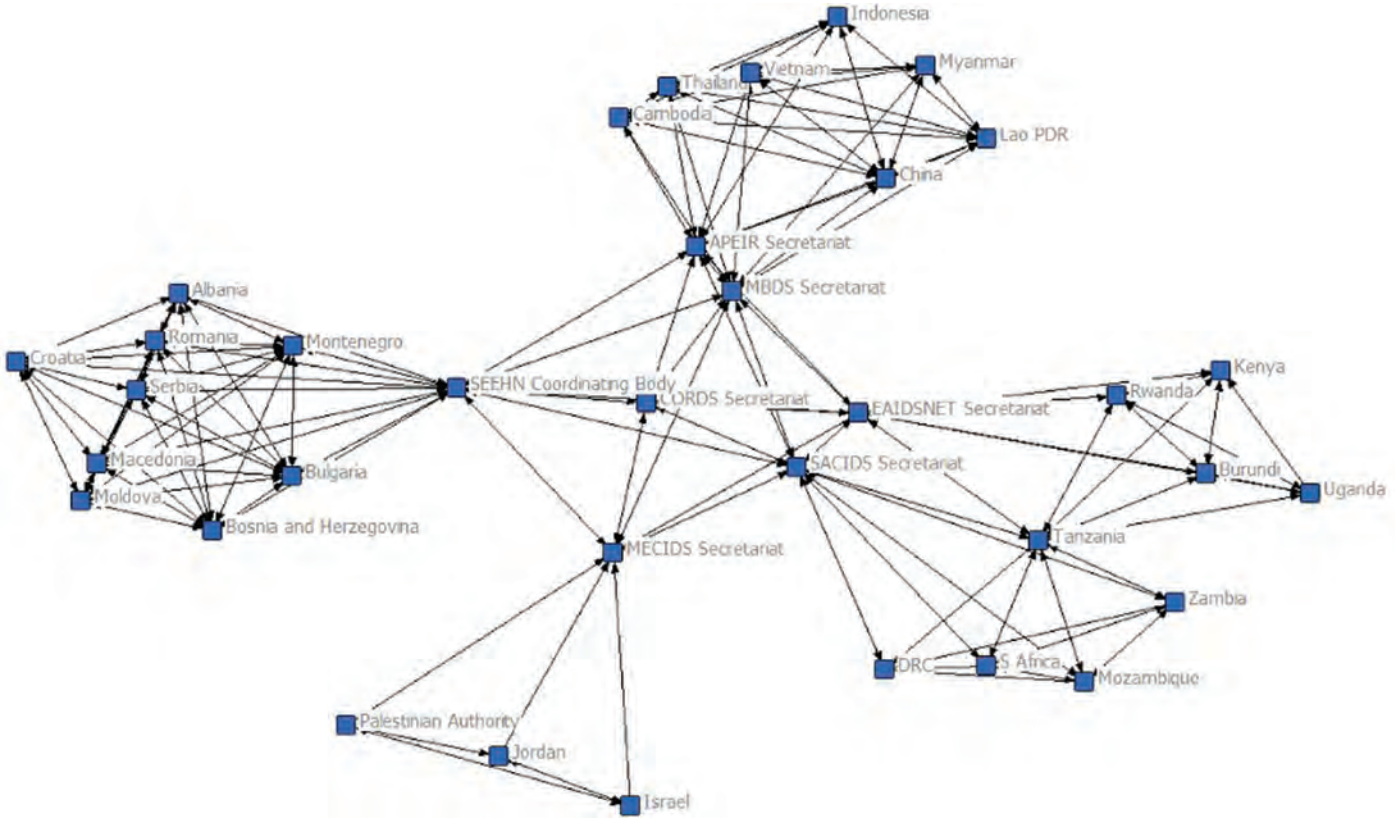
Emerging Health Threats Journal



Supplement 1, 2013

Co-Edited by Suwit Wibulpolprasert, Louise S. Gresham and Mark S. Smolinski

A World United Against Infectious Diseases: Connecting Organizations for Regional Disease Surveillance

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Emerging Health Threats Journal

The *Emerging Health Threats Journal* is an international, peer-reviewed journal publishing the latest and best research on emerging threats to human health. Its focus is threats from any source, including the environment, chemicals, radiation, pathogens, and society. It welcomes papers on the preparedness and response to natural or man-made disasters, including those that involve the deliberate release of chemical, biological, or radio-nuclear material.

Content will be determined by novelty and scope of the threat, and by scientific excellence. The *Journal* welcomes investigative studies that promote the understanding of factors involved in the emergence, prevention, and elimination of health threats. Articles on lessons learned from disaster and crisis response are particularly encouraged.

The *Journal* seeks high-quality submissions from academic, industrial, clinical practice, public health, and government research and planning sectors of original research articles, reviews, policy reviews, lessons learned, commentaries, and perspectives on emerging threats to human health.

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A World United Against Infectious Diseases: Connecting Organizations for Regional Disease Surveillance (CORDS)

Emerging Health Threats Journal – Supplement 1, 2013

Co-Edited by Suwit Wibulpolprasert, Louise S. Gresham and Mark S. Smolinski

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Acknowledgements

The editors of this *Emerging Health Threats* Journal supplement express their extreme gratitude to the Rockefeller Foundation for hosting the original convening of authors at the Bellagio Conference Center, Italy, sparking this ambitious body of work; to the authors for their insight into surveillance and innovation around the world; to Dr. Leslie A. Pray for reviewing the manuscripts and providing expert critical analysis of the papers and for her consistent style of expert editing and patience; and to the honorable reviewers from across the world. We thank the Nuclear Threat Initiative, as Interim Executive Secretariat of Connecting Organizations for Regional Disease Surveillance (CORDS), for overseeing the process of creating this supplement and the Skoll Global Threats Fund, Fondation Mérieux and Fondation Mérieux, USA for providing resources for the production of the supplement. Finally, we thank the Prince Mahidol Award Conference 2013 for the opportunity to share the rich experiences of regional disease surveillance networks at the global forum on A World United Against Infectious Diseases for which this supplement was commissioned.

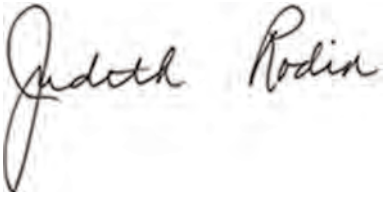
The world has made significant strides in tackling major public health challenges over the last several decades. We have eradicated one disease, smallpox, and are close to doing so with polio and guinea worm. We continue to make significant progress on other debilitating illnesses, including malaria, tuberculosis and HIV/AIDS. Yet, even as our technology and practices improve, new threats arise. In the last two decades, we have seen some 30 new zoonotic diseases emerge, from SARS to hantavirus to Ebola and more. Population pressures and economic growth push humans into ever closer contact with animals, disturbing ecosystems, and creating ripe conditions for new pathogens to jump from animals to humans. Add to this the incredible growth in global travel and trade and the risk of new diseases quickly spreading worldwide has never been greater. So while our ability to respond continually improves, the challenges we face increase as well.

Many factors make up the successful fight against emerging infectious diseases. But one factor trumps all—early detection and rapid identification of novel infections. If we can find a new pathogen early, we can often isolate it to the area in which it emerges. Conversely, failure to find the disease early allows the pathogen to propagate to new regions, countries and continents, making the response much more difficult and costly. Imagine if we had found HIV/AIDS when it was still contained to its region of origin—many of today's 35 million people infected worldwide would have never been exposed. Our tools of detection, including point-of-care diagnostics and digital surveillance, continue to improve. However, the global infectious disease surveillance system is disjointed. Practices and protocols vary, and inefficiencies abound. The initiative we are jointly supporting—Connecting Organizations for Regional Disease Surveillance (CORDS)—tackles this challenge by building trust and collaboration across national borders.

CORDS unites regional disease surveillance networks from critical hotspots around the world to promote exchanges of best practices in surveillance and catalyze innovation in early disease detection. By working together with international bodies, including the World Health Organization (WHO), World Organization for Animal Health (IOE), and the Food and Agriculture Organization of the United Nations (FAO), CORDS will speed the development, capabilities and sustainability of all its network members to improve global surveillance and mitigate the potential impact of disease outbreaks both from epidemic diseases and from the recrudescence of endemic diseases.

Each of our organizations comes to this issue with equal commitment but different perspectives – ranging from global health to disaster management to biosecurity and more. We are all united in our dedication to this effort, which fills a critical gap in global public health capacity. We look forward to CORDS contributing to improve health outcomes worldwide.

Sincerely,



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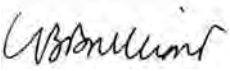

Larry Brilliant
President and CEO
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The revised International Health Regulations 2005 (IHR), which entered into force in May, 2007, imposed a duty on every country to develop the capacity to detect and respond to public health events of potential international concern. Member countries of the OIE have a responsibility to comply with the OIE international standards to prevent the movement of animal pathogens and diseases (including zoonoses) between countries, and the related OIE Performance of Veterinary Services Pathway addresses the quality of national veterinary services to comply with these international standards. In 2004, OIE and FAO established the Global Framework for the Progressive Control of Transboundary Animal Diseases to support regional efforts to prevent, control and eliminate priority animal diseases in each region, including major zoonoses.

While the responsibility to maintain and exercise these competencies of public and animal health surveillance and response must rest with each individual Member State, sub-regional and regional surveillance networks can also contribute to the objectives of early detection and control of transboundary threats at source. CORDS grew out of the successful establishment of one, the Mekong Basin Disease Surveillance network (MBDS), in which six countries in south-east Asia, sharing commonalities of borders, topography, and climate, recognised the potential value of sharing surveillance information concerning commonly perceived disease priorities. The CORDS regional network model has now been adopted by several other groups of countries in eastern Africa (EAIDSNet), south-east Europe (SEEHN), eastern Mediterranean (MECIDS), southern Africa (SACIDS), and another in south-east Asia (APEIR). Many other models of effective regional surveillance networks covering human and animal diseases exist, including those covering wildlife. Some of the networks are generic in scope and some specific, some focused on information sharing, while others address response and even longer-term control measures, including capacity-building.

Focusing on shared problems can allow a better understanding of the extent and nature of epidemic and endemic diseases, the conditions under which they are likely to appear or are exacerbated, and the most effective approaches to detection, prevention and control in any particular context. Often, this work must involve multiple sectors; the majority of epidemic infectious diseases affecting humans are zoonotic in origin. Further, this movement of pathogens is not unidirectional: there is spillover and spill-back between these highly interdependent domains, additionally modulated intensification of livestock production system, trade, climate change and the increasing human population. The international movement of pathogens, animals, people and goods has fuelled the emergence and international spread of disease throughout history, and lies at the heart of the IHR and the OIE international standards. Communication and collaboration between human, animal and ecosystem health sectors is essential if we wish to ensure the health of our populations, the safety and security of our food supply, and the economies and livelihoods of all those who depend on these interactions.

FAO, OIE, and WHO have agreed the importance of augmenting their collaborative efforts for the prevention, detection and control of disease arising at the human-animal-ecosystem interface. In this regard the Organizations have developed tools to support early warning and risk assessment. Event-based surveillance mechanisms, such as the joint Global Early Warning System for Animal Diseases (GLEWS), which includes zoonoses and food-borne pathogens, and disease-specific collaborations such as the network for animal influenza (OFFLU), are active between the three Organizations. These collaborations range beyond surveillance to incorporate joint response mechanisms as events demand. The Joint FAO/OIE Crisis Management Centre for Animal Health supports rapid response capacities to assist countries for animal diseases events (domestic, wildlife, terrestrial or aquatic), and has collaborated in outbreak responses with WHO and the Global Outbreak Alert and Response Network (GOARN). Similarly, a cross-sectoral 'One Health' approach is increasingly being adopted within and amongst countries to address these problems. Regional food safety surveillance networking initiatives inform the global food safety networks and frequently contribute to management of public health events under the IHR. Sub-regional and regional surveillance groups and field epidemiology training programs (FETPs) have brought human public health and animal health practitioners together for a new approach to field epidemiology and response in Africa, Asia and Europe; this is also true of some national FETPs and FETPVs. The new generation of public health and animal health practitioners will apply these principles as a matter of course.

The advantages of regional relationships between local partners have been appreciated, and this recognition is altering the approach of global networks in a kind of 'reverse engineering'. The GOARN, initially conceived as a global resource supported by WHO Headquarters, has developed a regionally-based approach which still contributes globally as needed. With a wider scope, the Asia-Pacific Strategy for Emerging Diseases (APSED) develops Member State and regional surveillance and response capacity through a policy of intersectoral collaboration and coordination, with FAO and OIE, for detection and control of zoonotic disease emerging at the human/animal/ecosystem interface. Positive trends for the future include the growth of regional networks incorporating surveillance, response, and applied intersectoral research for better forecasting, and the selection of evidence-based measures to control and, where possible, prevent, future epidemics.

Sincerely,

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Food and Agriculture Organizations of the
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Keiji Fukuda
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Contents

OVERVIEW

Creating a Global Dialogue on Infectious Disease Surveillance: Connecting Organizations for Regional Disease Surveillance (CORDS)

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Connecting Organizations for Regional Disease Surveillance (CORDS) is an international non-governmental organization focused on information exchange between disease surveillance networks in different areas of the world. By linking regional disease surveillance networks, CORDS builds a trust-based social fabric of experts who share best practices, surveillance tools and strategies, training courses, and innovations. CORDS exemplifies the shifting patterns of international collaboration needed to prevent, detect, and counter all types of biological dangers – not just naturally occurring infectious diseases, but also terrorist threats. Representing a network-of-networks approach, the mission of CORDS is to link regional disease surveillance networks to improve global capacity to respond to infectious diseases. CORDS is an informal governance cooperative with six founding regional disease surveillance networks, with plans to expand; it works in complement and cooperatively with the World Health Organization (WHO), the World Organization for Animal Health (OIE), and the Food and Animal Organization of the United Nations (FAO). As described in detail elsewhere in this special issue of *Emerging Health Threats*, each regional network is an alliance of a small number of neighboring countries working across national borders to tackle emerging infectious diseases that require unified regional efforts. Here we describe the history, culture and commitment of CORDS; and the novel and necessary role that CORDS serves in the existing international infectious disease surveillance framework.

Keywords: *regional infectious disease surveillance network*; *global health security*; *network-of-networks*; *IHR implementation*; *WHO geopolitical structure*

Introduction

In the past few decades, one or two new infectious disease threats have emerged every year somewhere on the planet. The vast majority of new human infectious disease threats are zoonotic, meaning that they originate in animals. As we develop more land, mine more of the earth's resources, and hunt and raise more animals for food, we increase our exposure to animal pathogens that have the potential to "jump" the species barrier. Because both people and products are able to transit the globe during the incubation period for many infectious diseases, index cases often occur continents away from where outbreaks originate. Whether it be SARS in travelers (2003), influenza H1N1 in passengers (2009), Nipah virus in exported pigs (1998, 1999), HIV in shipped contaminated Factor VIII (1983), or *E. coli* in foodstuffs (ongoing), the geographic expanse of infectious diseases is truly boundless. Thus, populations across the globe are at risk of newly arriving infections that may be unfamiliar, difficult to diagnose, and challenging to treat and control (1–3).

At the same time, the increasingly competitive global marketplace has created new trading communities that are more economically integrated than in the past. New regional and cross border trade agreements have contributed to this shift in the trade landscape. The shift is driving many economies to begin to orchestrate their surveillance efforts, especially against infectious disease,

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with their neighboring trading and travel partners. Countries across the world are self-assembling into regional surveillance networks that do not necessarily operate within the confines of the older geo-political regional boundaries set forth by country membership in the World Health Organization (WHO) (4–6).

This article highlights the work being done by Connecting Organizations for Regional Disease Surveillance (CORDS). CORDS is an international non-governmental organization that links six of these self-assembling regional infectious disease surveillance networks (7–8). Each network is itself an alliance of a small number of neighboring countries working across national borders – sometimes borders in conflict – to tackle infectious disease threats that require unified regional efforts. By linking the networks not only with each other but also with WHO, the World Organisation for Animal Health (OIE), the Food and Agriculture Organization of the United Nations (FAO), and other agencies and institutions involved with disease surveillance, CORDS exemplifies the type of combined vertical plus horizontal international collaboration that will be needed to prevent, detect, and respond to the shifting spectrum of infectious disease threats that are an unfortunate reality in today's "global" world (9–10).

As elaborated throughout this issue, CORDS members regularly collaborate to build national, regional and global capacity while at the same time responding to infectious disease emergencies as they occur. The bonds that are forming within and among the CORDS regional surveillance networks are nurturing not just a cross-border approach to disease surveillance, but also a cross-disciplinary One Health approach. During times of emergency, the personal relationships being nurtured by CORDS and its member networks help to ensure that the joint outbreak investigations and controls are carried out in a timely manner; that the necessary diagnostics and potentially life-saving vaccines and drugs are shared where they are needed; that biological specimens are available for regional laboratory testing; and that appropriate regional travel restriction or other control measures are implemented when the situation demands.

Although this article highlights CORDS and its member networks, many other economies, government agencies, and informal groups have assembled in recent years to collectively combat infectious diseases (11–13). Examples include the West African Health Organisation (WAHO), the Pacific Public Health Surveillance Network (PPHSN), the Association of Southeast Asian Nations (ASEAN) Plus Three (China, Japan, Korea) Field Epidemiology Training Network (ASEAN+3 FETN), the Asia-Pacific Economic Cooperation (APEC) and APEC Emerging Infections Network (APEC EINet); the Caribbean Epidemiology Centre (CAREC); ProMED-mail; and the Global Outbreak Alert and Response Network (GOARN). See Ref. 11 in this issue for a discussion of WAHO, PPHSN, and ASEAN+3 FETN.

History, Culture, and Commitment of CORDS

In 2007, the Rockefeller Foundation and Nuclear Threat Initiative (NTI) convened infectious disease surveillance representatives and other experts from across the world to share best practices and lessons learned in disease surveillance. Attendees of the meeting, which was held at the Rockefeller Foundation Bellagio Conference Center, Italy, were asked to recommend actions to advance the global capacity for public health surveillance and reduce the threat of infectious diseases, with a focus on the needs of developing countries. The resulting Bellagio Call for Action addressed three "vital concerns": (i) the need to build surveillance capacity, especially human and laboratory capacity, but also cross-border collaborative capacity; (ii) the need to develop and employ appropriate information and data-sharing technology to facilitate timely communication during times of emergency; and (iii) the need for a flexible approach to governance among the growing number of regional infectious disease surveillance networks that are self-assembling worldwide (14).

At the same time, regional disease surveillance networks themselves were recognizing a shared incentive to improve early detection and outbreak investigation and response. Driven by that incentive and with the support and partnership of NTI, the Rockefeller Foundation, Peter G. Peterson Foundation, the Fondation Mérieux, and the Skoll Global Threats Fund, the leaders of six existing regional disease surveillance networks founded CORDS. The six networks, all of which are described in detail elsewhere in this issue (see also Table 1) are: Mekong Basin Disease Surveillance Network (MBDS) (15), East African Integrated Disease Surveillance Network (EAIDSNet) (16), South Eastern European Health Network (SEEHN) (17), Middle East Consortium on Infectious Disease Surveillance (MECIDS) (18), Asian Partnership on Emerging Infectious Disease Research (APEIR) (19), and Southern African Centre for Infectious Disease Surveillance (SACIDS) (20). During CORDS's early years, NTI served the role of interim secretariat; Fondation Mérieux provided a home in Annecy, France, for convening CORDS. CORDS was formally created as a non-governmental organization in Lyon, France, in 2012.

Representing a network-of-networks approach, CORDS enables networks to interact not only with each other, but also with the WHO, OIE, FAO, and other surveillance partners. CORDS also partners with other public and private sector actors who share common health security goals (6,7,21,22); and with individual professionals.

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Table 1. Connecting Organizations for Regional Disease Surveillance (CORDS) Founding Networks

Name	Member Countries	Description
Mekong Basin Disease Surveillance Network (MBDS)	Cambodia, China (Yunnan and Guangxi Provinces), Laos PDR, Myanmar, Thailand, Vietnam	MBDS was established in 1999 to strengthen national and Mekong regional capabilities in disease surveillance and response to outbreaks of priority diseases in order that they can be effectively controlled. MBDS is governed by memoranda of understanding between the ministers of member countries and an executive board, with activities coordinated by a secretariat and country coordinators. For more information, visit www.mbdsoffice.com.
East African Integrated Disease Surveillance Network (EAIDSNet)	Burundi, Kenya, Rwanda, Tanzania, Uganda	EAIDSNet was established in 2001 to enhance cross-country and cross-institutional collaboration on disease control, to improve the quality of data on communicable disease and the flow and sharing of information, and to improve the health of the East African population. EAIDSNet is a health sector institution of the East African Community. For more information, visit www.eac.int/eaidsnet.
South-eastern Europe Health Network (SEEHN)	Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Macedonia, Moldova, Montenegro, Romania, Serbia	SEEHN was founded in 2001 to coordinate and help with the implementation and evaluation of health policy and services among its regional members. The network is supported by a secretariat run jointly by the council of Europe and the WHO Regional Office for Europe. For more information, visit www.euro.who.int/en/what-we-do/health-topics/Health-systems/public-health-services/south-eastern-europe-health-network-seehn.
Middle East Consortium on Infectious Disease Surveillance (MECIDS)	Israel, Jordan, Palestinian Authority	MECIDS was established in 2003 to improve the ability of member nations to detect and respond to infectious disease threats through integrated surveillance systems and joint epidemiological and laboratory training. It is governed by an executive board guided by a set of standing operating procedures and associated protocols with activities coordinated by an international secretariat. For more information, visit www.mecidsnetwork.org.
Asian Partnership on Emerging Infectious Diseases Research (APEIR)	Cambodia, China, Indonesia, Vietnam, Thailand	APEIR was founded in 2006 by joining research efforts among different institutions in the most severely affected Asian countries to fight avian influenza in the region. It was initially named APAIR and further changed to APEIR when it expanded its interests to cover other emerging infectious diseases. Canada's International Development Research Centre (IDRC) is initially supporting the partnership. Key members include key multi-sectoral institutes in Cambodia, China, Indonesia, Thailand, and Vietnam. Other international agencies also supporting the alliance include AusAIDs, the Rockefeller Foundation, and WHO. For more information, visit www.apeiresearch.net/main.php.
Southern African Centre for Infectious Disease Surveillance (SACIDS)	Democratic Republic of Congo, Mozambique, South Africa, Tanzania, Zambia	SACIDS is a consortium of Southern African medical and veterinary, academic and research institutions in the animal, human and agricultural sectors. SACIDS was established in 2009 and is governed by two deputy directors, one for the human and the other for the animal health sector; at the national level, the coordinator is assisted by a deputy from the opposite sector with activities guided by a secretariat located in Tanzania. For more information, visit www.sacids.org.

CORDS operates as a community of practice: a learning partnership among people who share a common concern, in this case improving infectious disease surveillance capacity, and who come together regularly to learn how to do it better (23). CORDS networks regularly meet to exchange information and innovations (e.g., new data-sharing tools); participate in training courses and learn through case studies; and jointly build surveillance capacity. By providing a central forum for peers from different parts of the world to share expertise and best practices and, over time, nurture trust, CORDS fosters the development of professional collaborations and provides regular opportunities for joint learning and technical exchanges. CORDS strengthens the dialogue not just among public health, veterinary, and wildlife professionals from different regions of the world, but also between those professionals and WHO, OIE, and FAO.

The vision of CORDS is "*a world united against infectious diseases.*" Its mission is "*to link regional disease surveillance networks and improve global capacity to respond to infectious diseases.*" CORDS has four strategic objectives:

1) Improving Capacity: CORDS facilitates the sharing between networks of case studies, technical expertise, data, best practices, and resources to help networks and their member countries develop new skills and build operational partnerships across regions.
2) Advancing One Health: CORDS seeks to modernize disease surveillance by improving coordination between animal, human and environmental sectors at national, regional and international levels.
3) Promoting Innovation: CORDS serves as a venue for networks to share their innovative ideas and approaches to disease surveillance, and it also provides an organized platform for co-development of new technologies and innovations within and across regions.
4) Building Sustainable Networks: CORDS strengthens multi-country disease surveillance networks and facilitates the creation of sustainable new networks in areas of high disease risk by providing educational materials, success stories, progress reports, and other information to networks which they can use with their respective ministries to demonstrate the value of multi-country networks.

While CORDS is still early in its development, already its member networks have demonstrated that even in parts of the world historically (e.g., Southeast Asia) or currently rife with conflict (e.g., Middle East), public health and veterinary experts and officials from neighboring countries can come together in emergency situations and successfully coordinate efforts to prevent the spread of infectious disease (4–6, 24). The key to success is trust. Multi-country disease surveillance networks are successful only when individual experts from across countries and regions develop trust-based relationships that support the comfortable and timely exchange of views and information. For example, MBDS is a network of trust-based social relationships that have developed over time and did not exist thirteen years ago. As the network matured and as disease surveillance and control epidemiologists and other professionals from neighboring countries routinely worked together on joint surveillance goals, the sharing of data, tools, and innovative ideas and approaches increased substantially. CORDS is committed to nurturing a trust-based culture that encourages the secure and timely sharing of information and best practices between disease surveillance experts from across its member networks.

The operational philosophy of CORDS is to be small, nimble, and supportive of member networks. In accord with the trust-based and collaborative culture of CORDS, the CORDS Executive Board operates on consensus when it establishes the objectives, policies, and plans of action for the organization. CORDS rotates leadership such that all involved networks will have the opportunity for one of their representatives to serve as Chair of the Executive Board (EB).

Avenues for Engagement between CORDS and the Existing International Disease Surveillance Framework

Among the most obvious benefits of CORDS membership is that participating regional surveillance networks – and the countries linked by those networks – are improving national capacities in compliance with the revised International Health Regulations (IHR). The IHR provides a framework for improved international public health security by strengthening global surveillance, improving communication between WHO and member states, and setting ground rules to address national public health emergencies of international concern (25). It is a set of legally binding requirements agreed upon by the 194 member states to help structure a world that is on alert and prepared to respond to the threat of infectious epidemics. Many public health experts, including WHO leadership, have called for additional strategies to complement WHO efforts to build the mandated national capacities for compliance (5, 26–28). Indeed, the IHR itself includes provision for member states to seek technical assistance from WHO (29). However, WHO has limited funding and capacity to help countries meet capacity levels to detect and respond to cross-border threats. CORDS complements WHO efforts by helping regional networks to collectively built mandated core surveillance capacities through the sharing of information

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and standard protocols and the channeling of resources. WHO has been participating in CORDS activities and collaborating closely with the regional networks. WHO representatives regularly attend CORDS meetings; CORDS has held joint One Health meetings with WHO; and WHO has worked with both CORDS and its regional network members to build laboratory capacity.

CORDS fosters the sharing of information with other global infectious disease surveillance partners in addition to WHO, including OIE and FAO. Both are observers to the CORDS Executive Board. These collaborations are important to improving coordination between public health, veterinary, and wildlife surveillance and achieving the One Health strategic objective of CORDS.

Like its network members, CORDS cultivates trust-based relationships that enable neighboring countries to communicate and interact with each other during times of crisis more quickly and nimbly than is sometimes possible within the vertical and geopolitical structure of WHO. The vertical bureaucracy of WHO and member states dictates that permission from a top administrative unit is usually required to allow the sharing of information. The geopolitical structure of WHO is such that a number of neighboring countries are in different regions of WHO, which makes it difficult to communicate essential outbreak information via WHO channels in a timely manner. For example, Myanmar and Thailand are members of the South East Asia Region of WHO, while their neighbors China, Laos PDR, Cambodia, and Vietnam are members of the Western Pacific Region. Instead of relying solely on formal WHO communication channels during emergencies, neighboring countries are often able to launch more effective responses when they communicate directly with each other while at the same time communicating with WHO. The informal reporting structures of the regional disease surveillance networks featured here facilitate real-time information exchange and rapid and effective joint outbreak investigations. Moreover, CORDS networks also extend across non-member states.

The H5N1 pandemic threat in 2007 was a good example of informal communication facilitating a joint outbreak investigation between two countries in different WHO regions (15). The Thai team informed the Laos team immediately after the index case, in a Laotian girl, was diagnosed in Nong Khai province in Thailand, opposite the capital of Laos PDR, Vientiane. The Laos team immediately crossed the border to visit the girl, collect specimens, and start an investigation. The next day experts from the two countries conducted a joint outbreak investigation in the village where the girl resided, while at the same time reporting to WHO. This timely joint response was based on trust-based collegial relationships, without any requirement for permission from top leaders.

