 'Mortality in eighteenth-century London: a new look at the Bills', *Local Population Studies*, 77 (2006), 12–23.

—— 'Ancient and early modern mortality: experience and understanding', *Economic History Review*, 60 (2) (2007), 373–99.

—— 'Lying-in and laying-out: fetal health and the contribution of midwifery', *Bulletin of the History of Medicine*, 81 (4) (2007), 730–59.

—— 'Dr Smellie's prescriptions for pregnant women', *Medical History*, 52 (2) (2008), 257–76.

—— 'Long-term trends in fetal mortality: implications for developing countries', *Bulletin of the World Health Organization*, 86 (6) (2008), 460–6.

—— Løkke, Anne, and Poppel, Frans van, 'Two hundred years of evidence-based perinatal care: late-fetal mortality in the past', *Archives of Disease in Childhood: Fetal and Neonatal Edition*, 91 (6) (2006), F445–7.

Woodward, Donald, 'Some difficult confinements in seventeenth-century Yorkshire', *Medical History*, 18 (4) (1974), 349–53.

Wootton, David, *Bad Medicine: Doctors Doing Harm Since Hippocrates* (Oxford: Oxford University Press, 2006).

Wrightson, Keith, 'Infanticide in earlier seventeenth-century England', *Local Population Studies*, 15 (1975), 10–22.

Wrigley, E. A., 'Births and baptisms: the use of Anglican baptism registers as a source of information about numbers of births in England before the beginning of civil registration', *Population Studies*, 31 (1977), 281–312.

—— 'Explaining the rise in marital fertility in England in the "long" eighteenth century', *Economic History Review*, 51 (3) (1998), 435–64.

—— 'British population during the "long" eighteenth century 1680–1840', in Roderick Floud and Paul Johnson (eds.), *The Cambridge Economic History of Modern Britain, i. Industrialisation, 1700–1860* (Cambridge: Cambridge University Press, 2004), 57–95.

—— et al., *English Population History from Family Reconstitution, 1580–1837* (Cambridge: Cambridge University Press, 1997).

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