The trust-based social fabric being cultivated by CORDS and its member networks also helps to tackle the challenge of disease under-reporting, as well as wrongful accusations about neighboring WHO Member States. WHO is still limited in how it can intervene when a country does not report a disease threat (30).

Value of CORDS

CORDS cultivates networks of professionals who have the collective strength to translate information into near-real-time action during emergency situations. The value of CORDS ranges from the potential (e.g., knowledge capital, social capital, learning capital) to the applied (e.g., changes in practice based on CORDS interactions) to the realized (improved performance). Text Box 1 outlines examples of the value of CORDS.

Text Box 1. The value of CORDS

- **Weaving a strong global infectious disease surveillance fabric.** CORDS creates a social network for sharing information and documents, learning from experiences and common challenges, creating knowledge, stimulating change, and shaping new professional opportunities. The collective learning nurtured by CORDS turns short-term problem-solving into a long-term cumulative resource of approaches and solutions to infectious disease surveillance challenges; and creates horizontal channels of communication (e.g., network-to-network, country-to-country, network-to-private sector partner) that complement existing vertical structures (e.g., official WHO and Member State bureaucracies). Through these activities, CORDS weaves horizontal and vertical threads of communication and collaboration into a strong global infectious disease surveillance fabric. Examples of the horizontal collaboration being nurtured by CORDS include the spontaneity of the relationships among MBDS members being instrumental in forming the ASEAN Plus Three Centre for Emerging Infectious Disease, where 6 of the 13 members are MBDS members (15). Examples of vertical collaboration include WHO, OIE, and UN System Influenza Coordination (UNSIC) work with MBDS to develop scenarios and plan and carry out a series of pandemic preparedness tabletop exercises (19); WHO and MECIDS collaborating on IHR implementation strategies (18); and WHO assistance with the SEEHN regional assessment of national pandemic preparedness (17).

- **Contributing to global participatory policy reform.** CORDS plays a leadership role for policy reform on global issues (e.g., SACIDS advocacy for One Health policy [20], APEIR advocacy for research-based policy change [19]), draws additional policy attention to the concerns of regional networks, and creates a platform where national level action can be complemented by international level action.
- **Generating and managing knowledge.** CORDS generates and manages knowledge not only by carving new channels of communication so that surveillance data can be shared by individuals in a more timely manner than would otherwise be possible, but also by formulating and disseminating new surveillance norms and standards. CORDS also encourages the quick adoption of innovative technologies and innovations, such as point-of-care and rapid diagnostics (e.g., the joint SACIDS-EAIDSNet exploration of mobile technologies for disease surveillance in remote and cross-border areas [16]).

Conclusion

The collaborative capacity to immediately detect, respond, and effectively control the occurrence of infectious diseases and prevent them from becoming pandemics is of utmost importance. While the IHR provides an official platform for infectious disease surveillance experts to communicate essential information, the vertical structure of WHO and the outdated geopolitical boundaries of the WHO regions create obstacles for infectious disease surveillance practitioners and other professionals to communicate in a timely manner during crises. Ensuring that a robust response to global infectious disease threats is present anywhere and everywhere at all times requires combining formal WHO and other surveillance mechanisms with the nimble nature of the regional networks linked by CORDS and of CORDS itself. The horizontal, semi-formal, trust-based relationships among regional disease surveillance networks being cultivated by CORDS interweave with the more formal, vertical relationships between Member States and WHO, OIE and FAO to form a global disease surveillance fabric that promotes more effective actions than would otherwise be possible. By pursuing a common vision where disease no longer threatens the security and prosperity of nations, CORDS is revitalizing international efforts against biological threats and helping to weave "A World United Against Infectious Diseases."

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COACTION

The Evolution and Expansion of Regional Disease Surveillance Networks and Their Role in Mitigating the Threat of Infectious Disease Outbreaks

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We examine the emergence, development, and value of regional infectious disease surveillance networks that neighboring countries worldwide are organizing to control cross-border outbreaks at their source. The regional perspective represented in the paper is intended to serve as an instructive framework for others who decide to launch such networks as new technologies and emerging threats bring countries even closer together. Distinct from more formal networks in geographic regions designated by the World Health Organization (WHO), these networks usually involve groupings of fewer countries chosen by national governments to optimize surveillance efforts. Sometimes referred to as sub-regional, these "self-organizing" networks complement national and local government recognition with informal relationships across borders among epidemiologists, scientists, ministry officials, health workers, border officers, and community members. Their development over time reflects both incremental learning and growing connections among network actors; and changing disease patterns, with infectious disease threats shifting over time from local to regional to global levels. Not only has this regional disease surveillance network model expanded across the globe, it has also expanded from a mostly practitioner-based network model to one that covers training, capacity-building, and multidisciplinary research. Today, several of these networks are linked through Connecting Organizations for Regional Disease Surveillance (CORDS). We explore how regional disease surveillance networks add value to global disease detection and response by complementing other systems and efforts, by harnessing their power to achieve other goals such as health and human security, and by helping countries adapt to complex challenges via multi-sectoral solutions. We note that governmental commitment and trust among participating individuals are critical to the success of regional infectious disease surveillance networks.

Keywords: *regional networks*; *disease surveillance*; *trust*; *pandemics*; *cross-border*; *SARS*; *International Health Regulations*

Introduction

The world has awakened to the threat of disease pandemics arising from growing global inter-connectedness. The rapid spread of SARS from Hong Kong to Toronto in 2003 demonstrated the speed with which highly pathogenic epidemics can move across the world, necessitating surveillance and control approaches that cut across national boundaries (1). Governmental and international agencies are building and strengthening infectious disease surveillance at all levels, from the national to international, to facilitate earlier detection and communication of disease outbreaks on a global scale (2–7). Here, we tell the story of surveillance networks that neighboring countries worldwide are organizing to control outbreaks at their source, across national borders. Distinct from more formal networks in geographic regions designated by the World Health Organization (WHO), these networks usually involve groupings of fewer countries chosen by national governments to optimize surveillance efforts. Sometimes referred to as sub-regional, these "self-organizing" disease surveillance networks complement national and local government recognition with trust-based relationships between practitioners across borders. Governments, public health authorities,

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international organizations, academia, foundations, and non-governmental organizations mobilize technical and financial support for these networks. Some of these regional networks existed before the sudden outbreak of SARS (2003). We describe their emergence, development, and value among the many other parallel efforts to protect populations against the global spread of infectious disease, with a focus on three of the earlier emerging networks: the Pacific Public Health Surveillance Network (PPHSN) (1996), the Mekong Basin Disease Surveillance (MBDS) network (1999), and the East African Integrated Disease Surveillance Network (EAIDSNet) (2000). The regional perspective represented in the paper is intended to serve as an instructive framework for others who decide to launch or join existing regional networks as new technologies and emerging threats bring countries even closer together.

The Rise of Self-Organizing Regional Disease Surveillance Networks

Regional networks have increased in response to changing global disease dynamics. Zoonotic diseases account for 70 percent of emerging infectious diseases, and the global health and economic impacts of SARS, H5N1 and H1N1 have turned the world's attention to global pandemic threats. Common drivers include increased cross-border trade, mobility and migration of humans and animals, livestock productions systems, population density, viral adaptation and ecological shifts as a result of climate change (8).

While some of the more recently emerging regional disease surveillance networks are research-focused, the earlier networks were practitioner-based and aimed to bring together epidemiologists responsible for surveillance. The earliest example is the Organisations de Coordination et de Cooperation pour la lutte contre les Grandes Endemies (OCCGE), established in West Africa in the early 1960s. In 1987, the OCCGE merged with the West African Health Community (WAHC) to form the West African Health Organisation (WAHO) (9).

Several other regional disease surveillance networks arose in the mid-1990s. The Pacific Public Health Surveillance Network (PPHSN) formed in 1996 as a voluntary network to coordinate efforts to control infectious disease in 22 Pacific Island countries and territories. PPHSN met a need among countries and island territories in the region to streamline their disease reporting and response. The network operates under the auspices of the WHO Western Pacific Regional Office and the Secretariat of the Pacific Community (SPC).

In 1999, technical representatives of the six Mekong countries (Cambodia, China, Lao PDR, Myanmar, Thailand and Vietnam) recommended to their governments formation of the Mekong Basin Disease Surveillance (MBDS) network. This small number of countries bridging the much larger WHO Southeast Asia and Western Pacific regional offices, and also forming a subset of the Association of Southeast Asian Nations (ASEAN), decided that coordination through MBDS would enable them to address similar epidemiological profiles across their multiple shared borders.

The following year, in 2000, representatives from ministries of health and academic institutions in Kenya, Tanzania and Uganda formed the East African Integrated Disease Surveillance Network (EAIDSNet). This network supported the WHO African regional office's policy of integrating disease surveillance systems (10). Anticipating and supporting the development of a health desk within the re-emerging East African Community, countries familiar with working together wanted to prepare common procedures for combating disease threats such as Ebola or, more commonly, cholera (11). Rwanda and Burundi joined EAIDSNet in 2007.

Phases of Network Development

We characterize the evolution of PPHSN, MBDS and EAIDSNet in three overlapping phases (1996–2007; 2003–2009; and 2006-present). These phases reflect both incremental learning and growing connections among network actors and changing disease patterns, with infectious disease threats shifting over time from local to regional to global levels. The occurrence of SARS during the first phase, H5N1 during the second phase, and H1N1 during the third phase reinforced the roles of these networks and strengthened the resolve of members to prepare joint plans to combat such threats.

Phase 1: Training and connecting people to contain local epidemics (1996 to 2007)

During the early phases of network formation, populations struggled with diseases of primarily local concern. Priorities for disease reporting reflected the epidemiology of the time: diarrheal diseases like cholera; malaria; pneumonia; typhoid; hemorrhagic fevers like dengue; and HIV/AIDS and tuberculosis.

As the first step in establishing these networks, their members made and formalized connections among technical experts across the ministries of health and other public health institutions in the countries and agreed on strategies. The PPHSN formed a coordinating body, with representatives of the countries and territories and of allied bodies, including as permanent members WHO, the Secretariat of the Pacific Community, and Fiji School of Medicine (12). MBDS established a secretariat in Thailand, with coordinating and executive committees; and outlined a collective vision for governance and outputs in a memorandum of understanding signed by ministers of health for all six countries. EAIDSNet operated a temporary secretariat with a coordinating committee based in the Tanzanian National Medical

Research Institute until it formally incorporated into the East African Community (EAC) in 2004.

Also during this first phase, the networks identified priority diseases and clarified disease definitions; harmonized reporting tools; prepared joint outbreak investigations; and disseminated information through network publications. PPHSN set up PACNet as an early warning system for disease outbreaks (Text Box 1); MBDS and EAIDSNet shared only limited surveillance information and undertook minimum collaborative response activities during this early phase of network formation.

Text Box 1. PACNET

The PPHSN set up PacNet in 1997 to share timely information on disease outbreaks in order to ensure appropriate action was taken in response to public health threats (12). PacNet demonstrated early success by providing early warnings of dengue, measles, and influenza that led to preventive measures taken across the region. Its early success served as a building block for prioritizing regional surveillance of outbreaks of emerging and re-emerging diseases. Subsequently, all major outbreaks that posed threats to the region were notified and monitored through PacNet. These included SARS; dengue in Tong, New Caledonia, and Wallis and Futuna; measles in the Marshall Islands and Guam; rubella in Samoa, Niue and Tokelau; and influenza in New Caledonia.

All three networks focused on training health workers in field epidemiology, as the epidemiology workforces in some countries were not fully developed. For example, between 2001 and 2007, under the leadership of the Field Epidemiology Training Program in Thailand, MBDS trained 45 medical doctors in field epidemiology, disease surveillance, and response. Many of the individuals who completed the course later went on to lead or play significant roles in their respective ministries/countries; the relationships established during the course fostered the growth of informal, inter-governmental networks and future collaboration.

Phase 2: Enhancing cross-border and national surveillance systems to address regional threats (2003 to 2009)

As HIV/AIDS spread increasingly in border areas and new zoonotic infectious diseases such as SARS emerged, a growing number of countries expressed heightened commitment to comply with the revised International Health Regulations (13). The networks used the communications infrastructure and the institutional agreements, arrangements, and definitions established early on to enhance cross-border disease surveillance and control projects. Both MBDS and EAIDSNet accelerated their efforts to strengthen district health management teams at border districts and to collaborate in the development of training programs for enhanced surveillance and control efforts.

At the same time, individual networks successfully integrated local, national and regional level health officials. For example, MBDS utilized existing bilateral and multilateral agreements between governments in the region to expand its cross-border initiative from four border sites in 2007 to 24 sites in 2010, effectively covering almost all key border crossings in the region. These combined capacities and growing trusted relationships further enabled collaboration in preparing for and responding to H5N1, dengue outbreaks, and natural disasters such as Cyclone Nargis that hit Myanmar in 2008 (14).

Also during phase 2, network activities moved beyond the health sector to include other sectors at border areas, including customs and immigration (Text Box 2). Multisectoral reporting teams highlighted that the spread of HIV/AIDS was significantly higher in border areas of the Mekong region than in other areas; and that East African countries were facing burgeoning cross-border epidemics, including HIV/AIDS but also Rift Valley Fever and other zoonoses (Text Box 3).

Text Box 2. Cross-border activities in the Mekong Basin region

Building on good bilateral agreements among governments of the six countries and led by Lao PDR, which shares borders with all other MBDS countries, during phase 2 of its development MBDS created several multi-sectoral border response teams comprised of health, customs, immigration, and border officials. Through the cross-border sharing of human resources and expertise, the teams participated in a number of joint outbreak investigations. These included a joint dengue fever investigation between the Lao and Thai provincial sites, enabling officials to effectively stamp out the cross-border outbreak; a joint typhoid investigation between the Lao and Vietnam provincial sites; and a joint avian influenza investigation of cases in humans, triggered by the discovery of an infected Lao citizen in Thailand (15). Also during phase 2, MBDS partnered with Mahidol University, Thailand, to train border health officials in geographic information system (GIS) and other analytic techniques and in the social, political, and economic aspects of border health. This training enhanced skills in research, outbreak investigation, and communication; and established friendships and trust among officers from adjacent cross-border provinces.

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Text Box 3. EAIDSNet: focusing on the animal-human health interface

During phase 2, EAIDSNet responded collectively to numerous outbreaks of cross-border significance, including Rift Valley Fever (2007), Marburg (2007), and wild poliovirus (2006, 2009, 2010). The outbreaks prompted a greater focus on the animal-human health interface and the need to develop integrated surveillance strategies. Thus, with a focus on One Health, the network conducted field simulation exercises at the Kenya-Uganda border to test national avian influenza preparedness and response plans; and conducted a review of information and communication technology (ICT) capabilities and developed and piloted a web portal linking existing human and animal disease surveillance reporting systems across facilities in border districts (11).

Phase 3: Strengthening preparedness for pandemics and other public health threats of regional and global scale (2006 to present)

Growing global concern about the threat of H5N1 pandemic and other emerging infectious diseases prompted previously independent regional networks to start sharing experiences and learning from each other. In 2007, representatives from MBDS, EAIDSNet, and other regional networks from Southeast Asia, East Africa, and the Middle East met in Bellagio, Italy to discuss possibilities for collaboration (16). The Bellagio meeting was followed by a series of exchange visits during which the networks shared approaches to pandemic preparedness across regions and jointly piloted new information and communications technology (ICT) tools for communicating about disease outbreaks. Network members from MBDS report that these cooperative efforts helped strengthen their pandemic preparedness, citing improved national surveillance efforts and cross-border communication during the H1N1 outbreaks of 2009 (17). The Bellagio meeting also led to creation of Connecting Organizations for Regional Disease Surveillance (CORDS) (Text Box 4).

Text Box 4. CORDS

In 2007, the Rockefeller Foundation (RF) supported the Nuclear Threat Initiative (NTI) to convene a Bellagio meeting of regional surveillance networks from across the globe to initiate a dialogue about how to harness lessons learned, emerging technologies, and nascent support. Participants from many networks recognized the value in sharing approaches and strategies, while donors and other development partners recognized the opportunity to reduce fragmentation and increase efficiencies in the global surveillance space. Subsequently, RF, NTI, and existing regional surveillance networks created a community of practice, "Connecting Organizations for Regional Disease Surveillance" (CORDS) (21, 22). Among its first activities, the community formulated a steering group comprised of key regional network representatives to define a learning agenda. More recently, CORDS registered as a legal, non-profit international organization in Lyon, France, in 2012. CORDS will convene the 1st Global Conference on Regional Disease Surveillance Networks at the Prince Mahidol Award Conference in 2013. Through these and other activities, CORDS is strengthening regional disease surveillance networks and global capacity for early detection and mitigation of pandemic threats.

Expansion of Regional Networks

Not only has the regional disease surveillance network model expanded across the globe, it has also expanded from a mostly practitioner-based network model to one that covers training, capacity-building, and multidisciplinary research. This section describes more recently formed efforts.

Practitioner Networks

The governments of Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Moldova, Montenegro, Romania, and the former Yugoslav Republic of Macedonia established the Southeastern European Health Network (SEEHN) in 2001. SEEHN's goal is to foster cross-border collaboration to align national practices with European Union standards and requirements. Key activities include joint preparation of influenza pandemic preparedness plans at both national and regional levels and the introduction of molecular techniques into influenza surveillance laboratories within the region (18).

In 2003 representatives of the ministries of health of Israel, Jordan and the Palestinian Authority established the Middle East Consortium on Infectious Disease Surveillance (MECIDS) (2). MECIDS began as a set of informal working relationships among technical staff for monitoring food-borne outbreaks. Like the earlier networks, they began by harmonizing reporting methodologies; conducting joint training; sharing data and analysis; facilitating cross-border communication; and responding to cross-border outbreaks. Eventually, the network expanded its focus beyond food-borne outbreaks. MECIDS employed preparedness planning exercises in response to an outbreak of H5N1 in 2006; and conducted a series of national pandemic influenza table-top simulation exercises between 2007–2008, culminating in a regional exercise in 2008. These efforts contributed significantly to the region's response to the

2009 H1N1 outbreaks, putting into place many of the plans that emerged from the exercises (19, 20).

The Association of 10 Southeast Asian Nations (ASEAN) Plus Three (China, Japan, Korea) Field Epidemiology Training Network (ASEAN+3 FETN) was formalized in 2011. A permanent coordinating office was set up in Thailand, with support from the Thai Ministry of Public Health; and a steering committee formed, with the chair rotating annually. The network holds biannual steering committee meetings, videoconferences every three months, and special videoconferences during outbreaks or other emergencies (e.g., during a severe outbreak of hand, foot, and mouth disease (HMD) in China, Japan, Vietnam and Thailand in 2012; and when Thailand faced unprecedented nationwide flooding in 2011). A 2012 videoconference was called to discuss mysterious deaths among villagers in the central province of Vietnam that were attributed to a disease called inflammatory palmoplantar hyperkeratosis (IPPH) syndrome (23). ASEAN+3 FETN builds on the social capital created by MBDS and complements MBDS efforts toward strengthening field epidemiology capacity in the region.

Research Networks

The Asia Partnership on Emerging Infectious Disease Research (APEIR) began in 2006, initially with a focus on avian influenza research (24). APEIR covers Cambodia, China, Indonesia, Laos, Thailand and Vietnam. Building on the MBDS model of regional cooperation and including many of the same individual members and country representatives, APEIR also brought in the agriculture, education and sciences sectors from academia to promote interdisciplinary research collaboration. The network comprises 30 partner institutions that collaborate on research and policy advocacy. Distinct from the more operational surveillance networks, APEIR's chronology was to begin with identification of research priorities from individual countries as well as inter-country issues. In its second phase, a coordinating office was established, hosted by the Health Systems Research Institute of Thailand, to coordinate funding support for research projects. The network currently focuses on dissemination and new collaborations in research. Research topics include ecological drivers of emerging infectious diseases such as migratory bird pathways and backyard poultry systems; and socio-economic impact studies and policy analysis. The network also focuses on strengthening research capacity among its members.

The Southern African Centre for Infectious Disease Surveillance (SACIDS) was formalized in 2008 as a consortium of academic and research institutions with a One Health focus (25). It aims to strengthen capacity to detect, identify and monitor infectious diseases of humans, animals, and plants and their interactions in order to better manage the risks posed by them. SACIDS bridges the ministries of human health, livestock and wildlife in the 14 Southern African Development Community (SADC) countries and brings together infectious disease researchers from multiple sectors. Sokoine University of Agriculture, Tanzania, serves as a formal institutional base for the network. The focus of SACIDS is on academic training and research capacity development. The network has also been working with EAIDSNet to pilot an android driven mobile telephone system for rapid cross-border communication of animal-human health surveillance information.

Value of Regional Networks

Infectious disease patterns reflect dynamic systems of global interconnectedness. Networks are not only the means through which rapid diffusion of disease can spread, but they can also become a critical alternative to formalized institutional responses to outbreaks. This is especially true for issues of transnational concern where formal governance structures are inadequate (26). Here, we explore how regional disease surveillance networks add value to global disease detection and response and the challenges they face.

1. Complementing global, other regional, and country disease surveillance systems. The WHO leads the global response to disease outbreaks, not just from its headquarters in Geneva but also at the regional and country levels, taking advantage of expertise available through partner institutions. In 2000, recognizing that comprehensive surveillance depends on many different players and networks, WHO created the Global Outbreak Alert and Response Network (GOARN) which serves as a network of networks "to link this expertise and skill to keep the international community constantly alert to the threat of outbreaks and ready to respond" (27). More recently, the International Health Regulations (IHR) mandate official reporting of certain types of disease outbreaks to WHO. Complementing WHO efforts are a range of global internet-based networks and electronic search engines such as the Public Health Agency of Canada's Global Public Health Intelligence Network (GPHIN) (28) and ProMed Mail (29). These efforts aim to facilitate surveillance on a global scale, while offering new opportunities for information sharing and access. Global disease surveillance still faces challenges in reporting due in part from the lack of national disease surveillance capacity in lower and middle-income countries; limited diagnostics capabilities; and disincentives to reporting due to harsh economic consequences (30, 31). Regional disease surveillance networks have addressed some of these limitations, and have helped to cross the geographic and topical boundaries of the

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Table 1. A summary of activities undertaken by networks in CORDS

Practitioner-driven networks	Countries Involved	Diseases Monitored through Regular Cross-Border Reporting	Illustrative Joint Response of Regional Significance & Sectors involved	Pandemic Preparedness Exercises Undertaken	Work at the Animal-Human Health Interface	Financing
MBDS (1999)	Cambodia, China (Yunnan and Guangxi Provinces), Lao PDR, Myanmar, Thailand, Vietnam	Acute flaccid paralysis, SARS, cholera, H5N1, dengue fever/ dengue hemorrhagic fever, typhoid fever, measles, malaria, pneumonia, HIV/AIDS, tuberculosis	SARS, H5N1, cholera Cross-border response teams comprised of health, customs, immigration, and border officials	Six national tabletop simulation exercises; one regional exercise; multiple provincial and cross-border exercises	Core component of strategic plan; field epidemiology training for veterinarians; border investigations involving human and veterinarian sectors	RF, NTI, Google.org,
EAIDSNet (2000)	Burundi, Kenya, Tanzania, Rwanda, Uganda	Acute haemorrhagic fevers, Cholera, Yellow fever, Measles, Plague, Poliomyelits, Bloody diarrhea Cerebro-spinal meningitis, Neonatal tetanus, Rabies, Malaria, Typhoid fever, Diarrhea in <5 years	Cholera, ebola, marburg, wild polio virus. Cross-border response teams with veterinary, human health, security, biosecurity and communication	Regional tabletop simulation exercise; national-level desk top exercises; cross-border field simulation (Kenya-Uganda border)	Component of transboundary integrated disease surveillance efforts; veterinarian sector participates	RF, European Union, EAC
SEEHN (Southeastern European Health network) (2001)	Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Moldova, Montenegro, Romania, former Yugoslav Republic of Macedonia	Influenza, brucellosis, measles, Crimean-Congo hemorrhagic fever, West Nile Fever, salmonella; vaccine preventable diseases	Works with experts from WHO, European CDC, UK Department of Health. Involvement of health and other sectors (veterinary, customs, ecology, wildlife, etc)	Joint preparation of influenza pandemic preparedness plans at both national and regional levels; introduction of molecular techniques into influenza surveillance laboratories region-wide. Regional table top pandemic preparedness exercise	Broader investigation of Brucellosis and pandemic preparedness with involvement of veterinary sector.	SEE countries governments Greek government French government Belgian government
MECIDS (2003)	Kingdom of Jordan, Israel, the Palestinian Authority	Salmonella, shigella, H5N1, leishmaniasis	Foodborne disease, H5N1, H1N1 Ministries of human and animal health and agriculture	Tabletop simulation and semi-functional drills; trainings, data sharing	Training and exercises conducted across sectors for identification and response	NTI; World Bank
Research-driven networks	**Countries Involved**	**Types of Research**	**Sectors Involved**	**Pandemic Preparedness Exercises**	**Animal-Human Health Interface**	**Financing**
APEIR (2006)	Cambodia, China, Indonesia, Laos, Thailand and Vietnam	Knowledge generation, policy research, research capacity building, on avian influenza and infectious diseases	Research partnerships with Agriculture, Health, Education, Sciences	n/a	Multi-country research partnerships; Eco-health concepts; e.g., Surveillance and Monitoring of Avian Influenza in Migratory Birds; Policy impact assessments of poultry vaccination	IDRC, Health Systems Research Institute (coordinating office)
SACIDS (2008)	Democratic Republic of Congo, Mozambique, South Africa, Tanzania, Zambia	Research using geo-spatial analyses, resource mapping and preparedness analyses, research on specific diseases, applications of mobile technology	Research partnerships with human, livestock and wildlife health	n/a	Climate dependent vector-borne diseases; diseases with potential inter-species concern; disease of economic and food security importance; bacterial rare diseases; dangerous emerging diseases	RF, Google.org, NTI, Wellcome Trust

largely vertical networks under WHO leadership. For example, MBDS has helped to connect a small number of countries that share borders but reside within two separate WHO regions.

2. Harnessing network power. The regional networks described here and throughout this issue of *Emerging Health Threats* have gained interest among some scholars for their contributions to global health security, particularly for their role in implementing the International Health Regulations (2005) (2, 32). However, other scholars have critiqued the health security motive as driven by trade interests and fears of bio-terrorism. Critics argue that vertical disease surveillance networks sometimes unfairly challenge low-income countries to upgrade their surveillance capacity for the benefit of more developed countries; and that efforts to harmonize definitions, detection and reporting benefit nations with more advanced surveillance systems and developed economies more than they benefit less advantaged nations (4, 6, 33, 34). If many low and middle-income countries lack access to the tools and knowledge to participate effectively, the networks are rendered less significant to the global response and less relevant to their own needs. Indeed, in coining the term "network power," Grewal (35) suggested that globalization implicitly benefits powerful nations and groups through the establishment of dominant "standards" adopted through networks.

But network power can work to the advantage of low and middle-income countries. We posit that investing in regional disease surveillance networks strengthens national health systems and regional and global cooperation, thereby promoting health security everywhere (36). Regional disease surveillance networks prioritize building trust-based relationships that enable informal reporting and the rapid sharing of sensitive information; and enabling cross-border collaboration and the strengthening of technical capacity to detect and respond to infectious diseases in peripheral border areas with marginalized populations. When organizing their networks, nations and individuals make decisions based on local needs and priorities. In sum, regional networks strengthen *social and intellectual capital, capacity, and connectedness.*

Network power of this type is maximized when multiple mechanisms in the region are well coordinated. For example, in the Mekong region there are many mechanisms in addition to MBDS that can enhance disease surveillance, including WHO, ASEAN, the Asian Development Bank Mekong Project, and Aryawadee-Chaophraya-Mekong Economic Cooperation Strategies (ACMECS). The coordinating office or steering committee of each regional network needs to recognize and work with these other mechanisms to avoid duplication and to utilize the strengths of each mechanism. For example, with WHO or ACMECS support, MBDS was able to involve Myanmar in regional activities when funding for Myanmar was embargoed due to political sanctions by western governments.

3. Adapting to complex challenges. As network scientist Albert-Laszlo Barabasi pointed out, "The truly important role networks play is in helping existing organizations adapt to rapidly changing conditions. The very concept of network implies a multidimensional approach" (37). The rapidly changing conditions associated with infectious disease spread require multinational, multi-sectoral, multi-disciplinary solutions. In part because of their local reach, regional disease surveillance networks can contribute to these solutions by engaging other institutions and sectors in their efforts to establish multi-sectoral cross-border outbreak response teams or multi-disciplinary research teams.

4. Making networks work. Multi-country networks work when principles of sovereignty are maintained, when trust and confidence are established, and when technical professionals can freely deliberate and make collective decisions (38, 39). Further, the networks featured in this supplement illustrate other essential features as outlined by Anklam (40). Each regional network began with voluntary, not mandatory, participation; involvement is based on expertise, not by formal position, with expertise becoming available to the network as needed; and network members have a sense of belonging that fosters trust and cooperation. In sum, the networks featured here have cultivated a growing capacity to detect and curtail global and regional threats through local action and collaboration.

Future challenges

The regional networks described in this paper have been supported by governmental commitments of personnel and expertise and essential catalytic funding by philanthropic partners. For example, the Rockefeller Foundation, with its ability to work flexibly with a range of institutions – from governments to academic institutes to non-governmental partners – awarded a combination of grants to regional networks in support of research; training; information and technology innovation; policy-making among government, academia, and other sectors; and travel and communications to enable members of different networks to connect with each other. The Foundation approach required a delicate balance to ensure that complementary interests among all partners were met as the networks worked toward achieving their respective common goals. While philanthropic donor support was critical to initiating the networks, members will need to mobilize the majority of future resources

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from their governments and other sources in order to sustain their efforts. Sustaining networks also requires maintaining the interest and support from national governments and future generations of public health leaders, particularly when founding members/partners retire; and continuing engagement and support from other stakeholders and ministries, including customs, border security. Because surveillance is a public good at national, regional and global levels, asking member countries, international organizations, and other partners to invest is a legitimate approach.

In addition to challenges around financing and sustainability of networks, language and cultural differences, along with the broader geopolitical context, often present barriers to effective cooperation. This is true even though regional networks organize in response to shared threats and challenges.

Conclusions

Table 1 summarizes the major features of the networks described in this Supplement and connected through CORDS. Practitioner networks began by defining and reporting infectious diseases. They then established cross-border reporting mechanisms that prioritized diseases according to how frequently they would be reported. As relationships matured, countries within the networks undertook joint outbreak investigations and other response efforts, and incrementally included sectors beyond health. In recent years, they have applied pandemic preparedness exercises for joint planning and focused increasing attention on the animal-human health interface. Research networks described in this supplement emerged later, with a focus on multi-sectoral collaboration and research on the animal-human health interface. Figure 1 illustrates how the networks connect through overlapping country membership within regional networks and between regional secretariats.

Two key factors contributed to the emergence and growth of regional infectious disease surveillance networks. First and foremost, the ongoing engagement of governments, coupled with the longevity of membership of individuals in the networks, has enabled some networks to extend over more than a decade and all networks to build incrementally on knowledge and experience. In many of these networks, senior members have actively mentored the younger generation to take on increasing leadership and decision-making roles. Second, the networks have leveraged multiple initiatives and have adapted their respective governance structures to the context of their regional institutional landscapes.

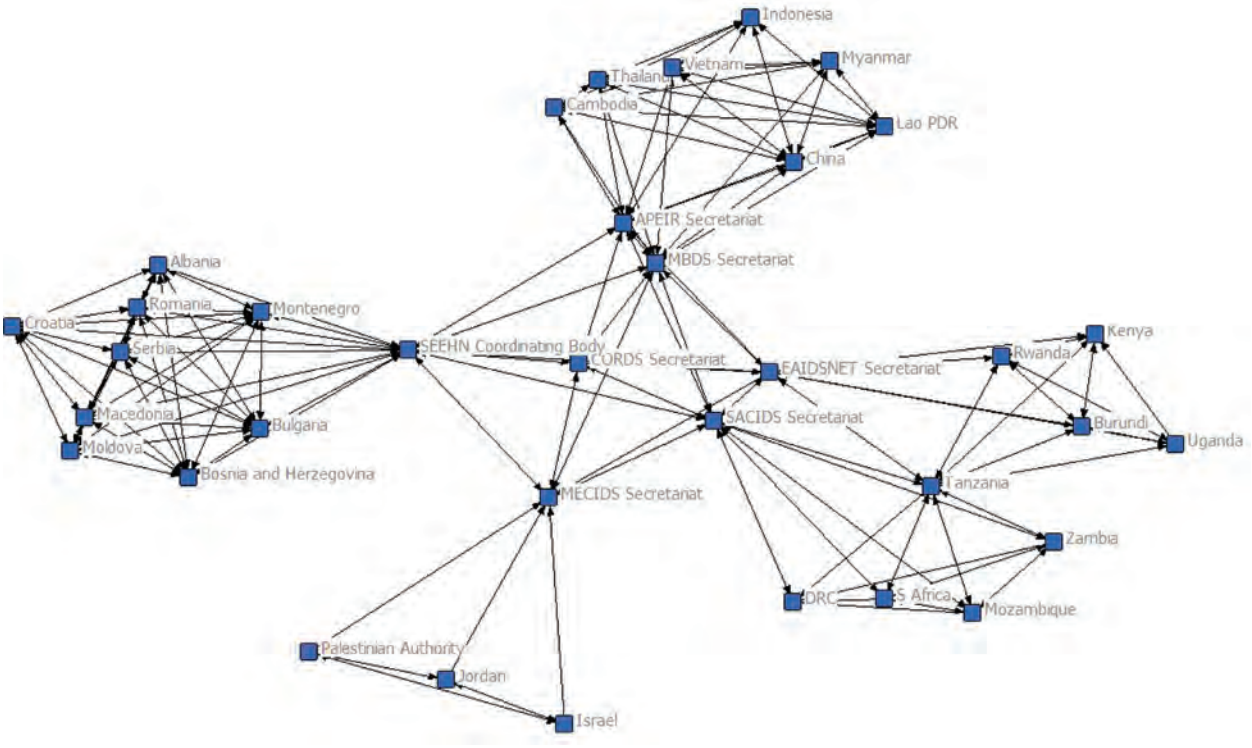

Fig. 1. A social network graph illustrating the connections among countries and regional networks in CORDS (CORDS = Connecting Organizations for Regional Disease Surveillance; MBDS = Mekong Basin Disease Surveillance network; EAIDSNet = East Africa Integrated Disease Surveillance Network; SEEHN = Southeastern European (SEE) Health Network; MECIDS = Middle East Consortium for Infectious Disease Surveillance; APEIR = Asia Partnership on Emerging Infectious Diseases Research; SACIDS = Southern African Centre for Infectious Disease Surveillance). Source: Katherine C. Bond.

For example, EAIDSNet was able to integrate into the EAC after the EAC became a treaty organization, while MBDS remained an informal network of governmental and private philanthropic and technical partners until it was formalized as a nationally registered foundation in 2012. MBDS was also the basis for the formation of the ACMECS, ASEAN+3FETN and APEIR. As the networks become institutionalized, they will face a new set of challenges, from identifying diversified and sustainable sources of funding to adapting to newly emerging public health threats. Given that the drivers of emerging infectious diseases are likely to continue or increase, we expect to see ongoing interest in this approach and the establishment of new networks in other regions, such as South Asia. The last 15 years has demonstrated the strong likelihood they will succeed.

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COACTION

Mekong Basin Disease Surveillance (MBDS): A Trust-Based Network

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The Mekong Basin Disease Surveillance (MBDS) network was formally established in 2001 through a Memorandum of Understanding signed by six Ministers of Health of the countries in the Greater Mekong sub-region: Cambodia, China (Yunnan and Guangxi), Lao PDR, Myanmar, Thailand and Vietnam. The main areas of focus of the network are to: i) improve cross-border infectious disease outbreak investigation and response by sharing surveillance data and best practices in disease recognition and reporting, and by jointly responding to outbreaks; ii) develop expertise in epidemiological surveillance across the countries; and iii) enhance communication between the countries. Comprised of senior health officials, epidemiologists, health practitioners, and other professionals, the MBDS has grown and matured over the years into an entity based on mutual trust that can be sustained into the future. Other regions have started emulating the network's pioneering work. In this paper, we describe the development of MBDS, the way in which it operates today, and some of its achievements. We present key challenges the network has faced and lessons its members have learned about how to develop sufficient trust for health and other professionals to alert each other to disease threats across national borders and thereby more effectively combat these threats.

Keywords: *MBDS*; *trust-based collaboration*; *Mekong Basin*; *infectious disease surveillance*; *regional network*; *cross-border*; *human resource*; *outbreak investigation and response*; *FETP*; *epidemiological capacity*

Introduction

In February 1999, representatives of the six bordering countries through which the Mekong river runs – Cambodia, China (Yunnan and Guangxi), Lao PDR, Myanmar, Thailand, and Vietnam (Figure 1) – convened in Bangkok, Thailand, and agreed to work closely to combat disease outbreaks in the region (sometimes referred to as the Greater Mekong Sub-Region). At this meeting, facilitated by the Rockefeller Foundation (RF) (2), participating epidemiologists and policy makers proposed creation of the Mekong Basin Disease Surveillance (MBDS) network and, upon returning to their respective countries, obtained approval from their ministers of health to establish MBDS. Development of MBDS was in direct response to the 1997 memorandum of understanding between the World Health Organization (WHO) and the Association of South East Asian Nations (ASEAN) which identified disease prevention and control as a priority for inter-country collaboration; and it coincided with a "wake-up call" from the WHO Director-General "to the world's governments, decision makers, and the private sector to take action against infectious disease before it is too late" (3).

The flow of the Mekong river and its tributaries provide environmental continuity and shared livelihoods, but also common health challenges for people of diverse nationalities closely linked by cultural, historical, and linguistic ties. For example, cholera is a constant threat to livelihoods in all countries in the region; its reporting is politically sensitive particularly because of its threat to tourism (4). In 1999, when MBDS was coalescing into a network, there was a serious outbreak of cholera in a remote northern province of Cambodia bordering Vietnam during which 874 cases and 56 deaths were

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Fig. 1. Greater Mekong Sub-region. Source: United Nations Environment Programme (UNEP) (1).

reported (5). Cambodia recognized that not only did it need to strengthen community-based surveillance, but also that it could better contain such epidemics if Cambodian and Vietnamese epidemiologists and officials worked together.

Health status in the region also reflects national as well as regional economic and political diversity. So while the spectrum of communicable diseases in the six countries is qualitatively similar, incidence varies considerably. For example, in 2010 the incidence of tuberculosis in China, Lao PDR and Thailand ranged from 78 to 137 cases per 100,000 population, which was about half the incidence in Cambodia, Myanmar and Vietnam where it ranged from 199 to 347 per 100,000 (6). In 2010, infant mortality rates ranged from 42 to 50 per 1000 live births in Cambodia, Lao PDR and Myanmar, compared to 11 to 19 per 1,000 live births in Thailand, China and Vietnam.

The context in which MBDS emerged differed from the one in which it operates today. People living in the six countries were familiar with the dangers of communicable diseases – such as multi-drug-resistant malaria, dengue hemorrhagic fever, sexually transmitted diseases, HIV/AIDS, tuberculosis, Japanese encephalitis, visceral leishmaniasis, hepatitis E and cholera. Also, while there was a strong tradition of public health and epidemiological intelligence in the region, particularly in Thailand, the lower income countries were still developing human resources to strengthen their health systems. National systems for controlling outbreaks of infectious diseases were weak and understaffed. Moreover, although international aid supported vertical reporting to WHO of national data for specific diseases such as malaria, tuberculosis and HIV/AIDS, epidemiologists found it difficult to communicate politically and economically sensitive information horizontally between countries or via the internet. The six countries set up MBDS with three main areas of focus: i) to improve cross-border infectious disease outbreak investigation and response by sharing surveillance data and best practices in disease recognition and reporting and by jointly responding to outbreaks; ii) to develop expertise in epidemiological surveillance across the countries; and iii) to enhance communication between the countries. Today, MBDS plays a key role in disease control in the region, enhancing efforts by governments, WHO, and U.S. Centers for Disease Control and Prevention (CDC) to build national and regional capacity to face the dangers of new disease outbreaks such as SARS and avian influenza H5N1 (7).

Governance and Values

The health ministers of each MBDS member country signed two memoranda of understanding, the first in 2001 and the second in 2007, to provide an agreed framework for the governing structure and processes of the consortium (Figure 2): each country would be represented by a country coordinator; the country coordinator would work closely with cross-border coordinators responsible for designated sites where the extent of cross-border movement could lead to disease outbreaks; a network secretariat would organize regular meetings of country and cross-border coordinators and support all members in the network's activities; and an MBDS Executive Board, made up of one policy maker at the senior level from each member country, would set policy and link the network to higher levels of government. Country coordinators are usually epidemiologists based in the health ministry departments responsible for disease surveillance; the MBDS Secretariat is hosted by the Thai Ministry of Public Health, which provides office space and other support.

The leaders of MBDS realized the importance of institutionalization of the network and have been working towards this since 2008. After a great deal of discussion and brainstorming, the network decided to turn itself into a legal entity. In January 2012, MBDS formally registered in Thailand as a foundation. The main purpose of this new arrangement is to mobilize funding so that MBDS can continue its activities unhindered. MBDS formed a new board with representatives of the six countries and a few "invited" members, and is recruiting

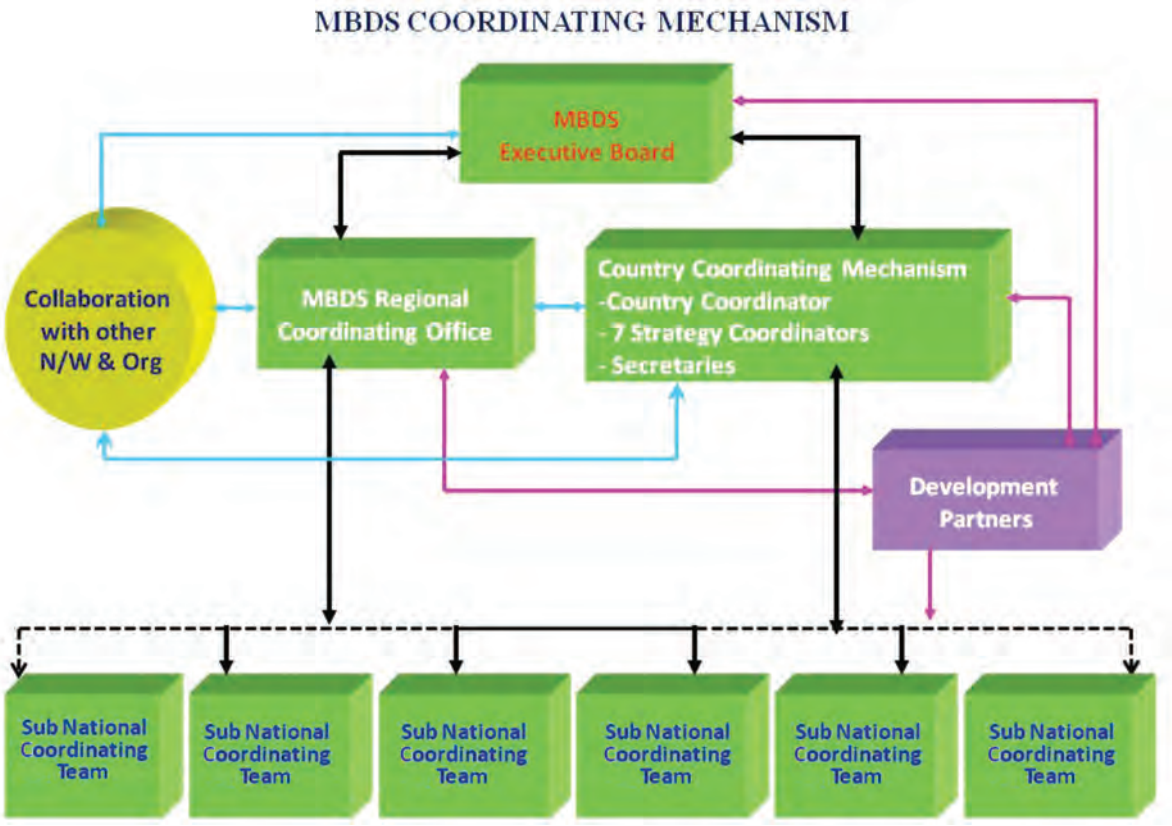

Fig. 2. MBDS coordinating mechanism (N/W & Org = networks and organizations). Source: MBDS.

a new director with relevant experience to help the MBDS Secretariat.

While MBDS operates within an agreed governance structure and according to agreed processes, it is driven by informal trust-based relationships between MBDS member countries. Although mutual trust is the core value of the network, this trust did not appear overnight, but grew steadily. Joint activities have gradually built a platform for regular interactions among the country coordinators, local cross-border teams, and other stakeholders to learn about each other as professionals and as individuals and to foster a sense of community. A decade after its birth, all founding MBDS leaders are still actively involved in network activities. This crucial continuity of leadership is also apparent at the border sites, for example, the Mukdahan and Savanhnaket health staff on the Thai-Lao borders regularly communicate with each other informally, as villagers and patients frequently cross the border. In a trip to the Bokeo and Chiang Rai site, a colleague working for one of MBDS's international partners (8) observed the cordial relationship between the staff of the local health departments of Lao PDR and Thailand and the active exchange of information taking place between them using modern technologies. Language is often a barrier in communicating, but this was not the case as the two countries understood each other's languages.

The informal trust-based relationships between MBDS member countries complement the formal vertical MOU-based relationship and WHO/International Health Regulations reporting structures (9, 10) - especially important as the MBDS countries cross two WHO regions (i.e., the South-East Asia Region and Western Pacific Region). Thus, the governing structure of the MBDS is – like a piece of "social fabric" that is skillfully woven by crisscrossing horizontal (informal trust-based relationships) and vertical (formal and official relationships) threads.

International Organizations Partnering With MBDS

A number of partners contributed to the development of MBDS. The RF was the primary and first donor and provided core support from 1998 to 2012. Other major donors and partners have included: the Agence Française de Développement (AFD); Asia-Pacific Economic Cooperation Emerging Infections Network (APEC EI-Net) maintained by the University of Washington; ASEAN Plus Three Emerging Infectious Disease (EID) Programme under the auspices of the Association of Southeast Asian Nations (ASEAN) Secretariat and

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funded by the Australian Agency for International Development (AusAID); Asian Development Bank Greater Mekong Sub-regional Communicable Diseases Control Project (ADB-GMS-CDC); Innovative Support to Emergencies, Diseases and Disaster (InSTEDD); Kenan Institute Asia; Nuclear Threat Initiative Global Health and Security Initiative (NTI GHSI); Program for Monitoring Emerging Diseases (ProMED), an activity of the International Society for Infectious Diseases (ISID); RAND Corporation; World Health Organization (WHO); the World Organization for Animal Health (OIE); and the United Nations System Influenza Coordination (UNSIC).

MBDS has itself contributed to the development of other similar regional networks, through the active involvement of its members. The spontaneity of the relationships between MBDS members was instrumental in forming the ASEAN Plus Three Centre for Emerging Infectious Disease where 6 of the 13 members are MBDS members (11), the ASEAN Plus Three Field Epidemiology Training Network (12), and the Asian Pacific Emerging Infectious Diseases Research Network (APEIR) with 3 of its 5 members from MBDS countries (13). These networks were also linked by MBDS's to its participation in Connecting Organizations for Regional Disease Surveillance (CORDS).

Strategies and Achievements

Over time, MBDS priorities have evolved to reflect its three phases of development (Table 1) (see reference 17 for a discussion of the three phases). During the first phase (1999 to 2003), country representatives met regularly, set up committee structures, established the MBDS Coordinating Office in Thailand, and began developing capacity.

The arrival of avian influenza H5N1 in late 2003 and the growing threat of an imminent influenza pandemic signaled the need for new methods to strengthen preparedness nationally and regionally. Thus, during the second phase (2004 to 2007), while MBDS representatives continued to build capacity and worked together to set up multiple cross-border projects, they undertook regional simulation exercises to plan for pandemics. Specifically, as described in Text Box 1, MBDS and its partners

Table 1. Timeline of significant epidemiological events and regional collaborative response during the initial 12 years of MBDS

Year	Outbreaks/epidemiological events	Regional collaboration
MBDS Phase 1: Formation and development of MBDS, building trust and capacity		
1999	Cholera outbreak in Vietnam	International Field Epidemiology Training Program (IFETP)-Thailand responded (14)
2000	The first licensed rotavirus vaccine was withdrawn in 1999	Asian Rotavirus Surveillance Network was initiated in 2000 (15)
2002	Severe Acute Respiratory Syndrome (SARS) outbreak in China	Information exchange within the sub-region on cases and travelers
2003	SARS and H5N1 avian influenza outbreaks in China, Vietnam, and Thailand	Initiation of ASEAN Plus Three work plan
MBDS Phase 2: Building capacity, setting up cross-border sites and preparing for pandemics		
2004	Avian influenza outbreak in Prachinburi, Thailand; Tsunami in Thailand	Human and animal sectors started working together in all countries; ASEAN Plus Three Ministers of Health joint declaration on protection and control avian influenza (16); surrounding countries assisted Thailand cope with the tsunami.
2005	Avian influenza and botulism outbreaks in Thailand; human plague outbreak in China	IFETP-Thailand recruited a veterinarian.
2006		In-country regional simulation exercises to prepare for pandemics
2007		Regional pandemic preparedness simulation exercise
MBDS Phase 3: Seven core strategies based on needs identified during phases 1 and 2		
2007	Cholera outbreak in Thailand; Chigunkunya outbreak and melamine contamination of milk products in China	Joint cholera outbreak investigation between Thai and Lao teams (Text Box 2)
2008	Cyclone *Nargis* in Myanmar	ASEAN/MBDS assistance to Myanmar
2009	Pandemic H1N1 in all MBDS countries and measles in Hanoi, Vietnam	Communication on outbreak detection and responses; and FAO started an International Field Epidemiology Training Program for Veterinarian (FETPV) in this region
2010	Hand foot and mouth disease in China and dengue hemorrhagic fever in Lao PDR	Start of ASEAN Plus three Field Epidemiology Training Network (11)
2011	Tsunami in Japan; flooding in Thailand	Tele-conferences between ASEAN Plus Three countries on hand foot and mouth disease and to respond to the flooding

(RF, NTI, CDC and RAND) designed and carried out a series of "tabletop" simulation exercises to: i) explore national and regional cross-border strategies in pandemic emergencies; ii) identify priorities to improve preparedness and response; and iii) develop recommendations to help guide further MBDS programming and donor investments. These exercises informed development of the MBDS Action Plan (2008–2013) described in Table 2 (21, 22).

Text Box 1. MBDS regional tabletop simulation exercises

In 2006, after the outbreak of H5N1 avian influenza in the region, MBDS countries recognized the urgent need to strengthen national and regional preparedness to face new pandemic threats. From August to October 2006, MBDS brought together representatives from the public health, agriculture, foreign affairs, defense, and finance sectors and from WHO, OIE and UNSIC to develop scenarios and plan and carry out a series of tabletop simulations within each country. In March 2007, Cambodia hosted the first ever regional level pandemic preparedness simulation exercise, attended by 85 participants. The simulation focused on pandemic capabilities with the greatest relevance to transnational cooperation: surveillance and information sharing, disease prevention and control, and communication. These exercises contributed to greater confidence and ownership at the national level; and improved communication, trust and collaboration at the regional level. They also led to other applications of the tabletop simulation methodology. Myanmar used the methodology in 2008 to plan its response to a severe outbreak of diarrhea; Lao PDR used it in 2009 to plan medical emergency preparedness while hosting the Southeast Asian Games; and Vietnam conducted tabletop simulation exercises in 2009 and 2010 for the control of animal-to-human disease transmission.

During the third phase (2008 to 2011), network activities fell within seven core strategies, each strategy led by one country based on its capacity or its interest to develop the relevant capacity: (i) enhance cross-border communication and information exchange; (ii) improve the human-animal sector interface and strengthen community surveillance; (iii) develop human resources and strengthen epidemiological capacity; (iv) strengthen capacities for information and communications technologies; (v) strengthen laboratory capacity; (vi) strengthen risk communications; and (vii) conduct and apply policy research. (See Table 2 for a summary). Here, we describe two of these core strategies in detail (i and iii).

Enhancing Cross-Border Communication

MBDS established 16 functioning cross-border sites at major crossings between the six countries (Figure 3). The purpose of these sites is to facilitate cross-border teams of health, customs, immigration, and border officials to undertake joint outbreak investigation and response. National MBDS coordinators and adjacent provincial site coordinators exchange routine surveillance data about suspected outbreaks: daily for any case of influenza H1N1, acute flaccid paralysis (AFP, i.e., potential polio), SARS, cholera/severe diarrhea, encephalitis, tetanus, meningitis, diphtheria, and public health emergencies of international concern (PHEIC); weekly for cases of leptospirosis, chikungunya, dengue fever, typhoid fever and measles; monthly for cases of malaria and pneumonia; and less frequently for cases of HIV/AIDS and tuberculosis. Field Epidemiology Training Program (FETP)-Thailand works in collaboration with the rapid response teams at cross-border areas to evaluate and strengthen their joint surveillance and response activities (23, 24). These teams investigated and contained dengue fever outbreaks between Lao PDR and Thai provincial sites in January 2005 (Khanthaboury Province) and June 2006 (Xaythuthong province); a typhoid and malaria outbreak between provincial sites in Lao PDR and Vietnam (Savannakhet and Quang Tri provinces) in 2006; and an avian flu incident in Lao PDR after detecting an infected Laotian in Thailand in 2007 (Text Box 2). In May 2008, the Thai and Myanmar MBDS teams worked together to combat the effects of Cyclone Nargis when it hit Myanmar (Text Box 3).

Strengthening Epidemiological Capacity

MBDS and its partners have organized extensive training for member countries under the leadership of the International Field Epidemiology Training Program (IFETP)-Thailand. IFETP-Thailand, the U.S. CDC and WHO provided two-year FETP training to mid-career public health professionals from all six member countries (plus Malaysia and Bhutan) and on-the-job training to FETP alumni to become FETP trainers. Additionally, with support and commitment from the U.S. CDC, the WHO Western Pacific Regional Office, and other development partners, a competency-based epidemiology training program, similar to FETP, was launched and grew promisingly in Vietnam, Lao PDR and Cambodia, with graduates from IFETP-Thailand serving as trainers for these national programs. Other training programs that MBDS has been involved with include postgraduate training for physicians from Lao PDR and China, with the support of NTI and the Prince of Songkhla University, Thailand; short-course training on laboratory management, geographical information systems, and use of epidemiological software for members of the cross-border rapid response teams, with support from the RF;

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Table 2. MBDS Core Strategies

Strategy	Country responsible	Major activities and achievements	Partner support (See text for full names)
1. Enhance cross border communication and information exchange	Lao PDR	Set up 16 cross-border sites for disease control cooperation and disease surveillance information exchange.	ADB-GMB-CDC, ASEAN Plus Three EID Programme, K.L. Asia, RF
2. Improve the human-animal sector interface and strengthen community surveillance	Vietnam	Shared experiences of collaboration between animal and human sectors working between the Cambodia and Lao border provinces.	ADB-GMB-CDC, ASEAN Plus Three EID Programme, K.L. Asia, ProMed, RF, WHO
3. Develop human resources and strengthen epidemiological capacity	Thailand	Conducted joint investigations of dengue hemorrhagic fever and H5N1 influenza cases 2007; trained 41 FETP trainees and 6 FETP trainers; agreed on human resource development indicators (18); and established FETP programs in Vietnam (2009), Lao PDR (2009), and Cambodia (2011).	ADB-GMB-CDC, APEC EINet, ASEAN Plus Three EID Programme, INSTEDD, K.L. Asia, NTI GHSI, ProMed, RAND, RF, University of Washington Center for Excellence in Public Health Informatics, WHO
4. Strengthen capacities for information and communications technologies	Cambodia	Established GeoChat, a SMS-based real time surveillance reporting system across the MBDS countries, in Mukdahan, Thailand.	ADB-GMB-CDC, APEC EINet, InSTEDD, K.L. Asia, ProMed, RF, University of Washington Center for Excellence in Public Health Informatics
5. Strengthen laboratory capacity	China	Assessed capacity and needs of 40 laboratories in six MBDS member countries in Cambodia, Guangxi, Yunnan, Lao PDR, Myanmar, Thailand, and Vietnam.	ADB-GMB-CDC, AFD, ASEAN Plus Three EID Programme, InSTEDD, K.L. Asia, NTI GHSI, RF, WHO
6. Strengthen risk communications	Myanmar	Documented experience of national level disaster management collaboration with ASEAN and UNICEF.	ADB-GMB-CDC, ASEAN Plus Three EID Programme, ProMed, RF, WHO
7. Conduct and apply policy research	Collective	Assessed pandemic influenza response among MBDS countries (19); and the potential of regional infectious disease surveillance networks to facilitate implementation of international health regulations (20).	ADB-GMB-CDC, ASEAN Plus Three EID Programme InSTEDD, RAND, RF

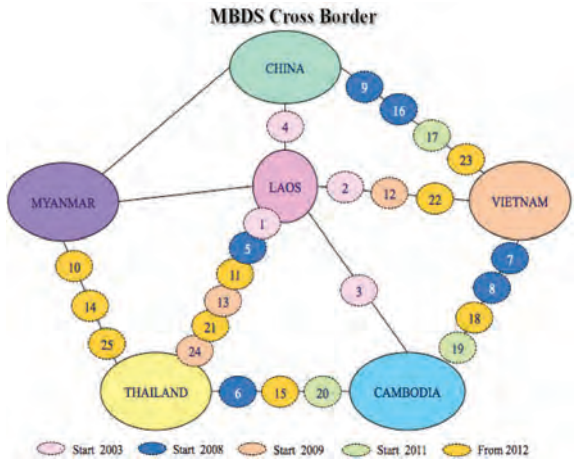

Fig. 3. Location of cross-border sites developed from 2003 to 2012 ("From 2012" sites include some sites still pending). Source: MBDS.

short-course training courses in surveillance and response organized by the ministries of health in Cambodia, Lao PDR, Vietnam, and China; and a variety of training projects supported by RF and NTI through MBDS.

Text Box 2. Joint outbreak investigation of a human H5N1 influenza case by Rapid Response Team (RRT) in Lao PDR, and Surveillance and Rapid Response Team (SRRT) in Thailand, 2007

Following an announcement of an avian influenza H5N1 outbreak among poultry in Nong Khai Province in Thailand, which borders Lao PDR, a similar outbreak among poultry was confirmed in Vientiane, Lao PDR. The Lao PDR investigation team had also identified three suspected human cases, one reportedly admitted to Sethathirath Hospital, Vientiane. The Lao and Thai teams worked closely with each other and with the Lao PDR and Thai Ministries of Health to facilitate confirmation of the first human avian influenza case in Lao PDR. After being admitted to the hospital in Vientiane on February 15, the index case was transferred to Nong Khai on February 17. The Lao RRT notified the Nong Khai Provincial Health Office of the transfer on February 19. The Lao RRT and Thai SRRT initiated a joint Lao-Thai investigation on February 20, with specimens for H5N1 testing collected that day and tested the next day at the Thai NIH. They tested positive. The Lao PDR and Thai Ministries of Health participated in the joint investigation on February 24–25, and the Lao PDR Ministry of Health publicly announced the first human case of infection with H5N1 virus on February 27. This collaborative effort strengthened the surveillance system, public health workforce, and border practices on both sides.

Text Box 3. MBDS response to Cyclone Nargis

On May 2, 2008, Cyclone *Nargis* struck the Irrawaddy Delta of Myanmar, causing the worst natural disaster in recorded history and resulting in at least 138,000 fatalities and destruction of property estimated at over U.S.$10 billion. Lack of relief facilities led authorities to fear a "second wave" of fatalities from diseases (25). A rapid response team of physicians, psychologists, and environmentalists from MBDS Thailand and Thai Red Cross assisted victims of the cyclone in the Myuangmya region, approximately 46 miles from the hardest hit area (Figure 4). The team was concerned about outbreaks of infectious respiratory diseases that might spread to neighboring countries without immediate intervention. No outbreaks were detected, except a few cases of respiratory illnesses. This post-disaster relief effort may not have been mobilized or succeeded in its mission without the existing relationships and collaborative procedures formed through the trust-based MBDS network.

Fig. 4. Images of MBDS post-disaster relief aid to Cyclone *Nargis*-affected area in Myanmar. Source: MBDS.

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Also to enhance epidemiological capacity, in 2009 IFETP-Thailand reviewed each member country's human resources capacity in epidemiology. Based on the review, Thailand developed and published a set of 20 indicators for human resource development in epidemiology (18) and conducted a follow-up review in 2012.

A number of evaluations of the MBDS have been carried out. The most recent was conducted by an independent team led by SEAMEO-Tropmed. It confirmed the relevance and efficiency of the MBDS network as it has responded to the needs of the countries in the region in terms of disease surveillance, capacity building, and outbreak investigation and containment. This review also highlighted the various impacts the network has had, including the creation of trust between countries (26).

Lessons Learned

Here we highlight two key lessons learned over the 13-year history of MBDS. First, there is a big difference between running a project and running a longer term trust-based collaboration. A project has an end date and responsible persons whose aim is to achieve the agreed results in due time no matter what will happen. A collaboration whose goal is to build trust requires more time and does not inherently have an end date. Trust cannot be established without the type of common understanding among member countries that can only be gained through continuous engagement. Only by working with each other over time, for example by making decisions about difficult situations through "consensus" and by rotating leadership of the network on an annual basis, did MBDS establish trust and derive strength from it. The mutual trust established over these years is a strong platform for sustaining MBDS collaboration into the future (27).

A second key lesson learned is the value of working with official structures. Most disease surveillance systems in the region and elsewhere are mainly run by government systems. It was a prudent decision at the beginning to place MBDS within the official governance structures of each country. For example, the fact that country coordinators are government officials who already know each other and are friendly to each other facilitates MBDS operations and makes MBDS contributions integral to government operations.

Moving Forward

Because building trust takes time, continuity of leaders and sustained support from development partners is crucial. Long-term commitment from the RF and other partners has significantly contributed to the network's success. The future will depend on how the health leaders of the six countries evaluate the continued relevance of the network in constantly changing contexts and how the network's new legal entity, the MBDS Foundation, carves out its role. It is expected that the newly formed MBDS Foundation, in addition to solidifying and institutionalizing cooperation, will serve as the network's financial arm by mobilizing resources from different funding agencies, including from governments of member countries. Also contributing to network sustainability are the large number of development agencies which have used the MBDS mechanism and structure for their own disease surveillance network; the ministries and provincial health offices in bordering countries or provinces which have the network's culture of cross-border information exchange; and the large number of FETP graduates now occupying important positions in member country ministries of health.

Since its inception, MBDS has been tested by historic health events. After several years of interactive learning through joint actions, individual leaders and their staff have firmly established a mutual trust and overcome many difficult challenges. A good example is the joint outbreak investigation into an H5N1 case between Lao PDR and Thailand which was implemented without even a formal document or official agreement (Text Box 2). In the first three years of MBDS existence, when mutual trust was not strong, sharing of outbreak information was difficult. However, as mutual trust improved, cross-border data sharing dramatically increased. Today, MBDS serves as an exemplary model for regional disease surveillance in other parts of the world, including Southern Africa, Eastern Africa, the Middle East and South Asia.

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COACTION

Regional Initiatives in Support of Surveillance in East Africa: The East Africa Integrated Disease Surveillance Network (EAIDSNet) Experience

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The East African Integrated Disease Surveillance Network (EAIDSNet) was formed in response to a growing frequency of cross-border malaria outbreaks in the 1990s and a growing recognition that fragmented disease interventions, coupled with weak laboratory capacity, were making it difficult to respond in a timely manner to the outbreaks of malaria and other infectious diseases. The East Africa Community (EAC) partner states, with financial support from the Rockefeller Foundation, established EAIDSNet in 2000 to develop and strengthen the communication channels necessary for integrated cross-border disease surveillance and control efforts. The objective of this paper is to review the regional EAIDSNet initiative and highlight achievements and challenges in its implementation. Major accomplishments of EAIDSNet include influencing the establishment of a Department of Health within the EAC Secretariat to support a regional health agenda; successfully completing a regional field simulation exercise in pandemic influenza preparedness; and piloting a web-based portal for linking animal and human health disease surveillance. The strategic direction of EAIDSNet was shaped, in part, by lessons learned following a visit to the more established Mekong Basin Disease Surveillance (MBDS) regional network. Looking to the future, EAIDSNet is collaborating with the East, Central and Southern Africa Health Community (ECSA-HC), EAC partner states, and the World Health Organization to implement the World Bank-funded East Africa Public Health Laboratory Networking Project (EAPHLNP). The network has also begun lobbying East African countries for funding to support EAIDSNet activities.

Keywords: *EAIDSNet*; *One Health*; *regional surveillance network*; *East Africa*; *EAPHLNP*; *disease surveillance*; *field simulation exercise*

Introduction

The East African Community (EAC) partner states (Kenya, Uganda, Tanzania, Rwanda, Burundi) share a similar disease profile (1). Communicable diseases remain a major public health problem in the region, with HIV/AIDS, malaria, tuberculosis, respiratory infections, and diarrheal diseases continuing to cause high morbidity and mortality. For example, East African countries have suffered a huge burden of cholera over the past several years due largely to poor sanitation and inadequate supplies of safe water (2). Between 2002 and 2006, most Tanzanian regions reported cholera cases; nine regions reported more than 2,000 cases (3). In 2009, several Kenyan districts suffered cholera outbreaks, with 274 deaths and approximately 11,000 cases reported (4). The risk factors for some of these diseases, including influenza, are different in East Africa than in other parts of the world, with HIV-infected persons being more susceptible (5). East Africa is heavily affected by the HIV pandemic.

The communicable disease burden in the region is made especially challenging by the fact that some disease

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outbreaks, like the viral haemorrhagic fevers, cross geopolitical borders of the EAC partner states (6–8). For example, in 2007 an outbreak of Rift Valley fever was reported in Kenya and Tanzania, resulting in more than 1000 cases and 300 deaths (9). Other viral haemorrhagic fevers with the potential to spread across borders that have been detected in East Africa include Ebola in Uganda in 2000 (Gulu, Masindi and Mbarara districts), 2007–2008 (Bundibugyo district), and 2011 (Luwero district) (10–12). Additionally, in 2007 two different outbreaks of Marburg virus were reported in Kamwenge district of Uganda (13).

Wild Polio Virus (WPV) has also been reported in EAC with evidence of spread across borders. In 2006, two cases of WPV were reported in northeastern Kenya (Garissa district) that were due to an importation from Somalia (14). In 2009 another 18 cases of WPV were reported in Northern Kenya (Turkana district) that were genetically linked to a strain circulating in South Sudan. Uganda, which was declared polio free in the year 2006, having reported the last case in 1996, reported four cases of WPV in 2010 that were genetically linked to the strain previously reported in Northern Kenya. In 2011, another case of WPV that was genetically linked to a circulating strain in Uganda was reported in Western Kenya (Rongo District) (15).

Most countries in the region lack incentives and resources to invest in cross-border interventions; and border areas tend to be inhabited by especially vulnerable human populations, including migrant and rural populations. The challenge is compounded by inadequate mechanisms for a regional approach to the prevention and control of communicable diseases. Consequently, East Africa is experiencing a general lack of preparedness to deal with public health emergencies occurring across international boundaries. Interventions are fragmented. Representatives from the ministries of health and academic institutions in Kenya, Tanzania, and Uganda formed the East African Integrated Disease Surveillance Network (EAIDSNet) (http://www.eac.int/eaidsnet) to address these challenges.

The main objectives of the EAIDSNet are to: i) enhance and strengthen cross-country and cross-institutional collaboration through regional coordination of activities for the prevention and control of diseases and through a One Health approach, ii) promote exchange and dissemination of appropriate information on Integrated Disease Surveillance (IDS) and disease control activities as per the WHO integrated disease surveillance and response strategy, iii) harmonize IDS systems, iv) strengthen capacity for implementing IDS and control activities, and v) ensure continuous exchange of expertise and best practices for IDS and control. This paper describes the history of EAIDSNet, major achievements and challenges, and strategies for sustainability.

History and Governance

A series of malaria outbreaks in East Africa in the 1990s led to the formation of EAIDSNet (16–18). At that time, there was no surveillance system in place for early detection of malaria outbreaks (19). In February 2000, the Tanzania National Institute for Medical Research (NIMR) brought together representatives of the Ministries of Health and the national health research and academic institutions of Kenya, Tanzania and Uganda to discuss the need for concerted efforts to ensure that correct epidemiological information is obtained and shared among the partner states and to achieve synergy in disease control efforts. Recognizing the need for a shared plan for the identification, monitoring and control of diseases in the region, EAIDSNet was founded in 2000 with financial assistance from the Rockefeller Foundation (RF) (20).

During the early days of the network, EAIDSNet activities were coordinated by the Tanzanian NIMR, which created a challenge for the sharing of information because not all member countries were obliged to submit surveillance reports to the Tanzanian NIMR. To address this, in 2003 EAIDSNet requested that a more regional body host the network. Subsequently, EAIDSNet was established under the auspices of the EAC, and coordination of activities was gradually moved from NIMR to EAC. In 2004, EAIDSNet was formally adopted by the EAC through the Council of Ministers, the second highest EAC organ after the Summit of EAC Heads of States. EAIDSNet activities became an integral part of the mandate of the disease prevention and control unit of the EAC health department (Figure 1; Text Box 1). Today, EAIDSNet activities must be approved by the EAC health sector coordinating committee, and all funds received by EAIDSNet must be included in the EAC budget and approved by the East African Legislative Assembly before activities are implemented.

In addition to further developing its governance structure and mechanism, in 2003–2006 EAIDSNet received additional support from RF to: (i) strengthen communication and collaboration in disease surveillance; (ii) strengthen the capacity of collaborating institutions and border district health management teams for strategic and operational approaches to disease surveillance and control; and (iii) collaborate on the development of staff training programs for implementation of disease surveillance and control activities.

Since 2006, EAIDSNet has focused most of its efforts on strengthening EAC preparedness to respond to regional and global infectious disease threats. In 2008 EAC began implementing the "Regional Project to Strengthen Cross-Border Human and Animal Disease Prevention and Control in the East African Community Partner States" (21). The mandate of EAIDSNet has also

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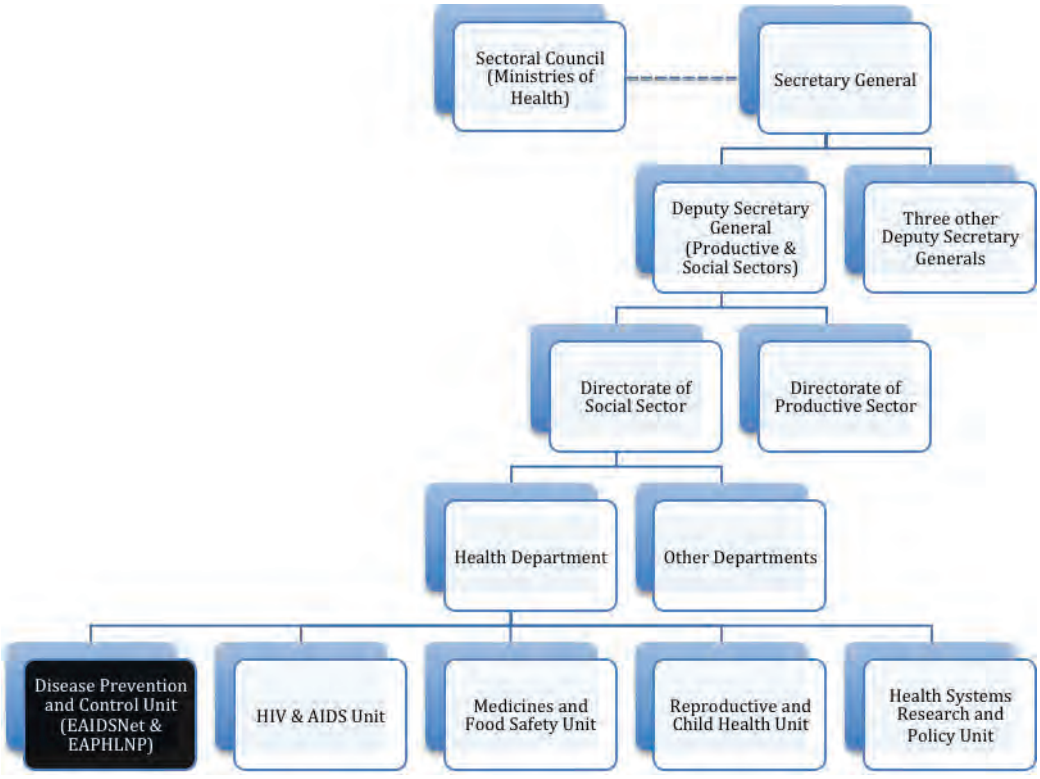

Fig. 1. Organogram of the EAC indicating where EAIDSNet is situated. Source: EAIDSNet.

expanded to Rwanda and Burundi, who formally joined the EAC in 2009.

Text Box 1. EAIDSNet led to the creation of a Health Department within the East African Community (EAC)

The need to coordinate EAIDSNet activities at the regional level created the demand for a public health specialist at the EAC. Consequently, EAIDSNet influenced and fast-tracked creation of a health department at the EAC. At the time of recruitment, the health specialist held both the animal and human health portfolios. Since then, through funding from different sources, additional officers have been brought on board to handle the different portfolios. Collaboration between the human and animal sectors has remained good, with One Health activities dominating the regional agenda.

Major Activities, Achievements, and Lessons Learned

Since the inception of EAIDSNet, recognition of the shared risk of public health threats in border areas has driven ongoing discussion about how to strengthen cross-border disease surveillance and response. Most recently, in June 2011, in collaboration with EAC partner states and under the auspices of the East Africa Public Health Laboratory Networking Project, EAIDSNet convened a meeting of laboratory and disease surveillance and response experts from the region. Government officials and development partners also attended the meeting. The objective was to agree on a framework for implementation of cross-border disease surveillance and joint outbreak investigations, including community involvement. Participants discussed harmonization of surveillance data collection and reporting, analysis, and dissemination; and joint outbreak investigation and response. Representatives from partner states made presentations followed by group discussions, plenary sessions, and in-country consultations.

During the meeting, partner states agreed on a framework for cross-border surveillance and response, which included identification of priority diseases for either immediate, weekly, or monthly reporting to the EAC Secretariat (See Table 1). Meeting participants also designed a schedule for cross-border meetings of adjoining border districts and for informal sharing of disease outbreak alerts; and discussed preparation for joint outbreak investigations and responses to diseases or threats occurring in cross-border districts (e.g., infectious diseases that incubate in one country but occur in another, diseases involving contact between people in neighboring countries). The framework for cross-border surveillance and response was developed within the context of IDSR and IHR (2005); however, it calls for information

Table 1. List of priority diseases for EAIDSNet cross-border disease surveillance.

		Frequency of Reporting		
1	Acute haemorrhagic fevers	Immediate	Weekly	
2	Cholera	Immediate	Weekly	
3	Yellow fever	Immediate	Weekly	
4	Measles	Immediate	Weekly	
5	Plague	Immediate	Weekly	
6	(AFP) Poliomyelitis[1]	Immediate	Weekly	
7	Bloody diarhoea		Weekly	
8	Cerebro-spinal meningitis		Weekly	
9	Neonatal tetanus		Weekly	
10	Rabies (animal bites)		Weekly	
11	Malaria		Weekly	
12	Typhoid fever			Monthly
13	Diarrhea in <5 years			Monthly

sharing not only through the IHR focal points, but also between neighboring cross-border districts.

In addition to achieving consensus on a framework for cross-border surveillance, the 2011 meeting resulted in the following recommendations for action, with some steps already taken:

- Seek endorsement of the framework for cross-border surveillance from member country Ministers of Health in order to enable formal sharing of information across borders. Following the meeting, partner states initiated in-country consultations to discuss the agreed upon framework and mobilize broad-based endorsement.
- Put together a regional rapid response team to conduct joint investigation of outbreaks in cross-border zones. Since the meeting, cross-border disease surveillance and response committees have been formed in the borders between Kenya and Tanzania, Kenya and Uganda, and Rwanda and Uganda. Similar rapid response teams will be formed between Tanzania and Rwanda, Tanzania and Burundi, and Rwanda and Burundi.
- Develop a regional mobile phone and web-based disease surveillance reporting system. A joint surveillance and information communication technology technical working group meeting was convened from April 30-May 3, 2012, during which technical user specifications were developed. A consultant will be hired to develop and deploy the regional mobile phone and web-based reporting system for surveillance data. The application used for the system will be enabled for both French and English languages. There will be further consultations with the countries, as the system is being developed to ensure it is acceptable to all stakeholders and implementation is on-track.

Case Study 1: Experiences of a Field Simulation Exercise of the Kenyan and Ugandan National HPAI Preparedness and Response Plans

Here we describe the experience of a simulation exercise conducted in 2010 to test the Kenyan and Ugandan national highly pathogenic avian influenza (HPAI) preparedness and response plans. The simulation exercise demonstrated EAIDSNet's role in facilitating multi-country joint testing of both national and regional preparedness plans for pandemic influenza; and highlighted areas for improvement.

First detected in Hong Kong in 1997 (22), highly pathogenic avian influenza (HPAI) has been detected in over 22 countries. Approximately 566 cases and 332 deaths have been reported in 15 countries (23). In addition to its high case fatality rate (60 percent), HPAI has been associated with a high economic burden amounting to an estimated loss of USD 20 billion primarily due to the culling of several millions of birds. While international efforts have led to widespread control of HPAI, the disease persists in several countries, including Egypt and Indonesia, and continues to pose a threat to animal and human health. Although the EAC has not experienced any documented cases of HPAI, the region is vulnerable because of its location in the migratory pathway of birds, its shared borders with high-risk countries, and continued importation of poultry products that may carry the virus.

EAIDSNet conducted one of the first field simulation exercises (FSXs) designed to test the effectiveness and efficiency of EAC partner state national HPAI preparedness and response plans. The focus of the exercise was on Kenya and Uganda. The FSX was conducted in Busia (Figure 2), a metropolitan border town between Kenya and Uganda. Busia lies within the migratory pathway of birds, has a thriving informal cross-border live bird market, and is home to many poultry farms. The exercise involved assessing the investigation and response of both countries to an imaginary scenario of a zoonotic public health emergency. Specific objectives of the FSX were to determine whether procedures were realistic and understood by all stakeholders; to reveal weaknesses and gaps; and to clarify roles and responsibilities of all key stakeholders.

The scenario for the simulation exercise was developed by experts from Food and Agriculture organization with the participation of EAIDSNet. It involved a report of bird mortality in a fish farm, followed a few days later by reports of significant mortality in a nearby backyard poultry farm and in a nearby commercial poultry farm. Meanwhile, the backyard poultry farmer had sold some of his chickens in a live bird market in Kenya. Subsequently there was a massive death of caged poultry in the bird market. Two traders from the market complained of fever, cough and sore throat and were treated at a private clinic. A few days later, the traders developed severe

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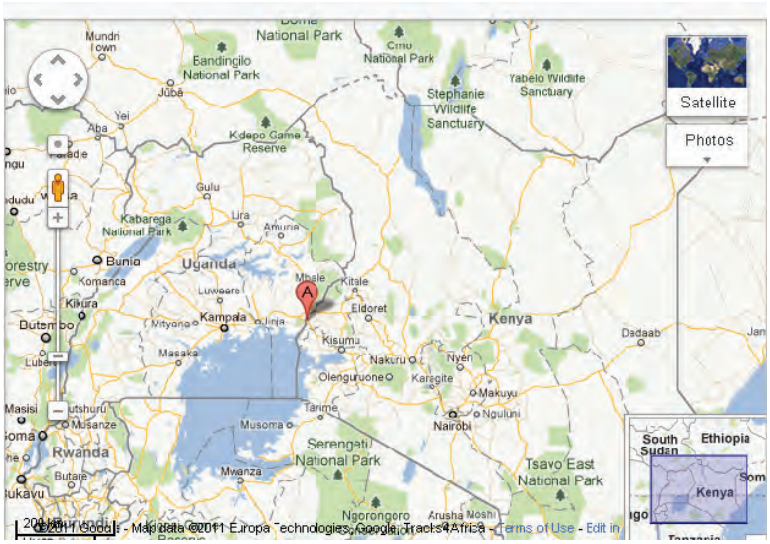

Fig. 2. Map showing the Kenya-Uganda border town of Busia, where EAIDSNet conducted a field simulation exercise to test the Kenyan and Ugandan HPAI preparedness and response plans. Source: Google Maps.

chest complications. The district veterinary officer was made aware of the two traders during his routine inspection of the market, after which he informed the clinician in charge of the local health center about the situation and referred the two traders to the health center. An evaluation criterion to determine the success of each operation was developed prior to the simulation exercise.

Several teams composed of staff of various disciplines, from both countries were formed to respond to the situation: veterinary, public health, communication, and security and biosecurity. Each team had specific roles and responsibilities to carry out. The veterinary team conducted investigations among both domestic and wild birds; identified and isolated infected areas; collected fecal, oral and blood samples from suspected birds; and confirmed HPAI at the central laboratory. They subsequently arranged for quarantine of birds at the live bird market, safe and timely disposal of carcasses, installation of footbath devices, provision of personal protective equipment, and disinfection of cages and affected areas.

The public health team conducted investigations and clinical assessments; transported suspected human cases to a designated health facility; set up an appropriate isolation unit and isolated patients; took samples for testing; and disinfected the ambulance. The communication team was responsible for producing and distributing paper and media communication; preparing and installing notice boards at crossing points; and creating public awareness through fliers, posters, and drama. Finally, the security and biosecurity teams were responsible for controlling traffic at the border and checking to see whether poultry products were being carried on board; closing some routes to the informal live bird market in order to enable thorough inspection of the vehicles; installing car footbaths; and disinfecting vehicles.

The FSX proved to be an effective method of testing regional preparedness and response. It demonstrated that control of border trade is possible in the event of an outbreak; that the synergistic roles of the different teams can be realized if the teams are composed of human and animal experts from both sides of the border; and that it is possible to increase public awareness of the risk of emergence and spread of HPAI and of the identification of areas where appropriate responses are required.

However, the exercise also revealed some weaknesses: overall poor coordination of the response activities, inadequate biosecurity measures, poor communication, and minimal involvement of medical workers in response to the HPAI outbreak. To address these weaknesses, EAIDSNet recommended that each district set up permanent multi-sectoral rapid response teams; communication materials be translated into local languages that can be understood by illiterate communities; and instructions for roadblock operations be included in the preparedness and response plans.

Case Study 2: Piloting a Web-Based Portal for Linking Animal and Human Health Disease Surveillance

In Text Box 2, we describe the design and implementation of a web portal for the linking and sharing of animal and human disease surveillance data. The design and piloting of the web portal demonstrates EAIDSNet's capacity to facilitate joint collaboration in developing a regional mobile phone and web-based system for reporting surveillance data and thus reducing significantly the cost if each country were to develop its own separate system.

Text Box 2. EAIDSNet information communication technology (ICT) survey and web portal development

An important objective of EAIDSNet is to improve the flow and quality of data and the sharing of information on communicable diseases. To help achieve this objective, first we conducted an information communication technology (ICT) situation analysis among participating EAIDSNet institutions and determined level of ICT usage among health care providers. The survey revealed that computer literacy among health workers was high, but that reporting of surveillance data was paper-based, except in Zanzibar and Rwanda where an electronic system was in use. Other EAC countries were at various stages of implementing mostly open software electronic reporting systems. Then, based on results of the ICT analysis, we developed and piloted a web data portal linking existing human and animal disease surveillance reporting systems across health facilities in cross-border districts.

In preparation for development of the web portal, we held consultative meetings with healthcare managers, inter-government agencies, ICT solution providers, and telecommunication operators. We designed the web portal using Hypertext Preprocessor (PHP) web-authoring software (Adobe™ Dreamweaver™ CS3) and two types of mapping software (ArcView GIS-9™ and HealthMapper™). As part of the pilot phase, personnel from the Ministries of Health of the partner states captured public health priority disease data into the web portal.

The pilot EAIDSNet web portal successfully mapped trends over time for diseases in selected sub-regions, and cross-border health personnel were able to view epidemiological maps in real-time. However, we faced several challenges. These included country-specific reporting requirements; late submission of weekly epidemiological data from field stations to central units; a lengthy data validation process; and different agencies requiring different data. Together, the challenges created a "burn-out" effect on data personnel at the national level. A more user-friendly portal that could auto-populate data from existing country-specific and regional systems will be essential to ensuring sustained use of the EAIDSNet web portal.

Relationship to Connecting Organizations for Regional Disease Surveillance (CORDS)

Through Connecting Organizations for Regional Disease Surveillance (CORDS) (24), knowledge sharing between EAIDSNet and older and more experienced regional disease surveillance networks, like the Mekong Basin Disease Surveillance (MBDS) network, helped shape the strategic direction of EAIDSNet and, over time, has enabled EAIDSNet to improve on other networks' best practices. For example, CORDS and Rockefeller Foundation facilitated exchange visits between the EAIDSNet and MBDS networks; attendance by both networks at the Prince Mahidol Award Conference in 2010 and the East African Health and Scientific Conferences in 2009 and 2010; and joint desktop exercises. Similarly, younger disease surveillance networks, such as the nascent West Africa Disease Surveillance Network, have much to learn from EAIDSNet.

Moving Forward

While EAIDSNet has accomplished several major undertakings in its early years, a major challenge still facing the network is that meetings are often attended by new delegates from the partner states, requiring that issues agreed upon in previous meetings be re-visited and thereby slowing implementation of regional activities. Also, institutional participation in EAIDSNet declined when EAIDSNet came under the auspices of EAC and when partner states' Ministries of Health started determining who attends the meetings. This particularly affected the academic institutions whose operations are regulated by Ministries of Education or Higher Education and not Ministries of Health. Together, these challenges make it difficult to implement joint outbreak investigations of cross-border events.

Additionally, insufficient laboratory capacity remains a major weakness in regional surveillance of communicable diseases across the EAC. Much of the equipment is outdated or has not been serviced; and laboratory providers have little opportunity for career advancement. Upon realization of this weak link, the EAC, through EAIDSNet, has partnered with the East Central and Southern Africa Health Community (ECSA-HC) to create the World Bank-funded East African Public Health Laboratory Networking (EAPHLN) Project. By strengthening laboratory capacity, the aim of EAPHLN is to improve regional surveillance in East Africa. By doing so, EAPHLN will help to realize the vision of EAIDSNet. Also looking to the future, EAIDSNet has begun lobbying East Africa countries for funding to support EAIDSNet activities.

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Southeastern European Health Network (SEEHN) Communicable Diseases Surveillance: A Decade of Bridging Trust and Collaboration

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The communicable disease threats and changes that began emerging in south-east Europe in the early 1990s – after a decade of war and while political and health systems region-wide were undergoing dramatic changes – demanded a novel approach to infectious disease surveillance. Specifically, they called for an approach that was focused on cross-border collaboration and aligned with European Union standards and requirements. Thus, the Southeastern European Health network (SEEHN) was established in 2001 as a cooperative effort among the governments of Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Moldova, Montenegro, Romania, Serbia, and the former Yugoslav Republic of Macedonia. In 2002, SEEHN initiated a communicable diseases project aimed at strengthening both national and regional surveillance systems with a focus on cross-border collaboration. Over time, SEEHN has nurtured growth of a regional fabric of SEE experts in communicable diseases surveillance and response who are able to discuss emerging issues and best practices at any time and without being constrained by the rigidity of traditional or existing systems. Main achievements to date include joint preparation of influenza pandemic preparedness plans at both national and regional levels and the introduction of molecular techniques into influenza surveillance laboratories region-wide. Here, we describe the history of the SEEHN communicable disease project; major activities and accomplishments; and future sustainability of the regional infectious disease surveillance network that has emerged and grown over the past decade.

Keywords: *SEE*; *SEEHN*; *communicable diseases surveillance network*; *South-eastern Europe*

Introduction

Communicable diseases continue to pose a threat for southeastern European countries. New infectious diseases are emerging, old diseases are reappearing (e.g., tuberculosis, West Nile Fever etc.), and incidences for many diseases are rising (e.g., HIV and other sexually transmitted infections) (1–5). Much of this evolving disease burden began in the early 1990s, when transition toward a market economy led to widespread social unrest and when civil wars in the region displaced large numbers of people and created populations that were vulnerable to communicable diseases and difficult to reach through existing health care systems (6–9). Health care reforms and the privatization of previous public services led to the technical and political isolation of many national public health institutes and services and to a lack of coordination of cross-border activities. Systemic reporting of infectious disease events was lacking in some countries; outbreak investigations were inefficient; and surveillance practices were poorly financed, outdated,

and without the flexibility needed to respond to the wide range of health threats emerging during that time. Added to these regional challenges, new global markets have facilitated the spread of infectious disease (10).

These regional and global changes demanded a novel approach to infectious disease surveillance at the regional level – one well integrated with national systems, focused on cross-border collaboration, and aligned with European Union standards and requirements. To achieve that end, in 2002 the Southeastern European Health Network (SEEHN) initiated a communicable diseases project aimed at strengthening regional surveillance via a network of experts, communicable diseases surveillance officers, ministries, public health institutes, and universities. This paper describes the history and governance of SEEHN, with a focus on its communicable disease project (one of three major SEEHN projects); major activities and accomplishments of the SEEHN communicable diseases project; and strategies for sustainability.

History and Governance

The Southeastern European Health network (SEEHN) is a cooperative effort among the governments of Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Moldova, Montenegro, Romania, Serbia, and the former Yugoslav Republic of Macedonia. Established in 2001 as the health component of the Stability Pact for southeastern Europe, SEEHN operates at political and technical levels to enhance regional cooperation and coordination in public health and to promote sustainable development of SEEHN member states by improving people's health (11).

The Stability Pact

The Stability Pact itself was established in 1999, in response to a decade of conflicts, war, humanitarian emergencies, and economic crises throughout the region. The goal of the Stability Pact was to promote stability and reconciliation in the region through three major sets of activities: (i) democratization and human rights, (ii) economic reconstruction, cooperation and development, and (iii) security (12). The role of the Stability Pact has changed over time. Originally, it served mostly as a platform to channel funds and coordinate donors' activities. Over time, it evolved into a forum for member countries and international partners to convene on an equal basis in order to identify common problems and devise shared strategies for addressing those problems.

Public health was viewed as an uncontroversial area that could have an especially significant impact on strengthening regional social cohesion. Thus, in 2000 the ministries of health of Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Macedonia, Romania, and the former Serbia and Montenegro convened a preliminary meeting in Sofia to discuss the wisdom of collaborating in regional and cross-border public health and adding health into the social cohesion agenda of the Stability Pact. In 2001, the ministries of health of all Stability Pact member countries requested that the World Health Organization (WHO) Regional Office for Europe, in collaboration with the Council of Europe, organize the First Forum of Health Ministers of South Eastern Europe. That meeting, held in Dubrovnik, Croatia, resulted in signing of *The Dubrovnik Pledge* (13), which laid out several specific objectives: increase citizens' access to appropriate, affordable and high-quality health care services; intensify social cohesion by strengthening community mental health services; increase the quality of and regional self-sufficiency in the provision of safe blood and blood products; develop integrated emergency health care services that are offered free of charge to the user; strengthen the surveillance and control of communicable diseases; strengthen institutional capacity and intersectoral collaboration for access to affordable and safe food products; and establish regional networks and systems for the collection and exchange of social and health information. The pledge ended with a call to international donors for financial assistance and to the WHO Regional Office for Europe and the Council of Europe for technical and policy support. The SEE Health Network (SEEHN) was set up later that year to ensure implementation of *The Dubrovnik Pledge*.

Communicable diseases was one of public health topics chosen by SEEHN as an area of concentration. A regional communicable diseases project office was established in Tirana, Albania, near the Institute of Public Health; and a regional network of experts, communicable diseases surveillance officers, ministries, public health institutes, and universities was formed. Over time, the project has also benefited from input from partners from other regions of Europe, such as the Institut de Veille Sanitaire (INVS) in France, the National Public Health Institute of Slovenia, and the Center of Diseases Control in Greece or other institutions in Belgium and UK.

The first SEEHN communicable diseases project meeting was held in Vlora, Albania, in August 2002. Representatives from each member country met to review existing surveillance and early warning systems for the timely detection and control of epidemics and unusual events, ways to strengthen national and cross-border surveillance, and ways that national surveillance systems could be better linked to regional and global alert and response networks. Meeting attendees established principles of cooperation for the newly formed communicable diseases surveillance network (see below); appointed leading coordinators for the network from each country in consultation with respective ministries of health (with the expectation that leading coordinators would be

supported by teams of experts in various animal and human health areas); and proposed a strategic plan for the network (see below) (14).

Since that first meeting in Albania in 2002, a commitment to long-term collaboration, coupled with the emerging risk of pandemic influenza and the mandate of the revised IHR, have driven new efforts to strengthen cross-border communicable diseases control across southeastern Europe. Most recently, a Regional Health Development Center (RHDC) on Communicable Disease was established at the Institute of Public Health, Tirana, Albania, in November, 2010.

SEE Communicable Diseases Surveillance Network: Principles of Cooperation

Attendees of the 2002 SEEHN communicable diseases project meeting established the following principles of cooperation for the newly formed surveillance network: ownership by countries of Southeastern Europe (SEE); partnership approach; equal involvement of SEE countries; equal distribution of activities and resources; sustainability (SEE ministries of health commitment to project implementation at national level, capacity-building, and mobilizing of resources for further expansion); complementary and continuity (which implies building up ongoing plans); establishment of fixed funds allocated to management; decentralization of resources; transparency and accountability; overall management by a coordinator and a multi country steering committee; and regular reporting by the coordinator and steering committee to the network.

The SEE Communicable Diseases Surveillance Network Strategic Plan

The four phases of the SEEHN communicable diseases project strategic plan are: (i) strengthen national surveillance systems through prioritization, evaluation, coordination and integration mechanisms and through training in applied field epidemiology; (ii) establish national policies and guidelines for communicable disease surveillance systems and response protocols for outbreaks that are tailored to country and subregion needs but also compatible with European Union approaches and procedures; (iii) strengthen integrated laboratory surveillance capacities and information exchange mechanisms, with special emphasis on influenza and national influenza preparedness plans; and (iv) develop and deepen regional cooperation, with a focus on common cross-border technical capacity required to deal with potential outbreaks and ensuring proper implementation of the 2005 IHR.

Major Activities

Over the past decade, the SEE communicable diseases surveillance network has undertaken several major activities in accordance with the four phases of the strategic plan, depending on country and subregion needs.

Phase 1: Human Capacity to Conduct Surveillance

The first activities of the SEEHN communicable diseases network were aimed at strengthening regional institutional and human capacities in public health surveillance and safety and health protection standards region-wide. Many of these activities were trainings. SEE surveillance officers and other public health specialists participated in an introductory course conducted by the European Programme for Intervention Epidemiology Training (EPIET) and an international applied epidemiology course conducted by Emory School of Public Health (Atlanta, Georgia, United States) and U.S. Centers for Disease Control (CDC). Additionally, regional experts collaborated with EPIET, WHO, and INVS to prepare a package of introductory training materials in applied epidemiology and surveillance system management. The package was distributed, translated as necessary, and used to train a number of communicable diseases surveillance managers across the region. Other trainings were conducted as necessary on data management and information systems, geographic information systems (GIS) and public health mapping, second generation HIV surveillance, and other topics of national or cross-border relevance.

Additionally, a prioritization exercise to determine the most important issues related to surveillance and response of communicable diseases was organized in November 2002 in Bucharest, Romania. Afterward, many of the countries performed a rapid evaluation of their own national needs in field epidemiology and ways to use existing trainings in their own curricula and practice. Based on the rapid evaluations, some countries prepared their own national introductory and applied field epidemiology courses in their national languages using national or subregional case studies (15).

These various early training activities were followed in 2003 and 2004 with assessments and analyses of communicable surveillance systems and early warning systems to streamline efforts on how to improve and integrate national surveillance systems in Albanian, Bulgaria, Moldova, Macedonia, and the former Serbia and Montenegro. In collaboration with WHO and other European experts, SEE experts prepared and implemented the assessments at national institutions and at SEEHN regional meetings in Romania and Bulgaria.

This early period of network activity was characterized by increasing contact among specialists and growing coordination among SEE countries; exchange of information on epidemiological situations and other irregular events; joint planning of future surveillance systems reforms; networking among public health and other

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relevant institutions, including laboratories; and the promotion of regional expertise in communicable disease surveillance and response. Since then, the network has held annual meetings, usually in country member capitals, with technical support provided by WHO experts and other consultants.

Phase 2: National Policies and Guidelines

Major activities undertaken during the second phase of the SEEHN communicable diseases project included: harmonization of guidelines, case definitions, and procedures with EU country standards; preparation of national policies and guidelines on communicable diseases surveillance systems and outbreak responses; revision and adaptation of new legislation on communicable disease issues; assessment of national influenza surveillance systems; preparation of national influenza pandemic preparedness plans; translation of the revised IHR into member country languages; and development of initial work plans on IHR implementation. While not all member countries completed all tasks, almost all member countries prepared national guidelines on communicable diseases surveillance and response and adapted their case definitions to align with EU standards. Launching of the revised IHR prompted different actions in different countries, with some countries preparing fact sheets and other tools to help with implementation.

Phase 3: Laboratory Capacity and Information Exchange

The third phase of the strategic plan addressed actual emerging problems, especially avian influenza. The network sought to increase regional capacity to rapidly detect clusters of human cases of avian influenza (Text Box 1) and monitor the spread of avian influenza viruses in both human and animal populations by improving integrated surveillance systems and building laboratory capacity (Text Box 2). Specifically, the network collaborated with WHO and the newly established European Centre for Disease Prevention and Control (ECDC) to manage a regional network of influenza experts. SEE influenza experts also participated in European influenza meetings in other regions and began sharing knowledge, experience, and information with experts from other areas of Europe. Additionally, SEEHN organized and coordinated joint trainings in influenza laboratory methodologies, with a focus on rapid diagnostic molecular techniques; and developed laboratory methodology training materials for use among experts with varying levels of experience in molecular techniques. Finally, a regional influenza diagnostic center was opened at the Cantacuzino Institute, Romania.

Text Box 1. A SEE regional assessment of national pandemic preparedness

A major activity of the third phase of the SEEHN communicable diseases surveillance network was an assessment of pandemic preparedness among all member countries. Country assessment visits were organized and agendas set by national contact persons. Each country was visited by a team of experts from various agencies, including WHO, ECDC, and the UK Department of Health. Comprised of experts from different areas of pandemic preparedness, the teams used an assessment methodology that had been previously applied in EU Member States (in 2006–7). The assessments involved meetings with various national and local government agencies and with regional institutes of public health to gather information on gaps, challenges, and opportunities for further improvement in pandemic preparedness. Topics addressed included planning and coordination; communication; situation monitoring and assessment; health system preparedness, including surveillance and laboratory readiness; pharmaceutical and non-pharmaceutical interventions; general society preparedness; local level preparedness planning; interoperability; and pandemic exercises. Observations made during the country assessment visits were presented in a workshop on pandemic preparedness in Romania in 2008.

After the assessment it was concluded that while a great deal of work in pandemic preparedness had been completed and much progress had been made, some components had not been addressed yet and others needed to be revised and strengthened. SEE countries and their partners were focusing efforts on strengthening avian influenza contingency plans; while doing so is a crucial step to containing the spread of a new human influenza virus, it is not the only step to pandemic preparedness. Recommendations were made for preparedness in other realms outside of the health sector; for regional collaboration; and for additional preparedness exercises.

Text Box 2. Building SEE molecular diagnostic laboratory capacity

Another significant component of the third phase of the SEEHN communicable diseases surveillance network strategic plan was building molecular diagnostic laboratory capacity. During the 2009–2010 H1N1 inflienza pandemic, hundreds of thousands of samples were tested in SEE laboratories in Tirana, Albania; Zagreb, Croatia; Belgrade and Novi Sad, Serbia; Romania; Bulgaria, Skopje, Macedonia; and

Sarajevo and Banja Luka, Bosnia and Herzegovina. Virologists and laboratory technicians responsible for the testing had been trained during the previous years using capacities developed by the SEEHN communicable diseases surveillance network. During the course of the pandemic, they shared their experiences with each other weekly and at meetings. Additionally, the Subregional Influenza Laboratory Centre at the Cantacusino Institute in Romania played a crucial role in helping several countries to document the beginning of the pandemic and in communicating to countries the importance of sharing subregional capacities.

Phase 4: Regional Cooperation

Much of the most recent network activity has revolved around strengthening regional cooperation. Many activities (especially during the 2008–2010 period) continue to focus on avian and other pandemic preparedness. These include: preparation of packages for assessing pandemic preparedness and response in each country, in collaboration with WHO and ECDC; assessment of pandemic preparedness in all SEE countries, again in collaboration with WHO, ECDC, and other international experts (Text Box 1); evaluations of the scale of the H1N1 pandemic in South East Europe and the burden of that pandemic on health systems in SEE countries; and evaluation of the use of pandemic preparedness plans in implementing the revised IHR. Plus, all SEE countries now participate in EuroFlu, a regional influenza surveillance platform launched by the WHO European region office in 2008.

In addition to its focus on pandemic preparedness, in 2008 a meeting was held in Zagreb, Croatia, to address the impact of the SEEHN communicable diseases surveillance network on IHR implementation. Following the meeting, national and subregional plans were developed to strengthen laboratory capacity and early warning systems for emerging and reemerging diseases. The plans were then tested in table top exercises in collaboration with the Health Protection Agency. At another meeting, experts from Macedonia, Albania, Italy, Greece, and the United Kingdom developed a SEE regional action plan for brucellosis surveillance and response (16, 17). In 2011, yet another meeting was held in Tirana, Albania, to share experiences and discuss potential solutions to a reemergence of measles in some SEE countries and lack of access to vaccination among some subpopulations (18–20). The meeting led to discussion of establishment of a web-based platform for sharing immunization data.

Key Achievements

The main achievement of the SEEHN communicable diseases project has been establishment of a regional fabric of experts in different fields of communicable diseases who are able to discuss emerging issues and best practices at any time and without being constrained by the rigidity of traditional or existing social structures. Over a decade of collaboration, network members have trained together, shared a wealth of collective experience, resolved difficult challenges, and learned the value of working together in pursuit of a common goal. The case studies presented in Text Boxes 1 and 2 illustrate how pooling resources across countries benefits not just the SEE region, but also bordering countries. Additionally, network members have served as expert consultants for various WHO, ECDC, and other infectious disease surveillance activities conducted in the SEE region, such as the pandemic preparedness assessments described in Text Box 1.

In addition to introductions of pandemic preparedness across the region (Text Box 1) and molecular techniques into influenza surveillance laboratories region-wide (Text Box 2), other major specific accomplishments include: training of more knowledgeable and better prepared communicable diseases officers (e.g., through applied epidemiology trainings and cross-border field outbreak investigations); improvement of national surveillance systems (e.g., establishment of national communicable diseases surveillance centers or strengthening of existing centers, introduction of surveillance problems into health care reforms); use of pandemic preparedness to strengthen general emergency preparedness; increased collaboration between animal and human sectors; and use of the network to improve initiation of IHR implementation in SEE countries.

Moving Forward

In 2008, the Stability Pact was transformed into its successor organization, the Regional Cooperation Council. This was in response to the need for a more regionally owned framework to reflect the substantial progress on the ground that had been achieved since the Stability Pact's origin and improving political, economic and social conditions across SEE. With full commitment and support from SEE countries, donor countries and other international actors, the Regional Cooperation Council inherited the mandate of the Stability Pact. As part of the transition to regional ownership, new terms for SEEHN operation, its structure, responsibilities, and funding mechanisms were laid out in the *Memorandum of Understanding on the Future of the South-eastern Europe Health Network in the Framework of the South East European Co-operation Process (2008 and beyond)* (21).

Today, SEEHN communicable diseases surveillance network members are fully committed to continuing and strengthening the collaboration that has been building over time. In addition to all member countries being fully committed to the new terms laid out in

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the *Memorandum of Understanding*, the *Memorandum* outlined steps for establishing Regional Health Development Centers (RHDCs). One of these centers was the previously mentioned RHDC on communicable diseases surveillance and control in Tirana, Albania. The center in Tirana is not only a legacy of the SEEHN communicable diseases surveillance network efforts over the past ten years, but it also represents transformation of past work into a long-term program of regional cooperation on communicable diseases surveillance and control and IHR implementation.

Additionally, the network derives strength from participation in Connecting Organizations for Regional Disease Surveillance (CORDS). Like other CORDS members, the SEEHN communicable diseases network is built on principles of trust and collaboration. CORDS interactions help to nurture both behaviors. Also through CORDS, SEEHN communicable diseases surveillance network experts regularly exchange information and share best practices with like-minded infectious disease networks, like the Middle East Consortium of Infectious Disease Surveillance (MECIDS), operating in other areas of the world.

Moving forward, partially drawing on the strength derived from CORDS, the SEEHN communicable diseases network will continue to address gaps in SEE regional infectious disease surveillance. For example, while all SEE countries participate in EuroFlu, not all SEE countries consistently report data. Plus, only four SEEHN countries conduct routine surveillance of severe disease due to influenza (Severe Acute Respiratory Infection, or SARI): Albania, Moldova, Romania, and Serbia. These gaps in influenza surveillance need attention.

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COACTION

Enhanced Surveillance for Detection and Management of Infectious Diseases: Regional Collaboration in the Middle East

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Formed before international negotiations of the revised International Health Regulations (IHR), the Middle East Consortium for Infectious Disease Surveillance (MECIDS) is a regional collaboration aimed at facilitating implementation of the revised IHR and, more broadly, improving the detection and control of infectious disease outbreaks among neighboring countries in an area of continuous dispute. Initially focused on enhancing foodborne disease surveillance, MECIDS has expanded the scope of its work to also include avian and pandemic influenza and other emerging and re-emerging infectious diseases. Here, we describe the history and governance of MECIDS, highlighting key achievements over the consortium's seven-year history, and discuss the future of MECIDS.

Keywords: *Middle East*; *cross-border collaboration*; *foodborne disease surveillance*; *avian influenza preparedness*; *pandemic influenza*

Introduction

Since the last decade of the previous century, there has been a continuous trend of increasing globalization of commerce, travel, production, and services. While this new phenomenon is providing many countries with significant economic advantages, it is also increasing the risk of novel infectious disease threats. Other environmental, host, and agent-related factors have contributed to the emergence or re-emergence of various infectious diseases (1, 2). The broad geographical dispersal of these newly emerging pathogens in both products and people has raised the need for new surveillance and response capabilities. The ability to sensitively, specifically, and promptly identify particular strains or subtypes of organisms using modern diagnostic techniques has become essential for rapidly and efficiently responding to disease outbreaks and preventing potential epidemic or pandemic spread. Additionally, as recent outbreaks of severe acute respiratory syndrome (SARS) and avian and pandemic influenza have demonstrated, these new threats are changing the way that outbreaks are dealt with—from mainly local and national responses to regional and even global approaches (2–4).

Global collaboration in infectious disease surveillance is orchestrated by the World Health Organization (WHO), most recently through the revised International Health Regulations (IHR 2005) (5). A legally binding document signed by all WHO Member States, the revised IHR set rules for improving communication between WHO and Member States and mandate that each country has the laboratory capacity to rapidly identify outbreaks. A year before the international negotiation of the revised IHR, a sub-regional surveillance network, the Middle East Consortium for Infectious Disease Surveillance (MECIDS), was established as a means to facilitate implementation of the IHR in three neighboring countries: Jordan, Israel, and the Palestinian Authority (PA). Since then, MECIDS has enjoyed a close relationship with the WHO, not just with respect to the revised IHR (see Text Box 1), but also with respect to receiving

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expert advice from WHO officials on any issue. Many MECIDS meetings are attended by officials from WHO headquarters in Geneva and from the WHO Eastern Mediterranean and European region offices. Although they are neighbors, the three countries extend across two different WHO regions: the Eastern Mediterranean and European regions. This paper reviews the development and deployment of this unique public health surveillance system.

Text Box 1. MECIDS and the International Health Regulations (IHR)

Although MECIDS was established before the final resolution by consensus on the new version of IHR 2005 (5), it has a special relationship with the World Health Organization (WHO) in general and concerning the IHR in particular. This is true even of the PA, who is not a member party in the IHR agreement (i.e., because the PA is a member of MECIDS, Palestinian officials participate in all MECID activities). In addition to the WHO generously providing public health advisors for MECIDS projects. MECIDS principals were chief delegates of their countries for international negotiations around the revised IHR; and MECIDS was operating according to the principles of the revised IHR even before the IHR were implemented. For example, during the AI outbreaks in 2006 (see Case Study No. 2), MECIDS partners decided to act according to the revised IHR even though the regulations were not being enforced yet (13). In 2007, MECIDS partners participated in a special workshop on how to implement the IHR in the MECIDS region. WHO officials from the IHR headquarters in Geneva and from the Eastern Mediterranean and European Region offices attended the meeting. Most recently in June, 2012, senior WHO officials attended a MECIDS workshop where officials from all three MECIDS country ministries of health drafted a trilateral public health agreement for regional land border crossing. The following month, MECIDS shared their IHR experience at a WHO IHR seminar in Lyon, France.

History and Governance

The potential for a Middle Eastern partnership in infectious disease surveillance was discussed in November, 2002, at a meeting held by two Washington, D.C.-based non-governmental organizations, Search for Common Ground (SFCG) and the Nuclear Threat Initiative (NTI). Meeting participants included public health officials and academics from Jordan (Ministry of Health and Royal Scientific Society), Israel (Ministry of Health, Tel Aviv University), and the Palestinian Authority (PA) (Ministry of Health, Al-Quds University). The vision was of a partnership that facilitates cross-border cooperation in public health, particularly in response to infectious disease outbreaks, through capacity building and also by encouraging human relationships that enhance regional stability and security.

The initial focus of MECIDS was on the sharing of data on foodborne disease outbreaks, specifically *Salmonella*. The same approach was more recently implemented for *Shigella*, another foodborne and person-to-person transmitted enteropathogens. Since then, data sharing has expanded to other disease areas, including avian and pandemic influenza and, most recently, vector-borne diseases.

Although its work began earlier (e.g., as described in Text Box 2, what would eventually become MECIDS held its first training in 2004), MECIDS was formally established in 2007. MECIDS maintains a secretariat headquarters at SFCG, Jerusalem, and is governed by an Executive Board that meets twice a year. Chairmanship of the Board rotates among countries every year, and Board decisions are reached by consensus. Since its formation, MECIDS has received contributions from various donors, including NTI; the World Bank (Washington, D.C.); Becton, Dickinson and Company (BD) (New Jersey, United States), and the International Council for the Life Sciences (ICLS) (Virginia, United States).

Text Box 2. Training

Regional training is an ongoing MECIDS activity. Initially, trainings were aimed at improving *Salmonella* diagnostic capabilities. In September, 2004, 35 Palestinian, Jordanian, and Israeli health professionals participated in a five-day workshop in Istanbul on key epidemiology concepts and other relevant knowledge that would help the professionals to monitor and respond to regional disease outbreaks. The following spring, microbiologists from all three countries attended a *Salmonella* identification workshop in Israel, where they received hands-on training from specialists at the Jerusalem Central Laboratory of the Israeli Ministry of Health. The four-day curriculum covered a range of topics, including *Salmonella* serotyping and phage typing, pulsed field gel electrophoresis (PFGE), use of the Vitek machine that MECIDS purchased for all three countries, and antibiotic resistance testing. In April, 2008, an additional training course on interventional epidemiology was held in Israel; 33 professionals from Israel and the Palestinian Authority attended.

Recently, efforts have shifted away from Salmonella, toward other issues. Laboratory and public health professionals from all three countries have attended meetings dedicated to the identification and

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characterization of another foodborne pathogen, *Shigella*; general laboratory safety and security issues; and the use of bioinformatics in microbiology and molecular epidemiology.

Activities and Achievements

MECIDS has been effective on many levels. In addition to sharing data and analyses, MECIDS partners have harmonized their infectious disease diagnostic and reporting methodologies; conducted joint trainings; and facilitated cross-border communication between laboratory technicians. Additionally, the partners established protocols for collaborative cross-border investigation of infectious disease outbreaks; set up an automatic notification system for cross-border events; and tested their preparedness for pandemic influenza. Here, we highlight three case studies that reflect the progress MECIDS has made during the last seven years.

Case Study 1: Laboratory-Based Enhanced Foodborne Disease Surveillance System

The consortium's first major undertaking was to establish a regional laboratory-based foodborne disease surveillance network (Figure 1). MECIDS partners agreed that significant upgrading in foodborne disease surveillance methods would play an important role in preventing and controlling the emerging foodborne disease outbreaks, which public health experts were predicting would increase as food trade in the region increased. Also, of note, as part of the WHO strategy to reduce the global burden of foodborne diseases, Jordan had been selected as the first sentinel site in the WHO Eastern Mediterranean region for a series of studies on the burden of

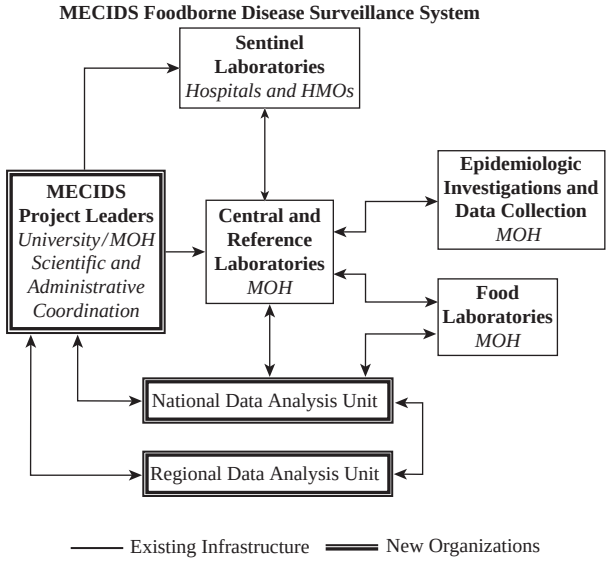

Fig. 1. A schematic of the MECIDS foodborne disease surveillance network. Source: MECIDS.

Salmonella, *Shigella*, and *Brucella* diseases. The studies revealed that foodborne disease burden was being underestimated and called for establishment and enhancement of sentinel laboratory-based surveillance for both *Salmonella* and *Shigella* in particular (6–8). Because of the likelihood that MECIDS would expand to other countries in the Middle East in the future and so that the network could be integrated with other existing networks in Europe (e.g., Enter-ne, Salm-Gene) and the United States (e.g., FoodNet, PulseNet), the partners decided to build a network that was comparable to those existing networks (9, 10).

Specifically, MECIDS chose *Salmonella* as its first foodborne pathogen target. The partners sought to establish a network of sentinel microbiological laboratories with the capabilities to identify *Salmonella*; harmonize data collection methodologies and built a common platform for communication, data sharing, and analysis; and strengthen reference laboratory capabilities to characterize *Salmonella* phenotypes (i.e., serotypes) and genotypic markers. In view of differences in existing capabilities and infrastructures between countries, the partners agreed that each country would outline its own specific immediate objectives which, once met, would help to achieve the overall goal of a regional foodborne diseases surveillance network (11). Each country selected which microbiological labs would serve as sentinel labs in the network; and designated a National Reference Lab (NRL).

In addition to selecting which laboratories would participate in the network, partners also developed standard testing procedures. The surveillance population was defined as patients attending sentinel labs for stool and/or blood cultures, food-handlers attending sentinel labs for stool cultures, and food items received by food labs. Specimens are tested for the presence of *Salmonella* using the same standard operating procedures; organisms identified as *Salmonella* in sentinel labs are submitted to the NRL for serogrouping, serotyping, and antimicrobial susceptibility tests. Also at the NRL, pulsed field gel electrophoresis (PFGE) is performed on selected isolates using standard protocols developed by the Salm-gene network in Europe. As a rule, *Salmonella* isolates are preserved at -70°C for further testing and genotyping.

Additionally, each country established a data analysis unit to manage all of the surveillance data and to serve as a central national focal point. Data collection started in 2005 (i.e., two years before MECIDS was formally established). Data include patient information (sex, age, if they are inpatient or outpatient subjects, address, etc.), as well as specimen type (stool, blood or urine) and isolate (*Salmonella* serogroup and serotype). In each country, data collected from both the sentinel labs and NRL are recorded in specifically designed data collection forms and sent on regular basis to the designated national data analysis units (i.e., the Disease Control Directorate

in Jordan, Disease Control in the Palestinian Authority, and the Center for Diseases Control in Israel). When an outbreak is first detected, the national data analysis units play a major role in alerting the public health authorities and initiating epidemiological investigations (11).

The MECIDS consortium also identified a regional data analysis unit: the Middle East Scientific Institute for Security (MESIS), located in Amman, Jordan; and established a mechanism for the national systems to share their data with the regional unit. Country reports that have been prepared by the national data analysis units, excluding patients' personal identifiers, are sent routinely to the regional unit where data are stored and regularly posted on the MECIDS website; national data are secured and only MECIDS members and authorized users are able to access them. Also, interim regional reports are presented and discussed at MECIDS executive board meetings; and posted on the consortium website. A manuscript compiling analyzed data of the first six years of regional *Salmonella* surveillance is in preparation.

Establishment of a Middle East regional laboratory-based foodborne disease surveillance network was a process – one that required building human and technical capacity so that partners could work together at similar levels of capability. This capacity was built largely through collaborative training. Text Box 2 describes a series of joint training courses on interventional epidemiology and laboratory technology that addressed not just *Salmonella* diagnostic capabilities, but also *Shigella* surveillance and regional infectious disease surveillance in general. In some cases, the necessary capacity building also involved the supply of equipment. For example, MECIDS developed support for the supply of PFGE equipment to Jordan and Palestinian Authority (both for the West Bank and Gaza), enabling both partners to collaborate with Israel which already possessed the equipment.

MECIDS researchers have also been involved in a variety of research projects on infectious disease burden in the Middle East. In 2011, MECIDS researchers reported on the underestimation of childhood diarrheal disease burden in Israel (12). More recently, MECIDS scientists completed a still unpublished study on the source and mode of transmission of *Salmonella* Infantis in Israel, where the proportion of *Salmonella* isolates identified as *S.* Infantis dramatically increased after 2009. Interestingly, recent serotyping of a large collection of *Salmonella* isolates from Jordan, Palestinian Authority and Israel showed high similarity in the distribution of *Salmonella* serotypes in Israel and the Palestinian Authority and differences in comparison to that of the Jordanian serotypes. These findings are most probably related to the closed links in food trade between Israel and Palestinian Authority.

Case study 2: Response to Avian Influenza (AI) in 2006 (13)

MECIDS partners share a unique geographical situation. Located at the junction of three continents (Asia, Africa and Europe), between the Mediterranean Sea and Arabian Desert, the three countries act as a "bottle-neck" through which a large portion of the world populations of certain migratory bird species concentrate on their way to and from their winter quarters in Africa (Figure 2). These birds serve as a continuous source of viruses, such as West Nile and avian influenza (AI). It has been estimated that every year approximately 500 million birds pass through Israel alone.

Thus, when the H5N1 AI pandemic threatened the Middle East, with poultry outbreaks occurring in nearby Turkey (October 2005), the Ministries of Health and Agriculture of the three MECIDS countries agreed to hold a meeting to discuss the threat. The meeting, which was held in Istanbul, Turkey, in December, 2005, was attended by senior officials from the Ministries of Health and Agriculture of Jordan, Israel, and the PA, as well as senior officials from the Egyptian Ministry of Health, WHO, U.S. Centers for Disease Control (CDC), and the European Union. Each country presented its national AI and pandemic influenza preparedness plan (the Ministries of Health of the attending countries had been drafting national preparedness plans since 2003 or before), and the foundation was set for real-time exchange of information in the event of an AI outbreak in the region.

Two months later, on February 16, 2006, another coordination meeting on AI took place on the King Hussein Bridge, a land crossing between Israel and Jordan, in order to share information on recent developments in AI preparedness. On the following day, the first AI outbreak in Egypt was detected involving backyard poultry, wild bird, and human cases. Although this outbreak took place hundreds of miles from the MECIDS countries, the threat was clearly imminent.

Indeed, on March 16, 2006, the first case of AI in any MECIDS country was diagnosed in Israel in some industrial coop turkey populations near the border with the PA Gaza Strip. The diagnosis was confirmed by the Israeli central veterinary laboratory. Four suspected human cases were referred to hospital emergency rooms, but none turned out positive for AI. This event was communicated immediately by phone to points of contact at the Palestinian and Jordanian Ministries of Health that had been designated at the Istanbul meetings. The World Organisation for Animal Health (OIE) and WHO were also immediately notified. Over the course of the next two weeks (March 16–31, 2006), a total of nine outbreaks of AI were recorded in industrial poultry coops across Israel. Five of these outbreaks were in coops bordering the Gaza Strip, of which one was in proximity to the Egyptian border; one outbreak took place in a poultry

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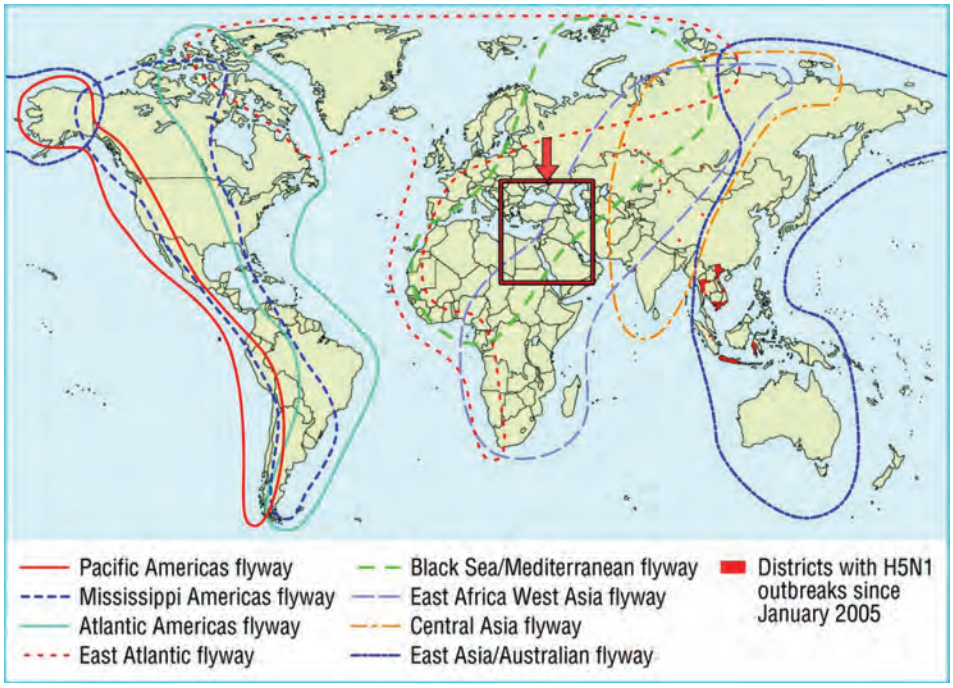

Fig. 2. Major bird migratory pathways worldwide, with MECIDS countries (in the box) serving as a "bottleneck" for the Black Sea/Mediterranean and East Africa/West Asia flyways. Source: MECIDS.

coop near Jerusalem, in proximity to the West Bank; and one outbreak took place in a settlement in the northern Jordan Valley near the border between Israel and Jordan. All poultry within three kilometer protective zones around each of the nine outbreak foci (i.e., a total of 1.2 million birds in Israel) were culled by poisoning their drinking water.

In addition to the AI outbreaks in Israel, samples from sick poultry in Gaza that were sent by the PA veterinary services to the Israeli central veterinary lab on March 22 2006, also tested positive for H5N1. In response, on that day, a meeting took place at the Gaza Crossing, with both Israeli and Palestinian veterinary and health officials attending. The officials agreed on shared protocols for coping with the outbreak and arranged for personal protective equipment, Oseltamivir tablets, and poison for poultry culling to be transferred from Israel to the PA. Over the course of the next two weeks, H5N1 virus was diagnosed in four additional locations along the Gaza Strip, among both industrial coop and backyard poultry populations. Authorities culled 600,000 birds using the same method that had been employed in Israel.

During the same time period, on 24 March 2006, Jordan reported an H5N1 outbreak in backyard turkeys in a Kofranja village (Ajloun) east of the Jordan Valley, 25 kilometers northeast of the previously mentioned infected Israeli coop in the Jordan Valley. The event was promptly reported to both Israeli and Palestinian "contact points" in the Health and Agriculture Ministries. Jordanian authorities culled 20,000 birds in the three kilometer protective zone.

On March 27, 2006, a tri-country coordination meeting took place in Jerusalem. The meeting was also attended by the WHO officer to the PA and a member of the Egyptian Embassy in Israel. Meeting attendees shared information regarding the regional AI threat and discussed cooperation, coordination and assistance among the Health and Agriculture Ministries.

Today, looking back six years after the event, MECIDS partners believe that the cooperation, mutual reporting and assistance that occurred at the time and which are described here significantly thwarted the AI threat. The opportunity to compare and synchronize preparedness plans prior to the event (i.e., during the Istanbul meeting in December, 2005) contributed to the successful mitigation and communication efforts that occurred during the actual AI outbreaks. The cooperation that occurred during the AI outbreaks extended beyond the neighboring countries providing each other with tangible aid (e.g. supplying the equipment necessary for bird culling). But also, public health officials in all three countries were updated in real-time. In addition, communication with the media was harmonized and contradictory messages to the public were prevented. The experience built trust and confidence among MECIDS member countries in cross-border health crisis management – a confidence that was tested and proven when the 2009 H1N1 pandemic influenza threatened the region.

Case study 3: Regional Response to the 2009 H1N1 Influenza Pandemic (14)

Following the AI crisis, in 2007 and 2008 MECIDS conducted a series of national pandemic influenza tabletop exercises to identify gaps in preparedness and cross-sectoral cooperation and to develop a plan of priority actions to improve preparedness and response. Also in 2008, the partners conducted a regional tabletop exercise to test cross-border cooperation and procedures in the event of a pandemic. The regional exercise involved not just public health experts and ministry of health officials, but also representatives from the transportation, education, interior, laboratory, and media sectors. The exercise was conducted in cooperation with observers from WHO (from headquarters in Geneva and both the Eastern Mediterranean and European regional offices) and the Turkish Ministry of Health. The following year, a novel influenza virus, H1N1, began its global spread.

On April 27, 2009, just two days after WHO raised the H1N1 pandemic threat level to Phase 4, MECIDS partners held an emergency teleconference to discuss a joint plan of action to mitigate the spread of H1N1 into and out of the Middle East. At that time, there were a few suspected cases in Israel. Two days later, on April 29, in response to H1N1 influenza outbreaks throughout the world, WHO Director-General Dr. Margaret Chan raised the influenza pandemic alert from Phase 4 to Phase 5. On May 1, MECIDS partners met at the WHO office in East Jerusalem with observers from the WHO and the Egyptian Embassy. The partners agreed to implement and coordinate prompt border and airport screening, laboratory testing, information exchange, and common communication strategies. This coordination was made possible by the confidence in cross-border health crisis management and trust among MECIDS partners that had been building over the past several years and to well-exercised national and regional pandemic preparedness plans. The need for such coordination was made all the more critical by the coinciding detection of new cases of avian influenza H5N1 in Egypt and concerns that the two influenza viruses would combine and form a new pandemic influenza virus.

In mid-June, the WHO raised the influenza pandemic alert from phase 5 to phase 6. At about the same time, Jordan and the PA reported their first cases of H1N1, mostly among university students returning from summer vacations in Canada and the United States.

Not until July 16, when WHO acknowledged that further spread of the pandemic was inevitable and that individual case counting was no longer essential, did the three MECIDS countries stop sharing daily reports of new cases.

Challenges Faced and Lessons Learned

The various national and regional networks of collaboration, communication, and information exchange that MECIDS partners have established over the past seven years are helping the partners not only estimate disease burden (9) but also harmonize public health intervention and prevention strategies (13, 14). The laboratory surveillance systems established or strengthened by MECIDS are an important component of this regional effort. However, a key challenge facing MECIDS is the significant lag time that still exists between the different stages of surveillance data collection and reporting (i.e., sentinel lab diagnosis, reference lab characterization of isolates, reporting). This time lag prevents real-time use of data. Another challenge is the need to be cognizant of variation in cultural and scientific sensitivities and representativeness that exists among the three MECIDS partner countries when making data comparisons at the regional level.

Moving Forward: Sustainability of MECIDS

As demonstrated in Case Studies No. 2 and 3, the platform of collaboration that MECIDS has established since that first seminal meeting in November, 2002, has become sustainable – even during times of political dispute and outbreaks of violence, as occurred in the Middle East during the influenza outbreaks of 2006 and 2009.

The "bottom-up" evolution of MECIDS through interactions between public health officials on opposite sides of country borders has been an important driver of MECIDS's success. The consortium was not built through a "top-down" directive from member countries or from agencies outside the sub-region.

Indeed, MECIDS has become a good example for other infectious disease networks that have emerged over the years and, through Connecting Organizations for Regional Disease Surveillance (CORDS), is sharing its experience with others. At the same time, CORDS also enriches MECIDS with other networks' experiences and good practices, especially with respect to implementing a "One Health" approach in tangible and rewarding ways and more than in the ad-hoc manner employed in response to the 2006 avian influenza outbreaks in MECIDS countries (Case Study 2).

MECIDS focus on foodborne diseases remains strong, with MECIDS partners not only responding to outbreak situations but also developing shared methods and a common regional database and researching the contribution of specific foods and foodborne pathogens to total disease burden. With more precise food- and pathogen-specific estimates, MECIDS partners will be able to construct effective food safety policies aimed at improving food trade and exchange in the region while simultaneously reducing the burden of foodborne disease. In the future, the consortium plans to extend its laboratory-based surveillance network from *Salmonella* and *Shigella* to other enteric pathogens, such as enterotoxigenic

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Escherichia coli, *Campylobacter jejuni*, and selected protozoa and viruses of public health importance in the Middle East.

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Sustaining a Regional Emerging Infectious Disease Research Network: A Trust-Based Approach

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The Asia Partnership on Emerging Infectious Diseases Research (APEIR) was initiated in 2006 to promote regional collaboration in avian influenza research. In 2009, the partnership expanded its scope to include all emerging infectious diseases. APEIR partners include public health and animal researchers, officials and practitioners from Cambodia, China, Lao PDR, Indonesia, Thailand and Vietnam. APEIR has accomplished several major achievements in three key areas of activity: (i) knowledge generation (i.e., through research); (ii) research capacity building (e.g., by developing high-quality research proposals, by planning and conducting joint research projects, by adopting a broader Ecohealth/OneHealth approach); and (iii) policy advocacy (e.g., by disseminating research results to policy makers). This paper describes these achievements, with a focus on the partnership's five major areas of emerging infectious disease research: wild migratory birds, backyard poultry systems, socio-economic impact, policy analysis, and control measures. We highlight two case studies illustrating how the partnership's research results are being used to inform policy. We also highlight lessons learned after five years of working hard to build our partnership and the value added by a multi-country, multi-sectoral, multi-disciplinary research partnership like APEIR.

Keywords: *APEIR*; *pandemic preparedness*; *multi-country*; *multi-sectoral*; *multi-disciplinary*; *trust-based research network*; *emerging infectious disease*; *policy*

Introduction

In 2004–2005, outbreaks of highly pathogenic avian influenza (HPAI) in poultry were reported in eight countries in Southeast and East Asia: China, Cambodia, Thailand, Viet Nam, Indonesia, South Korea, Japan, and Lao PDR. The outbreaks caused serious damages to the poultry sector and to the regional economy (1). Institutions in the most severely affected Asian countries joined together to form the Asia Partnership on Avian Influenza Research (APAIR) as a means to improve the regional response to the threat of pandemic influenza. Upon the emergence of H1N1 ("swine flu") in 2009, the network expanded its scope to include other emerging infectious diseases and was renamed the Asia Partnership on Emerging Infectious Diseases Research (APEIR). APEIR is also known as the Asia Emerging Infectious Disease (EID) research network (www.apeiresearch.net). Initially supported by Canada's International Development Research Centre (IDRC), the focus of the partnership has been on joint research activities and the translation of research results into policy and practice.

APEIR is a multi-country, multi-disciplinary, multi-sectoral research network whose focus is on regional priorities. The network is led and implemented by researchers and government officials from the region and includes representatives from more than 30 partner institutions (research institutes, universities, ministry departments). While primarily a research partnership, the network also advocates for policy and practice change in both animal and public health. Indeed, the two priorities are inter-linked. Policy advocacy provides a means to disseminate research findings, and scientific evidence from research studies assists in policy development.

The partnership has recently reviewed its functions and defined a new vision and mission. The APEIR vision is to be the leading knowledge and research network in Asia for emerging infectious diseases. Its mission is to develop a strong regional partnership in Asia that generates multi-disciplinary collaborative research on emerging infectious diseases and that facilitates communication and knowledge sharing among countries to reduce the

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threat of EIDs and the burden on these countries, especially on poor and marginalized groups in the region. APEIR's research mission is based on the Ecohealth paradigm, which is an ecosystem-based human health research approach that considers socio-economic, cultural, and environmental factors and is based on a set of six core principles (systems thinking, transdisciplinarity, multi-stakeholder participation, equity, sustainability, and knowledge for action) (2).

This article chronicles the history of APEIR and describes its governance and trust-based approach; major research activities and key achievements; and challenges for future sustainability.

History, Governance, and APEIR's Trust-Based Approach

A unique feature of APEIR is its trust-based, bottom-up approach. The network research teams and topics were formed through a collaborative process, starting with each country holding its own multi-partner consultation meeting to identify national research priorities and mechanisms for partnership at national and regional levels. Then, national stakeholders from member countries convened to discuss the possibilities. At the stakeholder meeting, country teams presented their research ideas, including objectives, team composition (lead person and institutions), concrete ideas for implementation, means of information sharing and networking, and policy relevance. Topics were identified as regional priorities if they were selected and supported by at least three countries. All of this occurred during the first year of the partnership, in 2006. Also during its first year of existence and also reflecting APEIR's trust-based, bottom-up approach, partners began a joint discussion on governance of the partnership, including both its structure and mechanism (see below). Today, the trust-based approach is exemplified by the transparent communications among the partners and the fact that all partners' contributions are considered and valued equally. Decisions are made after input from all partners.

During its second year of existence, in 2007, research proposals were finalized and funded and research projects initiated. Also during its second year, the partnership set up a regional Coordinating Office (CO), one of three key governance entities. Based at the Health Systems Research Institute (HSRI) in Nonthaburi, Thailand, the regional CO serves as the main communication hub among partners and coordinates and monitors the work of the research teams.

For the next few years (2008–2010), the research network was strengthened at both national and regional levels as collaborative research projects proceeded. Also during that period, APEIR developed a Strategic Plan 2010–2013 and identified three major, inter-related strategic directions: i) Knowledge generation and management: Support and share collaborative multi-disciplinary research on EIDs that transforms "tacit" knowledge into "explicit" knowledge through policy briefs and other products. ii) Capacity building: Strengthen the capacity of multi-disciplinary researchers, institutions and trust-based networks – within and among member countries. iii) Social and policy advocacy: Use strong collective social capital to advocate for appropriate social and policy responses, based on empirical evidence from research and practice.

Governance

In addition to the CO, the other two key entities of APEIR's governance structure are the Partnership Steering Committee (SC) and the national research teams themselves. Again reflecting its trust-based, bottom-up approach, the SC was formed by asking each country group to identify institutional representatives to sit on the SC. The country groups were asked to identify policy-makers, not scientists, and from different sectors (i.e., one representative from public health, the other from an agricultural sector). Thus, the SC is comprised of 13 members: two representatives from each country, plus a chairperson recommended by the other SC members. The chair serves a two-year term. The SC provides overall guidance, coordination and supervision of the work of the partnership. It appoints and guides the activities of the CO; and creates a supportive environment for the emergence of research projects and other network activities. Some SC members serve on high-level national committees or expert panels on EIDs, enabling them to share relevant APEIR research findings and thereby inform and influence policy.

The three governance entities – the CO, the SC, and the national research teams – regularly interact, mainly though emails. Additionally, face-to-face meetings and workshops have also been organized. For example, workshops have been held for the research teams to report their project progress and findings to the SC and for comments and recommendations from the SC to be incorporated into research updates and final reports. SC meetings are held twice a year, during which the CO reports on partnership activity progress; and SC teleconferences are conducted as needed.

Activities and Accomplishments

APEIR conducts a wide range of activities which, together, span its three strategic directions (i.e., knowledge generation and management, capacity building, and social and policy advocacy).

Knowledge Generation and Management

Under SC supervision, the national research teams have collaborated on the design, implementation, and

completion of five major IDRC-funded regional research projects (3):

1) In order to better understand the role of wild birds in spreading disease, APEIR formed a regional network for surveillance and monitoring of avian influenza viruses in migratory birds. The researchers concluded that major wild bird migration routes along the central Asia flyway overlap with areas that have experienced avian influenza outbreaks in poultry in Tibet, but that it is not clear whether the wild birds were the source of poultry infection (Text Box 1).
2) A multi-country APEIR team conducted an analysis of the socio-economic impact of human pandemic avian influenza outbreaks and control measures on small-scale and backyard poultry producers in Asia. The project revealed that the backyard poultry sector is resilient to shock even when the impact on livelihoods is considerable; and that the sector is likely to persist even if government policies call for a ''restructuring'' of the industry (See Text Box 2). By contrast, the small-scale commercial sector (i.e., smallholders whose livelihoods depend upon raising and selling poultry) is much more vulnerable to shock and needs government support to prevent bankruptcy and to assist restocking. However, farmers considered the compensation rate for culling of poultry during the HPAI outbreak to be far too small; the rate should be increased to discourage farmers from hiding or selling their infected poultry and to encourage farmers to apply control measures.
3) APEIR researchers conducted a study in five Asian countries on the characteristics and dynamics of backyard poultry systems in relation to reducing and managing avian influenza risks. The project found that biosecurity is generally quite low in both smallholder (100 percent) and larger commercial farms (70 percent).
4) An APEIR analysis of pandemic influenza preparedness policy identified variation in policy among countries and identified factors that influence policy formulation. The study concluded that scientific evidence does play a role in related discussions, but that national economic interest is also important (Text Box 2) (9).
5) Multi-country joint studies on the effectiveness of avian influenza control measures showed that: control of highly pathogenic avian influenza was achieved despite many control measures being implemented imperfectly; while vaccination in Vietnam and China was not expected to prevent (and did not prevent) all cases of infection, it almost certainly played a role in reducing both disease levels and the quantities of virus shed by vaccinated infected poultry; and, while poultry vaccination appears to have reduced the occurrence of outbreaks of poultry disease in Vietnam and China, it may be masking virus presence. Regarding the last finding, even where mandated by law, vaccination coverage is imperfect. Thus, the virus erupts from time to time. Reliance on mass vaccination may be leading to neglect of other measures.

These various research projects have generated a number of outputs, including books published in national languages, peer-reviewed scientific articles, reports, and presentations and conference papers. See the APEIR website for a list of published and on-line documents (10).

Text Box 1. Surveillance and monitoring of avian influenza in wild birds

Among APEIR's first research activities was formation of a regional network for the surveillance and monitoring of avian influenza in migratory birds to help with the assessment, prevention, and control of cross-species influenza disease transmission (Figure 1) (4). A multi-country research team comprised of Cambodian, Thai, Indonesian and Chinese scientists consolidated findings about the role of wild birds in the transmission of HPAI and collected additional samples from wild birds. For example, findings from several countries demonstrate spatial links between outbreaks of HPAI in poultry and outbreaks in wild birds (e.g., 5–6). However, some findings also reveal weak temporal links between poultry and wild bird outbreaks; evidence from Thailand suggests that spread of the virus appears to be predominantly through poultry (not wild birds). Testing of healthy wild birds resulted in a low proportion of positive samples in all countries, again demonstrating that carriage of H5N1 HPAI virus by these birds probably occurs infrequently. Together, the findings confirm the need to segregate poultry from wild birds, but also demonstrate that, even in places where wild birds and poultry are co-located, wild birds may not necessarily be the source of infection in poultry (and vice versa) (7).

Text Box 2. From policy analysis to policy impact assessment

Another of APEIR's first research activities was an analysis of national pandemic preparedness policies and plans among Asian countries. Funded by IDRC in 2007, APEIR analyzed policies regarding poultry vaccination and antiviral drugs in Thailand,

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Indonesia, and Vietnam. The research team found that the three countries' policies shared some similarities but also had some differences; and that scientific evidence played a role in policy development, but so too did national economic interest, with the same scientific evidence being interpreted differently in different countries and different national approaches sometimes impeding regional efforts (4, 8).

More recently, APEIR started another IDRC-funded study in 2011 that aims to measure the impact of poultry production policies that have been implemented in several Asian countries as protection against avian influenza threats (8). Specifically, China, Indonesia, Thailand, and Vietnam all have policies in place to protect the poultry industry by restructuring small producers into production zones or clusters in which improved standards of husbandry and farm biosecurity were to be applied. The APEIR study was designed to measure the impact of this restructuring on the risk of infection and spread of disease, including to humans. The project will be completed in 2013. The findings will improve the organization and management of poultry production zones and contribute to the ongoing policy discussion of the issue.

Capacity Building

With respect to the second of APEIR's three strategic directions, capacity building, the partnership has seized on a number of opportunities to increase the research capacity of participating research institutions as well as of individual researchers. Meetings and exchanges have enabled the national research teams to jointly design, plan, and implement their projects; and to learn from each other and share their knowledge, skills, and experiences. APEIR researchers have learned how to develop high-quality research proposals and how to harmonize their research so that they can conduct comparative studies.

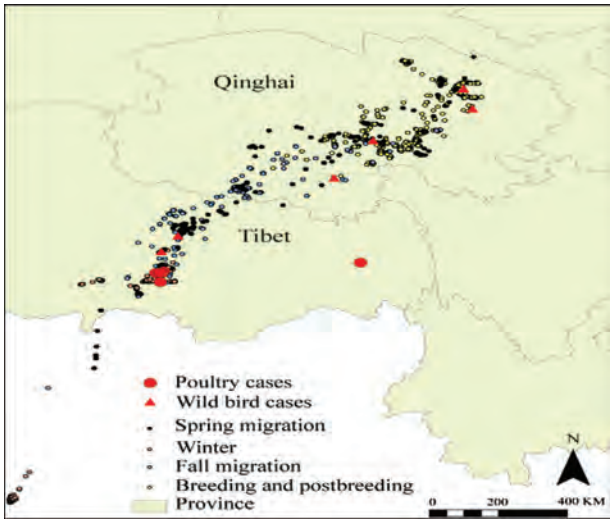

Fig. 1. Locations of HPAI outbreak sites and wild bird movements along the Qinghai-Tibetan Plateau. Source: APEIR.

Social and Policy Advocacy

Social and policy advocacy work has included producing policy briefs and other publications; holding workshops to present research reports to local authorities; and meeting or consulting with policy makers. As a result of these efforts, APEIR was recognized for its role in fostering regional collaboration at the Association of Southeast Asian Nations (ASEAN)+3 Health Ministers Meeting on Influenza A (H1N1), Bangkok, Thailand (ASEAN 2009). In 2010, APEIR held a media briefing in Kunming, China, that led to news reports around the world. Still, the network could do more. For example, it needs to take greater advantage of its SC members who are senior policy makers and who serve on high-level national committees on EIDs, as they can be effective agents for using relevant research findings to inform and influence policy.

Case Studies

We have chosen two case studies stories to illustrate the role of the APEIR research partnership in regional emerging infectious disease surveillance across Asia; and how APEIR research activities change course over time. Text Box 1 describes how an APEIR research team assessed links between avian influenza outbreaks in poultry and migratory birds and implications for EID surveillance policy. Text Box 2 illustrates how APEIR policy research has evolved from policy analysis (i.e., factors that influence national pandemic preparedness policy) to policy impact assessment (i.e., the impacts of implemented pandemic policies).

Relationship to CORDS

APEIR is an active member of Connecting Organizations for Regional Disease Surveillance (CORDS) (11, 12) and collaborates with other regional networks via CORDS in four areas: i) co-organizing with the Mekong Basin Disease Surveillance (MBDS) and other networks to share successful case studies and experience in regional partnership development, including fundraising experiences and policy advocacy; ii) co-funding workshops with other regional networks to disseminate research findings and experiences; iii) interacting with regional diseases surveillance networks by sharing experiences in designing and implementing multi-country, multi-disciplinary and multi-sectoral research projects; and iv) facilitating development of regional-specific research that responds to regional needs in the context of One Health.

Key Challenges and Lessons Learned

Over its five years, the APEIR partnership has faced several challenges and learned several lessons. Here we elaborate on two key sets of challenges and lessons learned. First, implementing cross-country, multi-institutional research projects takes time because of the harmonization required with respect to both methodology and timing. Harmonization in turn requires timely communication among the national teams, as well as strong leadership and coordination among project team leaders. Despite these challenges, working in partnership provides opportunities that would otherwise not be possible. Additionally, participating researchers are gaining new skills and experience that they can apply to other activities; and both the research institutions involved and the regional network itself are increasing their capacity to conduct similar regional studies in the future.

Second, while combining research with policy is extremely important for establishing a strong regional voice in international debates surrounding EID control debates, influencing policy makers, especially at high levels, can be challenging. APEIR is exerting influence in different ways. For some countries, such as Thailand, at least one of the SC members is in a very influential position to advocate for research-based policy change. Other countries are applying different approaches, such as engaging middle-level policy makers as chairs of steering committee for their projects, involving local policy makers in research, and organizing feedback meetings with local stakeholders.

Moving Forward

APEIR faces several major challenges to moving forward. Key among these is sustainability. At the time of the formation of APEIR, there were only a few other related networks in the region. Today, five years later, additional networks are emerging and competing for funding. The APEIR partnership is still young and still relies on continuous support from donors. During the first years of its existence, the overwhelming majority of funds for APEIR operations came from IDRC and were determined annually. The Health Systems Research Institute (HSRI), Nonthaburi, Thailand, has also provided significant in-kind contributions in terms of office space for the CO; coordination and communication support; and efforts to organize and convene the SC, regional workshops, and APEIR network meetings. In addition to funds, IDRC also provided key consultative services to help APEIR generate its own resources. As part of its Strategic Plan, 2010–2013, APEIR is striving to diversify its funding base by competing for EID research grants; by seeking more contributions from member countries and institutions; and by seeking funding from other development partners with the mandate and resources for supporting EID research and capacity-building activities in the region.

Another major challenge is that cross-country and Ecohealth/One Health approaches are still quite new to many APEIR members, making it difficult to coordinate agendas and methodologies. Differences in background, culture, and capacity can affect implementation. Related challenges are difficulty in mobilizing the partnership as a whole to generate new research ideas and to prepare high-quality research proposals for funding; and keeping old members and recruiting new members (both individuals and institutions) to the partnership.

Despite these challenges, APEIR has been successful in its early years, demonstrating value in many ways. In terms of APEIR's niche and future role vis-à-vis EIDs in Asia, APEIR's most important value-adding qualities are its multi-country, multi-disciplinary, and multi-sectoral approach; its professionally based but institutionally linked membership; and its strong research-policy interface and emphasis on policy research.

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The Southern African Centre for Infectious Disease Surveillance: A One Health Consortium

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Formed in 2008, the Southern African Centre for Infectious Disease Surveillance (SACIDS) is a One Health consortium of academic and research institutions involved with infectious diseases of humans and animals. Operating in partnership with world-renowned centres of research in industrialised countries, its mission is to harness innovations in science and technology for improving southern Africa's capacity to detect, identify, monitor (DIM) and manage the risk posed by infectious diseases of humans, animals, and ecosystems. The consortium's major capacity development activities include a series of One Health-based Master of Science (MSc) courses and a five-year DIM-driven research program. Additionally, SACIDS organized Africa's first One Health conference, in July 2011. This paper describes these and other major activities that SACIDS has undertaken to improve infectious disease surveillance across southern Africa. The paper also describes the role and collaboration of SACIDS with other national, regional and international consortia/networks that share a vision and interest in promoting novel approaches to infectious disease surveillance and outbreak response.

Keywords: *SACIDS*; *SADC*; *One Health*; *mobile ICT*; *CORDS*; *wildlife-livestock-human interaction*

Introduction

Founded in 2008, the Southern African Centre for Infectious Disease Surveillance (SACIDS) services the Southern African Development Community (SADC). Operating in partnership with world renowned research institutions in the United Kingdom, United States, and Asia, SACIDS (www.sacids.org) is a virtual center that links expertise and physical resources across institutions and health sectors with the goal of developing southern Africa's capacity for the cost-effective risk management of its regional infectious disease burden threat. It has become increasingly apparent that the most cost-effective strategy for addressing the high infectious disease burden and risk in southern Africa must be through the sharing of expertise and resources across institutions; through close collaboration between the human and animal health sectors; and, ideally, through an approach that is based on ecological systems, which in Africa often transcend administrative or national boundaries (1).

The underlying concepts for One Health have long been recognized. In the 19th century, Rudolf Virchow observed, "Between animal and human medicine there is no dividing line – nor should there be. The objective is different, but the experience obtained constitutes the basis of all medicine" (2). In the 1960's, Calvin Schwabe stated, "There is no difference between human and veterinary medicine. Both sciences share a common body of knowledge in anatomy, physiology, pathology, on the origins of diseases in all species" (3). However, only recently, largely through the risk of emerging infectious diseases, has the One Health paradigm come into sharp focus, with the dialogue shifting from one

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centered on the practice of One Health (''One Medicine'') to one centered on One Health as an outcome or goal (4, 5). Yet, still there is no universally agreed definition of One Health. At the 2007 American Veterinary Medical Association convention, Lonnie King described One Health as ''a holistic systems approach to understanding health across all species'' (6). He explained, ''It's a recognition that human and animal health are inextricably linked, and One Health is about how to promote, improve, and defend the health and well-being of all species, with the cooperation of physicians and veterinarians.'' The AVMA describes One Health as a ''collaborative effort of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals and our environment'' (7). An arguably more comprehensive description is the European Commission definition: ''the improvement of health and well-being through (i) the prevention of risks and the mitigation of effects of crises that originate at the interface between humans, animals and their various environments, and (ii) promoting a cross-sectoral, collaborative, 'whole of society' approach to health hazards, as a systemic change of perspective in the management of risks'' (8).

In the absence of a single universally accepted definition of One Health, the trend is for practitioners to describe their own One Health focus, often reflecting the underlying driver or objective of their work. Given that infectious diseases drive the mission of SACIDS, the SACIDS focus on One Health seeks to apply the concept to the management of infectious disease risk. Accordingly, we have identified the SACIDS focus on One Health as: a collaborative effort between natural and social scientists to advance the understanding of interactions between humans, animals, and their environment in the endemic settings of southern Africa. While SACIDS's One Health focus broadly relates to definitions for One Health described by others (2–8), the SACIDS focus firmly reflects its own vision and mission. The vision of SACIDS is a southern African society protected from devastating infectious diseases affecting the health of humans, animals (i.e. both terrestrial and aquatic), and ecosystems (i.e., crop, fruit, and ornamental), thereby promoting livelihoods, socio-economic development (including market access), and the environment. The consortium's mission is to harness innovation in science and technology for improving southern Africa's capacity to detect, identify, and monitor infectious diseases of humans, animals, ecosystems and their interactions and to better manage the risk posed by them.

The need for a One Health approach is supported by the findings of several recent studies (9–15). Together, these studies have shown that about 60 percent of all infectious pathogens of humans originate from animals and that, over the last 25 to 30 years, some 70 to 75 percent of emerging infectious diseases in humans originated in animals. That trend is expected to continue in the future, as economic development, changes in habitation and farming systems, globalization of travel and trade, and climatic variations continue to fuel the emergence and spread of infectious diseases. Many of these animal-originating emerging diseases in humans are endemic to Africa (and Asia) and constitute a high risk for future marginalization of Africa; and could severely constrain human mobility and access to international markets for African animal and plant commodities. Reducing the risk posed by animal and human pathogens – and their interactions – requires more than an understanding of the diseases themselves. It also requires an understanding of the social context of disease. SACIDS researchers advocate that substantial advances in infectious disease prevention and management could be made not just by integrating research across health sectors (human, animal, ecosystem), but also across disciplines (natural and social science) (16).

SADC is geographically and culturally linked to the five-country East African Community (EAC): Burundi, Rwanda, Uganda, Kenya, and Tanzania. Together, the two regional economic communities (RECs) share not only a vision for inter-regional free trade, but also an abundance of wildlife animals in their savannah and forest ecosystems and an intense wildlife-livestock-human dynamic (17). Thus, some SACIDS activities are conducted in collaboration with the East African Integrated Disease Surveillance Network (EAIDSNet) (18).

Governance

The headquarters of SACIDS is located at the Sokoine University of Agriculture (SUA), Morogoro, Tanzania. SACIDS operates as a non-profit inter-institutional consortium through the legal framework of the SACIDS secretariat host (i.e., SUA) and member institutions. At the national level, several virtual centers for infectious diseases have been formed. Collectively, these National Centres for Infectious Disease Surveillance (NatCIDS) form the core of SACIDS (see Table 1). The underlying concept of the consortium's governance is equitable representation of the human and animal health sectors at both the national and regional levels in order to ensure effective inter-sectoral collaboration. SACIDS also operates in partnership with world-renowned centres of research in several industrialised countries, especially the University of London Colleges, United Kingdom. For a complete list of partnerships, see Table 1.

SACIDS seeks to enhance the effectiveness of existing official disease surveillance systems. Thus, at both national and regional levels, SACIDS is underpinned by sector ministries and regional inter-governmental

organizations, especially SADC, the New Partnership for Africa's Development (NEPAD), and the African Union. At the national level, each NatCIDS includes as active members representatives of the Ministries responsible for human health, livestock and wild animal health; operates under the patronage of national chief medical and veterinary officers; and is linked to national offices responsible for responding to natural emergencies.

Table 1. Participants in the SACIDS Consortium

Partnership Category	Partners		
Southern African pioneer partners and constituent members of SACIDS by agreement	*Partner*	*National Coordinator*	*Constituent Members*
	Tanzanian National Consortium	Professor Mecky Matee, Head Dept Microbiology, Muhimbili University of Health and Allied Sciences, MUHAS, Dar es Salaam, Tanzania	The National Institute for Medical Research (NIMR) Ifakara Health Research & Development Centre, Tanzania The Muhimbili University of Health and Allied Sciences (MUHAS) The Faculty of Veterinary Medicine, Sokoine University (FVM-SUA) The Central Veterinary Laboratory (CVL) The Tanzania Wildlife Research Institute (TAWIRI) The Institute of Resource Assessment (IRA), University of Dar es Salaam
	Democratic Republic of Congo (DRC) National Consortium	Professor Jean-Marie Kayembe Ntumba, Associate Dean, Faculty of Medicine, Institute of Public Health Kinshasa, DRC	The Institute of Public Health of the Faculty of Medicine of the University of Kinshasa The Faculty of Veterinary Medicine of the University of Lubumbashi National Institute for Biomedical Research (INRB) The Central Veterinary Laboratory in Kinshasa National Institute for Nature Conservation (ICCN)
	Mozambique National Consortium	Dr Luis Neves, Faculty of Veterinary Medicine, Eduardo Mondlane University, Mozambique	Faculty of Medicine - Eduardo Mondlane University (FM-EMU) Faculty of Veterinary Medicine – Eduardo Mondlane University (FVM-EMU) Directorate of Animal Sciences – Institute of Agricultural Research of Mozambique - Ministry of Agriculture (DCA-IIAM) National Health Institute – Ministry of Health (INS) National Institute for Fisheries Inspection (INIP)
	Zambia National Consortium	Dr. Aaron S. Mweene, Dean, School of Veterinary Medicine, University of Zambia	School of Veterinary Medicine, University of Zambia School of Medicine - University of Zambia Central Veterinary Research Institute (CVRI) Tropical Diseases Research Institute (TDRC)

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Table 1 (*Continued*)

Partnership Category	Partners		
	South African Institutes in the SACIDS Consortium	Professor Antony Musoke, Director, Onderstepoort Veterinary Institute of the Agricultural Research Council (ARC-OVI), Pretoria, South Africa	National Institute for Communicable Diseases of the National Health Laboratory Service (NICD/NHLS), Johannesburg, South Africa Onderstepoort Veterinary Institute of the Agricultural Research Council (ARC-OVI), Pretoria Faculty of Veterinary Science University of Pretoria (FVS-UP), at Onderstepoort Stellenbosch University, Medical School, Cape Town
London strategic smart partners	London International Development Centre, University of London Royal Veterinary College, University of London London School of Hygiene and Tropical Medicine, University of London Institute of Education, University of London Imperial College, London Institute for Animal Health		
South-South collaborating institutions	East African Integrated Disease Surveillance Network (EAIDSNet) Faculty of Tropical Medicine and Center of Excellence for Biomedical and Public Health Informatics (BIOPHICS), Mahidol University, Bangkok, Thailand Southern African Development Community (SADC) Epidemiology and Informatics Sub-committee of the Livestock Technical Committee SADC Trans-Boundary Animal Diseases (TADs) Programme of SADC Secretariat African Field Epidemiology Network (AFENET) African Research Consortium for Ecosystems and Population Health (AFRIQUE One) Southern African Consortium for Research Excellence (SACORE) Connecting Organizations for Regional Disease Surveillance (CORDS) Mekong Basin Disease Surveillance (MBDS) Network		
Consultative Group on International Agricultural Research (CGIAR) partner	International Livestock Research Institute (ILRI), Nairobi, Kenya		
Other collaborating institutions from the North	Centre for Population and Eco-Health, University of Glasgow, United Kingdom Centre for Infectious Diseases, University of Edinburgh, United Kingdom Global Health and Security Initiative of the Nuclear Threat Initiative (NTI), Washington, D.C., United States Centre for Zoonosis Control Hokkaido University, Japan School of Veterinary Medicine, University of Calgary, Canada Department of Geography, University of Cambridge, United Kingdom International Institute for Environment and Development, London, United Kingdom Institute of Tropical Medicine and International Health, Berlin, Germany Meteorology Office, Hadley Centre, Exeter, United Kingdom Fondation Mérieux, France InSTEDD (Innovative Support to Emergencies, Diseases and Disasters), Stanford University, California, USA and Cambodia		

At the regional, or SADC level, SACIDS is developing linkages with sections of the SADC Secretariat that deal with human and animal health matters, not only through desk officers but also directly with the communicable diseases and livestock technical committees that advise governments on priority diseases for regional priority.

Activities and Achievements

The initial focus of SACIDS is on capacity development through employment of the Community of Practice (CoP) principle (19). A CoP is a participatory partnership among people who share a common concern and interest, in this case the vision and mission of SACIDS, and who convene regularly to learn from each other (20). Building

on existing strengths and programs, SACIDS is focused on four major sets of activities:

1) Provide training through two "One Health" MSc courses, one at Sokoine University, Tanzania, with a focus on molecular biology; the other at the University of Zambia, Lusaka, with a focus on analytical epidemiology. Each course includes core modules on the understanding of key One Health challenges. The courses have been developed and are being delivered in collaboration with regional institutions and the University of London's London School of Hygiene and Tropical Medicine (LSHTM) and Royal Veterinary College (RVC).
2) Develop research capacity, focusing primarily on five disease-driven themes: (i) climate-dependent, vector-borne diseases (e.g., Rift Valley fever); (ii) diseases with potential inter-species concern/spread between wildlife, livestock, and humans (e.g., tuberculosis); (iii) diseases of economic and food security importance (e.g., foot-and-mouth disease); (iv) bacterial rare diseases (e.g., plague); and (v) dangerous emerging diseases (e.g., viral haemorrhagic fevers). The consortium's research on One Health policy is focused primarily on disease burden in the dry land ecosystems of southern and East Africa and its impact on livestock-dependent communities (21). Another cross-cutting area of research is that on participatory epidemiology (22) and the use of mobile technologies to collect and transmit field data.
3) Share expertise and resources across consortium institutions, especially for disease emergency situations (See Figure. 1). The value of this approach has been demonstrated by the discovery of two new arenaviruses, LuJo (23, 24) and Luna (25).
4) Examine approaches and mobile technologies for improving the efficiency of disease alerts, surveillance and response (26).

Additionally, SACIDS organized the first One Health conference in Africa at the National Institute for Communicable Diseases, Johannesburg, South Africa, in July 2011 (Figure. 2). The conference covered the same research themes listed above (under the second bullet point). For each theme, young scientists presented a series of short papers, followed by a keynote paper by an invited specialist of international repute. The final session was addressed by the special conference guest, Dr. David Nabarro of the United Nations, who spoke about ways that the One Health approach is contributing not just to health but also to food security and community economic well-being. Nabarro emphasized the importance of overcoming the tendency to work in "professional niches and bureaucratic silos and, instead, sharing data and analyses,

Fig. 1. Scientists from the SADC region, including a SACIDS-sponsored postdoctoral research fellow, working in the only biosafety level 4 (BSL-4) laboratory in Africa, which is located at the National Institute for Communicable Diseases, Johannesburg, South Africa. Source: SACIDS.

Fig. 2. A poster for the first One Health conference held in Africa, in July 2011, which was convened by SACIDS. Source: SACIDS.

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developing joint policies, doing research together, implementing joint investigations and being accountable for delivering results" (27). Nabarro's address was followed by a grand debate by invited specialists who described the various facets of One Health. The conference proceedings were published in a special supplement of *Onderstepoort Journal of Veterinary Research* (28).

SACIDS One Health efforts complement other efforts to integrate human and animal disease surveillance. For example, in the spirit of One Health, the Tanzania Field Epidemiology and Laboratory Training Programme (FELTP) is governed by a multi-sectoral steering committee whose members include representatives from the Ministry of Livestock Development and Fisheries, and efforts are underway to establish a veterinary stream of the Tanzania FELTP. TFELTP is a collaboration between MOHSW, Muhimbili University of Health and Allied Sciences (MUHAS), National Institute of Medical Research (NIMR), Centres for Disease Control and Prevention (CDC), World Health Organization (WHO), and African Field Epidemiology Network (AFENET) (25). It was established by the Ministry of Health and Social Welfare (MOHSW) in 2008, following an assessment of Tanzania's existing public health and surveillance systems and recognition of the need for a competently trained public health workforce (29). Additionally, most SADC countries have adopted the WHO-AFRO system for Integrated Disease Surveillance and Response (IDSR), which promotes a One Health-based strategy (30).

Case Studies

Text Boxes 1 and 2 present case studies illustrating the ongoing activities and early accomplishments of SACIDS. Text Box 1 describes how SACIDS's selection of tuberculosis (TB) as a priority disease reflects not only SACIDS's focus on One Health, given the potential spread of TB between animals and humans, but also seeks to enhance the effectiveness of already existing surveillance systems.

Text Box 1. Tuberculosis as a priority disease for both SACIDS and SADC

Various *Mycobacteria* strains, the causative agent(s) of tuberculosis (TB), can infect both animals and humans. SACIDS's focus on TB exemplifies not only how SACIDS is focused on developing and implementing a One Health approach to infectious disease surveillance, but also how SACIDS seeks to enhance existing surveillance systems by prioritizing the same diseases that the official organs of SADC prioritize. SADC prioritizes TB because member states carry a disproportionate burden of the dual epidemic of TB and HIV/AIDS compared to the rest of Africa and the rest of the world. The region is home to 25 percent of the sub-Saharan human population but accounts for 50 percent of TB cases reported. The SADC Health Protocol includes a specific Article 12 on TB control, advocating for global and regional partnerships to respond to the TB epidemic in the SADC region (30). This fact, coupled with a lack of knowledge about the role of zoonotic *Mycobacteria* strains in the infection of humans, was a key justification for the selection of TB as an exemplar disease for study by SACIDS.

Text Box 2. Piloting mobile technologies and One Health surveillance approaches

With funding from the Rockefeller Foundation, SACIDS is collaborating with EAIDSNet on the pilot application of a One Health-based mobile technology approach to disease surveillance. The project operates in Tanzania, Zambia, and Burundi. In Tanzania, the approach has been to involve human, livestock, and wildlife sectors at the national and local levels, relying on specialists from both the human and animal sectors to agree on a set of target diseases and to design shared data-collection forms. The forms are programmed into Android-driven mobile telephones using the EpiCollect and ODK programmes (31). Primary health workers enter disease data into the mobile telephones; and data are transmitted via the mobile telephone network to a server at SACIDS headquarters for storage, analysis, and mapping (Fig. 3). Piloting efforts thus far have shown that for effectiveness and sustainability, a mobile technology-based disease surveillance system will require three key elements: i) participatory epidemiological approaches; ii) form-based reporting; and iii) resident ICT expertise for programming at the discovery end and for local support, database handling, customized programming, trouble-shooting, and training at the user end (22).

The case study described in Text Box 2 demonstrates how SACIDS is fostering inter-sectoral collaboration in One Health surveillance and response through the use of mobile technologies. Once rolled out, the One Health-based mobile technology system described in Text Box 2 will help to meet the need for a systemic exchange of disease surveillance data across the human and animal health sectors within SADC. There is no such exchange occurring except via vertical programs like the ongoing WHO-supported rabies elimination project in Tanzania and South Africa. The episodes of Rift Valley fever in 1997/8 and 2007 in Tanzania brought to the fore the need for such exchange (16, 28).

Fig. 3. Images of the SACIDS-EAIDSNet piloting mobile technology being used to conduct One Health disease surveillance in Ngorongoro (Tanzania), the Kagera Basin (cross-border across Rwanda-Burundi-Tanzania), and the Zambezi Basin (Zambia) ecosystems. Source: SACIDS.

Relationship to CORDS

CORDS provides a common vision and goal for disease surveillance that transcends regions; allows for South-South-North exchange of experiences and mutual trust; and enables bilateral collaboration between disease surveillance networks from different regions and even different parts of the world (29). SACIDS stands not only to benefit CORDS, but was itself a builder of CORDS. SACIDS participated in all of the key meetings on regional disease surveillance that led up to the formation of CORDS in 2011 and is a founding member of CORDS (16). An example of the collaborative effort made possible by SACIDS's participation in CORDS is the joint SACIDS-EAIDSNet exploration of mobile technologies for disease alerts and surveillance in remote and cross-border areas (Text Box 2).

Challenges and Way Forward

The southern and East African regions suffer from among the highest animal and human infectious disease burdens in the world. The future will likely see a growing number of infectious disease outbreaks among both animals and humans as a result of climate change, interventions themselves (e.g., new vaccines), pathogen evolution, travel and trade, changing patterns of land use resulting in increased interactions between humans and both domestic and wild animals, increasing urbanization, population growth, and changing food consumption patterns. Together, these factors will create evolving One Health challenges, such as emerging zoonoses, and an increasing demand for scientific evidence in relevant policy decision-making. The challenges will be made more difficult if policy silos between human health, animal health, and agriculture prevent the type of inter-sectoral, inter-disciplinary collaboration that is needed for One Health infectious disease surveillance and response.

But as the burden increases, so too do opportunities for reducing the burden. It is anticipated that SACIDS itself will continue to evolve as an initiative that promotes novel One Health approaches to infectious disease surveillance, such as the application of improved diagnostic and information technologies that can be used in remote rural settings. To be effective, SACIDS will need to strengthen its "engagement" and convening strategy for developing smart, shared-vision partnerships at national, regional, and international levels. CORDS helps to nurture that strength.

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COMMENTARY

COACTION

Key Findings and Lessons from an Evaluation of the Rockefeller Foundation's Disease Surveillance Networks Initiative

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The Rockefeller Foundation has a long history of providing support for disease surveillance in Asia, globally, and more recently in Africa (1–3). Most recently, from 2007–2012, the Foundation provided $22 million in support for the Disease Surveillance Networks (DSN) Initiative with the goal of contributing to the mitigation of disease outbreaks by supporting trans-national and inter-disciplinary networks aimed at strengthening national, regional, and global disease surveillance and response systems. Specifically, the DSN Initiative aimed to build individual and institutional capacity to conduct disease surveillance and response efficiently and effectively; build bridges between disease surveillance networks and international agencies to increase the effectiveness of global response systems; and strengthen connections between animal health, human health, and environmental health through a "One Health" approach.

The underlying hypothesis of the Initiative was that robust trans-boundary, multi-sectoral and cross-disciplinary collaborative networks lead to improved disease surveillance and response. In 2009–2010, the Rockefeller Foundation undertook an independent evaluation of the Initiative, with a focus on the Mekong Region in Asia, Eastern and Southern Africa, and with global partners involved in the Initiative. Evaluation teams led by the Southeast Asian Ministers of Education Tropical Medicine and Public Health Network (SEAMEO TropMed), the Swiss Tropical and Public Health Institute and African Public Health Research Centre, and the University of Washington assessed the validity of the underlying hypothesis and sought evidence of achievements, challenges, and lessons related to DSN formation and sustainability, capacity, tools, and transdisciplinary approaches (Text Box 1). Evaluation teams collected different types of data: (i) through field visits and interviews with key stakeholders; (ii) from a detailed analysis of Foundation portfolio grants; and (iii) through an innovative network analysis of the growth and connectivity of regional and global networks.

Text Box 1. Intended outcomes of the Rockefeller Foundation support to the Disease Surveillance Networks (DSN) Initiative

Outcome 1: Networks: Trans-boundary disease surveillance networks in Southeast Asia, and in Eastern and Southern Africa are formed, sustained, and evolve in order to enable disease surveillance practitioners to collaborate, share information, and learn how to more effectively address disease threats.

Outcome 2: Capacity: Disease surveillance practitioners and their institutions strengthen, apply, and distribute technical and communication skills in disease surveillance to more effectively address disease threats.

Outcome 3: Tools: Disease surveillance practitioners have access to – and use –improved tools and methods to effectively and efficiently monitor, share and report information; and respond to disease threats.

Outcome 4: Transdisciplinary Leadership in One Health: Policy makers, human health and veterinary practitioners take a trans-disciplinary approach to policy and practice in animal and human health while emphasizing "One Health" principles at global, regional and local levels.

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In commissioning the independent evaluation, the Foundation was interested in knowing whether the Foundation's work in disease surveillance was relevant to current global and regional trends and challenges in disease surveillance; whether it was efficiently and effectively used to improve skills and capacity for early detection and response; whether it was helpful to containing infectious disease outbreaks, thereby saving lives and livelihoods; and whether it is sustainable in the longer term.

This article discusses key findings of the evaluation and implications for those involved in strengthening the field of disease surveillance. The evaluation represents the only formal set of evaluations conducted thus far on any of the Connecting Organizations for Regional Disease Surveillance (CORDS) networks.

Evidence of Achievements

Evidence collected during the evaluation indicates that the Initiative made great progress towards achieving its intended outcomes. Very broadly, with its partners, the Initiative provided vision and support that helped to establish new fields of practice in One Health, as well as global health diplomacy; built substantial capacity through targeted high quality grantee support; and fostered trust among key stakeholders. These efforts were facilitated by the generation of new knowledge in the application of networking to promote global health and in the governance of sub-regional networks; and by the elaboration and adoption of innovative Information Technology (IT) tools for surveillance and response. Specific findings are described below.

Effectiveness and Sustainability of the Networks (Intended Outcome 1)

The evaluators found conclusive and compelling evidence that effective and sustainable disease surveillance networks have been well established in Asia (notably the Mekong Basin Disease Surveillance [MBDS] network) (4) and that promising networks are emerging in Africa (5–6). Field visit and interview data indicate that networks supported by the Rockefeller Foundation DSN Initiative work have demonstrated effectiveness in reporting and containing outbreaks such as dengue, severe acute respiratory syndrome (SARS), and influenza. Stakeholders on every level validated the relevance and utility of the networked approach to disease surveillance. The regional network structure is seen as one that promotes the sharing of knowledge, resources, and best practices and thereby improves country-level efficiency in adopting effective surveillance and response systems. Network structures are also seen as a way of distributing capacity and assuring timely access to technical capacity in resource poor settings. Finally, they are seen as a way to build deeper and more extensive global, regional, and local ties between disease surveillance organizations and countries. These ties not only increase access to knowledge sharing, but they also create new pathways for the flow of critical information.

Major factors driving the success of regional DSNs in Asia and Africa include: trust; transparency; a cooperative spirit; and partners with a sustained vision of a strong informal network. Government ownership, leadership and political will are also essential for success.

As shown in Figs. 1 and 2, a systematic network mapping analysis of the DSN Initiative presence in the World Health Organization (WHO)'s Global Outbreak and Alert Response Network (GOARN) shows that a small number of DSN grantees act as hubs in the larger network, connecting dozens of organizations to the global disease surveillance community and forming additional connections between organizations and countries already represented. In addition, many countries with minimal network representation benefit from organizational ties with DSN grantees. Fig. 1 shows individual disease surveillance grantees of the Rockefeller Foundation DSN Initiative prior to their involvement with the Initiative, with grantees not being well connected either to GOARN or to existing regional networks. Fig. 2 shows the growing connectedness between Initiative grantees and other organizations and countries. With Initiative support, grantees are connected both geographically and thematically with key players in disease surveillance at the global, regional, and local levels.

Not only has connectedness increased, but also critical networks at local and regional levels have become stronger as a result of the DSN Initiative. Border crossings are considered the most critical areas for containing the spread of highly infectious diseases and

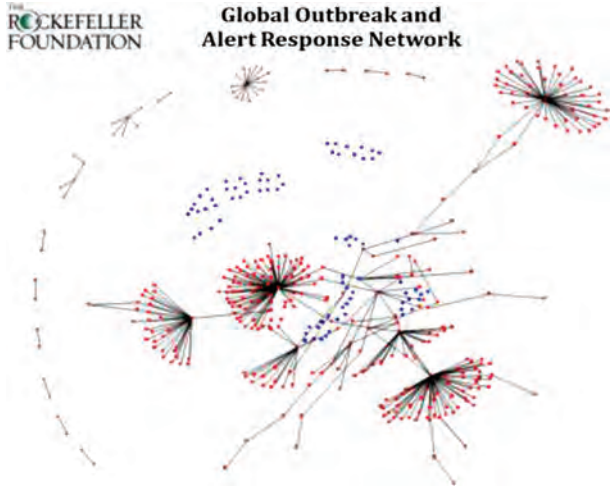

Fig. 1. Disease surveillance organizations before involvement in the Disease Surveillance Network (DSN) Initiative. Blue dots represent DSN grantees from Asia and Africa when they were first supported by the Initiative. Source: Rockefeller Foundation and Neil Abernethy.

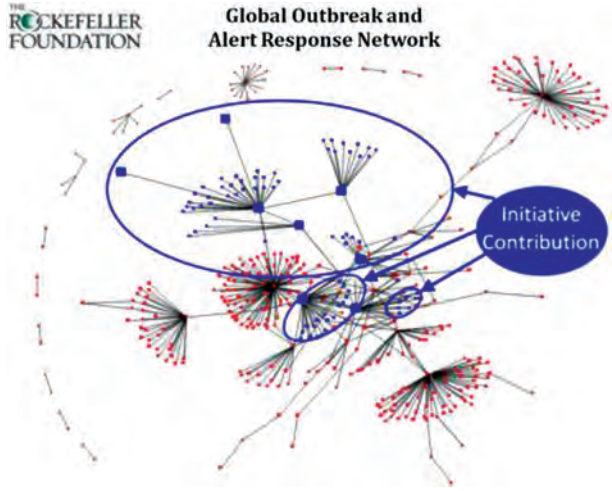

Fig. 2. Grantees after involvement with the DSN Initiative – better connected locally, regionally and globally. Connections circled in blue are those that formed after the DSN Initiative began supporting regional DSNs in Asia and Africa. Source: Rockefeller Foundation and Neil Abernethy.

pandemics from country to country. Yet, they are often the most isolated and with least capacity in the whole disease surveillance system. As shown in Fig. 3, from 2004 to 2010, local cross-border surveillance sites in the six countries of the Mekong Basin Disease Surveillance (MBDS) network increased from four to 24, covering most of the critical trade routes (4).

New Capacity (Intended Outcome 2)

A second intended outcome of the DSN Initiative was to build capacity to more effectively address infectious disease threats. Portfolio, field visit, and interview data indicate that the Initiative supported activities that contributed positively and substantively to building individual, institutional, and network capacity in epidemiology, surveillance, and outbreak investigation and response. Specifically, the Initiative supported the provision and, with local partners, development of training, thought leadership, curricula, tools, technical support, and forums for learning, sharing, and developing knowledge and best practices. Additionally, Initiative support has facilitated substantial interaction not only among different networks, but also among different sectors (e.g., animal and human health, livestock, agriculture, transportation, security, immigration). For example, MBDS is cited by network participants, peers, and partners as being fundamental in promoting the sharing of knowledge, resources, and best practices to improve the Mekong countries' surveillance and response systems. As another example, the East Africa Integrated Disease Surveillance Network (EAIDSNet) and Southern African

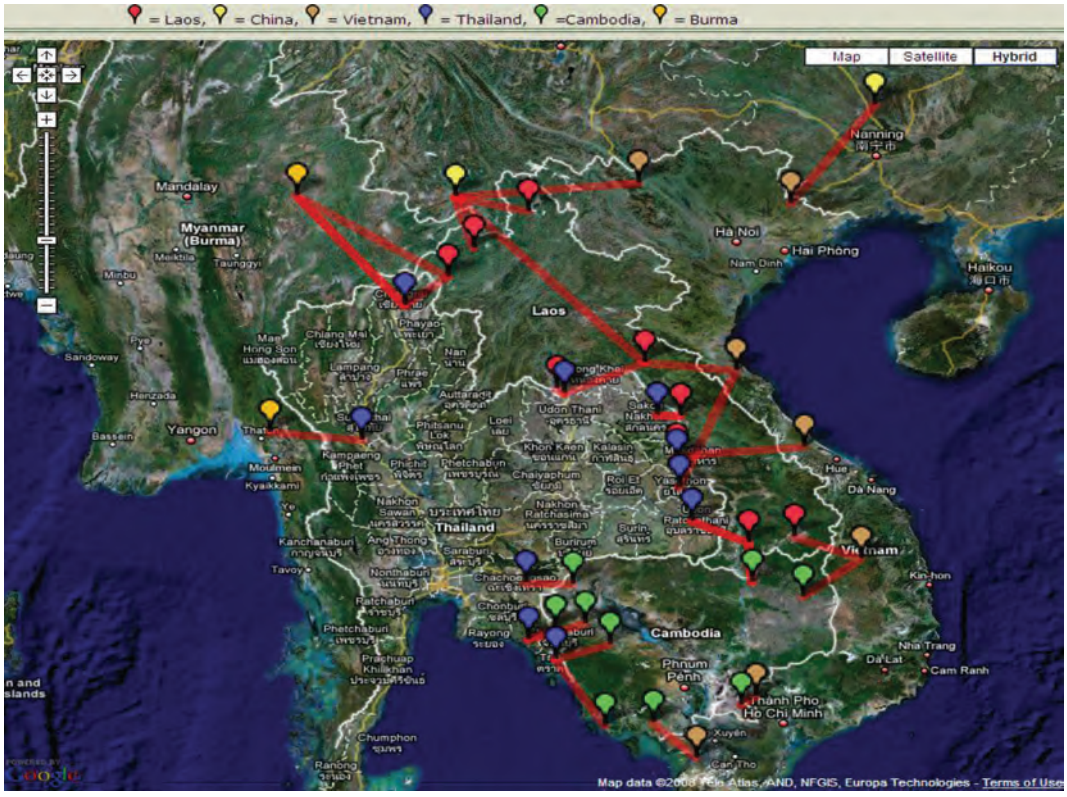

Fig. 3. Cross border surveillance sites in the six countries of the Mekong Basin Disease Surveillance Network (MBDS): Thailand, Cambodia, Lao PDR, Vietnam, Myanmar and Yunnan Province, China. Source: Rockefeller Foundation.

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Centre for Infectious Disease Surveillance (SACIDS) are jointly testing mobile phone surveillance tools (See Text Box 2 in [6]).

New Tools (Intended Outcome 3)

Grantees of the DSN Initiative asked for, helped to develop, and piloted a wide range of new and innovative tools for real time transmission of clinical observations and expert advice using mobile technologies, Geographical Information Systems (GIS), and web-based platforms. While most tools were well received and proved to be useful, some need more time for integration because of varying technical and cultural practices.

Transdisciplinary Leadership in One Health (Intended Outcome 4)

The inclusion of One Health as a central focus of the Initiative was perceived to be highly relevant to the challenges in the field of disease surveillance, especially given that the animal and human health disciplines have operated in silos for decades. The One Health concept is now widely known by local, regional, and global practitioners and has received funding from other major donors (e.g., U.S. agencies, the Asia Pacific Emerging Disease Framework [APSED] and other WHO regional frameworks) as a result of extensive efforts by Initiative partners and grantees to communicate the concept and its practical application. For example, the recent USAID Emerging Pandemic Threats Program fund of $400 million is built directly on the work of Initiative grantees and their partners (7).

Overall Impact

The evaluators concluded that the Initiative has had significant impact on the field of disease surveillance policy and practice at both regional and global levels, particularly through its support of regional networks in Asia and through its early application of One Health principles in Africa and worldwide. In Asia, the Initiative contributed significantly to containing outbreaks in the Mekong Basin countries by supporting changes at the provincial, district, and village levels that helped to prevent the spread of several different outbreaks at different times and in different locations, saving lives and lessening the negative impact on the livelihoods of some of the world's poorest people. The Initiative has ensured its continued relevance at both regional and global levels not only by being an early adopter of the One Health perspective, but also by listening to its partners and network members, shifting its focus over time in response to changing needs and trends in human/animal health, and embracing the growing need for health diplomacy.

Initiative grantees' policy reach extends beyond One Health. The regional disease surveillance networks supported by the Initiative and described in this supplement have become key players in developing a wide range of regional and global policies and in the collaborative implementation of those policies. For example, the Asian Development Bank modeled its Greater Mekong investments on Initiative work. Some of this reach can be credited to the Rockefeller Foundation's long history of work in the field of public health and its credibility and perceived leadership among development partners in linking theory, research, policy, and practice. Indeed, it was the Foundation's history of work in public health that served as a solid rationale for its involvement in the DSN Initiative.

Challenges for the Rockefeller Foundation

The Evaluation highlighted several key challenges faced by the Initiative and lessons learned and revealed areas where the Foundation needs to strengthen its own systems and strategies (7–9). First, despite gains in capacity in skills and practical knowledge, there is uneven documentation in both the peer-reviewed and non peer-reviewed literature of the work of the Initiative. Second, Foundation information systems were unable to provide timely and complete information on grantee outputs. Third, efficiency and sustainability would be enhanced by coordination with other large funders and partners. For example, the simultaneous growth of networks such as WHO's Global Outreach Alert and Response Network, the Global Laboratories Directory and Network, and the U.S. Centers for Disease Control (CDC) were not planned to interoperate with the DSN grantees, limiting opportunities to efficiently work and grow together. Fourth, a formal exit strategy to guide the Foundation when concluding the work of the Initiative was not put into place early enough. Finally, monitoring and evaluation practices within grants were informal and not well documented.

Recommendations

The evaluation teams made detailed recommendations in three main categories for the Foundation's work in Asia, Africa, and globally (7–9): (i) ensure sustainability of the substantial gains made by the Foundation's grantee partners; (ii) promote the One Health concept and practice; and (iii) capture the lessons and achievements of the Initiative and communicate these widely.

In response to these recommendations, the Foundation convened all DSN grantees in April 2011 in Nairobi, Kenya, to consolidate the experience and learning of the Initiative, disseminate evaluation findings, and consider the needs of the field going forward. The Foundation also supported the legal institutionalization of MBDS to ensure continuity of the work in Asia and provided further time-bound support to SACIDS. In addition, in partnership with the Nuclear Threat

Initiative (NTI), Fondation Mérieux and the Skoll Global Threats Fund, the Foundation supported the legal institutionalization of CORDS to ensure its sustainability. Finally, the Foundation provided transition support for its One Health work, with the expectation that this will come to fruition and be highlighted at the Prince Mahidol Award Conference in Bangkok, 2013, where the theme is "A World United Against Infectious Diseases: Cross-Sectoral Solutions."

Conclusion

In conclusion, the evaluation of the Disease Surveillance Networks Initiative was an important undertaking within the Foundation. Lessons learned have been shared internally and are being applied to the current and future work of the Foundation. The results demonstrated the value and merit of the Foundation's investments in supporting disease surveillance networks and other grantee work in this portfolio, resulting in a successful application to the Board of Trustees of the Foundation for additional funding to support sustainability among key partners. Sustainability of the progress achieved and relationships nurtured through the DSN Initiative is important to the Foundation, especially as internal efforts are directed elsewhere. Building on the clear evidence of ongoing relevance, motivation, and sustained engagement in the networks by members and partners, and solid interest from other funders, the Foundation has supported institutional independence of MBDS and CORDS.

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COMMENTARY

COACTION

Clinical Laboratory Networks Contribute to Strengthening Disease Surveillance: The RESAOLAB Project in West Africa

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Sufficient laboratory capacity is essential to effective infectious disease surveillance and control. This is recognized in the current International Health Regulations (IHR), which identify laboratory services as a category of core capacities that all the World Health Organization (WHO) Member States are expected to develop and maintain (1). IHR Core Capacity 8 requires laboratory services for every phase of real-time event management (i.e., detection, investigation, and response), with sample analysis being performed either domestically or through collaboration centers (2).

Laboratory services are considered a key component of national health systems, with the Integrated Disease Surveillance and Response (IDSR) utilizing the structures, processes and personnel of national clinical laboratory services for disease surveillance. However, laboratory services for both patient care and disease surveillance remain among the most neglected components of the overall health system in resource-poor countries. Challenges include lack of national laboratory policy and strategic planning, insufficient numbers of trained professionals, poor laboratory infrastructures, and absence of quality management systems (3).

Thus, several calls have been put forth to improve laboratory capacity in resource-poor countries. In 2008, representatives of African governments, local and international partners participated in a consensus meeting on clinical laboratory in Maputo, Mozambique. Meeting participants called on national governments to develop national laboratory policies and to provide laboratory support for diseases of public health importance; and they called on donors and development partners to commit to work collaboratively with each other and with coordination from national governments to strengthen laboratory systems (4). The WHO Regional Office for Africa (WHO/AFRO) has also advocated strengthening national public health laboratories (5). Also in 2008, WHO and the US Centers for Disease Control and Prevention (CDC), Atlanta, USA, convened in Lyon, France, an international conference on laboratory quality systems. During that meeting, the need for accurate laboratory testing was stressed, with poor quality laboratory services in resource-constrained countries leading to untold misery in human lives and unnecessary expenditures due to inadequate treatment (6). Eight key interventions were identified: (i) strengthening laboratory management at all levels; (ii) strengthening infrastructure and support systems; (iii) developing human capacity; (iv) establishing a national laboratory referral network; (v) establishing a national quality assurance program; (vi) developing a comprehensive monitoring system including laboratory information management system; (vii) coordinating government and partner support activities; and (vii) mobilizing resources to finance the strategic plan. The need to integrate networks that already exist – mostly those related to malaria, tuberculosis and HIV/AIDS – was also stressed.

In response to these calls, several international development partners have been implementing capacity building programs that include the training of laboratory personnel in epidemiology (7), microbiology (8) and quality assurance (9). In 2005, Fondation Mérieux, with the support of the European Commission, launched a national laboratory network initiative in Mali called Action BIOMALI. In just four years, the network grew to cover more than eighty public and private laboratories. In 2009, in response to official demands from the Ministries of Health of two neighboring countries, Burkina Faso and Senegal, and with the support of the French Development Agency (AFD) and Fondation Mérieux, the Mali network was expanded into a three-country regional network called RESAOLAB. This article

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describes the major activities and accomplishments of RESAOLAB and presents RESAOLAB as an example of how disease surveillance capacity can be built using a regional network strategy.

Established in 1967, Fondation Mérieux is an independent family foundation. Recognized as a state-approved charity in Lyon, France, the Foundation works to reduce the impact of infectious diseases that affect developing countries and currently operates in four countries. Fondation Mérieux prioritizes partnerships and catalyzes both local and international initiatives aimed at helping researchers and health care workers in developing countries learn how to use the best available scientific and medical tools so that they can meet their countries' public health needs in the long term and independently. Based on its long history of expertise in clinical biology and a comprehensive approach to public health, the Foundation's work serves as a model for strengthening local laboratory capacities.

RESAOLAB

RESAOLAB strengthens the quality of clinical laboratory services through inter-country meetings and workshops that promote the exchange of knowledge and experiences and harmonization of documents and tools. The network focuses on three main areas of activity: training laboratory personnel, setting quality assurance, and strengthening epidemiological surveillance.

Training laboratory personnel

The three network countries jointly developed a shared national strategic plan for continuous education of laboratory technicians; all three Ministries of Health officially validated the plan. The countries also jointly wrote content for the continuous education program, which includes a total of nine training modules. In each country, four reference structures were set up to organize training sessions, with a focus on use of harmonized equipment. To date, a total of 64 training sessions have been conducted, with 25 participants per session. The training modules are available for self-training through the GLOBE portal (10).

Setting quality assurance

As with the laboratory technician training, the three network countries jointly developed a shared national plan for laboratory quality management, which was then validated and adopted by all three Ministries of Health. The document defines standards for personnel organization, laboratory equipment, procedures, data processing, and hygiene and security. Additionally, the network identified and equipped four laboratories in each country responsible for maintaining external quality control. To date, the network has conducted more than 350 supervised external quality control assessments to evaluate the quality of diagnostics being used and identify necessary corrective measures.

Strengthening the epidemiological surveillance system

Improving the management and the quality of laboratory data has a direct impact on the epidemiological surveillance system. RESAOLAB developed an open-source Laboratory Information and Management System (Lab-Book) for monitoring all daily surveillance activities (from requests for analysis to reporting). Based on jointly defined reference terms, Lab-Book contains an epidemiological application for reporting laboratory data; in collaboration with WHO/AFRO, RESAOLAB conducted a regional workshop to discuss use of the new tool, including the role of the laboratory in reporting epidemiological data to surveillance databases. Fifteen laboratories in each country are expected to participate in a pilot launch of Lab-Book. The network also proposed computer and other equipment, Internet services, and training that will be necessary for integrating Lab-Book across the region.

Key achievements

In addition to the activities described above, three other key achievements are worth noting here. First, after many meetings advocating for laboratory governance and following Burkina's lead, Senegal established a national laboratory department under the Ministry of Health. Second, during a cholera outbreak in Mali in July 2011, RESAOLAB laboratory technicians played a critical role in the collection and preliminary analysis of surveillance data by directly applied procedures they had learned in the "Epidemic-Prone Diseases in the Laboratory" training module. The outbreak affected nine health districts in Mopti and Timuktu. It started on July 5. By August 4,463 cases had been reported, with a case fatality rate of 5.18 percent (24 deaths). Finally, recognizing the value of regional laboratory networking, four other countries in the region – Benin, Guinea, Togo, and Niger – have made requests to their Ministries of Health to join RESAOLAB.

Conclusion

RESAOLAB grew from national and regional dialogue around the need for harmonized tools and processes. It serves as a model for groups of neighboring countries that would like to strengthen the laboratory component of their disease surveillance infrastructure by jointly developing and implementing trainings and other activities and by harmonizing and linking national databases into integrated regional systems. As described elsewhere in this special issue of *Emerging Health Threats*, other regions, like South East Europe, are taking similar steps to strengthening disease surveillance laboratory capacity (11).

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COMMENTARY

COACTION

Promising Pathways for Regional Disease Surveillance Networks

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Introduction

The globalization of trade and travel has led to the globalization of communicable diseases and, in turn, increased need for globalization of solutions to fight them. The self-organized regional disease surveillance networks described in this special issue of *Emerging Health Threats* are one such solution. They reflect the vision, commitment and leadership of country health leaders and their development partners (1–4). The networks described here are significantly different from and complementary to regional surveillance systems of the World Health Organization (WHO), World Organization for Animal Health (OIE) and Food and Agriculture Organization (FAO) (5, 6). They are more literally "sub-regional" – organized by a smaller number of countries and built on a foundation of trust, cooperation, and mutual public health interests; they connect "bottom-up" local, national, and neighboring trans-national surveillance to "top-down" global and larger regional systems through "horizontal" cooperation across borders, disciplines, and sectors. These networks have demonstrated their value, judging from formal evaluations (7–11) and based on networks' own descriptions of joint investigations of priority diseases and other activities that ranged from human and system capacity building to pandemic preparedness and regional support to a member country following a major natural disaster (12–17). But challenges remain. The networks can continue to learn and improve, building on a strong foundation of mutual trust, informal and formal communications, and regional cooperation. They can better inform and intersect with efforts addressing other regional and global public health challenges, such as natural disasters, antimicrobial resistance, and product safety.

This paper describes five promising pathways for these networks, based on lessons derived from their experiences to date and a shared desire to lean confidently into the future. The strategic objectives of Connecting Organizations for Regional Disease Surveillance (CORDS) – build sustainable networks, improve capacity, advance One Health, and promote innovation – fully support the five promising pathways (18). Moreover, CORDS provides a means for regional networks to share experiences and work together as they proceed down these pathways toward improvement. CORDS played a vital role in bringing the regional networks together and will catalyze future cooperation (18, 19).

Five Promising Pathways

The challenges of emerging infectious diseases are even more acute in these times of global austerity, when resources are especially limited and must be used efficiently and creatively. To address these challenges, we describe a new "Promising Pathways Model" with five promising pathways that are encompassed within three key concepts: *Accountability* (pathway 1) is enhanced through the use of standardized international monitoring frameworks. *Cooperation* across disciplines/sectors (pathway 2) and borders (pathway 3) enables rapid and coherent public health responses. *Innovation* in technologies (pathway 4) and regional network business models (pathway 5) provides new approaches to public health surveillance and network sustainability.

Accountability: Use global frameworks to guide network capability monitoring

The WHO International Health Regulations (IHR) modernized the global approach to disease surveillance and early warning and articulated the responsibilities of

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countries to prepare for and respond to public health emergencies of international concern (20). The IHR defines core capacities related to surveillance, response, preparedness, risk communication, human resources, laboratory and coordination. The OIE Terrestrial Animal Health Code complements this on the animal side (21). Interestingly, WHO recommends that IHR core *capacities* be measured according to *capability* level (22). The distinction is important, as capabilities-based planning has become international best practice for all types of emergencies–natural disasters, pandemics, accidents and intentional threats (23). Typical measures of capacity include number of persons trained, laboratories built and equipped, and computers provided; measures of capability reflect actual performance. The four-point WHO scoring scale reflects capacities (levels 0, 1) that escalate to capabilities (levels 2, 3). The OIE capability monitoring system is embodied in the Performance of Veterinary Services (PVS), which operates through a four-stage Pathway that includes evaluation, gap analysis, capacity building and maintenance (24). Both the IHR and PVS provide monitoring tools for measuring country progress that CORDS networks could use to guide their own monitoring and accountability efforts. Accountability ensures that regional surveillance is effective, efficient, consistent with international standards, responsive to local needs, and outcome-oriented.

Cooperation across disciplines/sectors: Integrate trans-disciplinary and trans-sector efforts to improve health security and human security

The IHR 2005 galvanized the connection between health and security and the concept of "health security" (25–29). Despite differing interpretations of what this means, both health security and the related "human security," which focuses on the welfare of common people, are pertinent to all countries (30–32) and hence to regional disease surveillance networks. Cooperation across multiple sectors – health, agriculture, finance, border security, customs and others – enhances situational awareness and response. With health concerns increasingly recognized within national security agendas (28, 30, 31, 33, 34), regional networks can contribute to improving both health security and human security by cooperating not just across borders, but also across sectors. Cooperation between the human and animal health sectors is especially important because most infectious diseases that have emerged in recent decades are of animal origin, with their emergence being linked to trade, economic, and political interests (28, 35, 36). As described throughout this issue, CORDS networks are adopting the One Health paradigm in various ways and to varying extents (e.g., see Ref 16 in this supplement for a more detailed discussion of One Health).

Cooperation across borders: Develop coherent regional policy for rapid response and economies of scale

As exemplified by the regional disease surveillance networks described in this issue, the cross-border collaborative activities of such networks complement those of WHO, OIE and FAO for disease detection, outbreak investigation and response (37–39). These networks can also cooperate in regional procurement, such as bulk purchase of equipment or vaccines, and in developing common protocols for laboratory testing (14, 15, 40) or disease reporting.

Innovation in technology: Capitalize on new and under-utilized technologies for data generation, analysis and action

Mobile phone, social media, geospatial, and other electronic tools enable broader coverage and faster disease surveillance, prevention, and control. CORDS networks are capitalizing on these and other technology innovations to improve both national public health systems of their respective countries and network cooperation across countries. For example, SACIDS is piloting a One Health-based mobile telephone disease surveillance tool. The phones are equipped with data capture and epidemiological analytical software (17, 41). Some of these technologies can also enable the public to play a more active role in public health surveillance. For example, MBDS has a core strategy for community-based surveillance, which calls for reporting of unusual events by community members (12, 42). Harnessing innovations for surveillance is effective only if the captured information is actually used. Studies in various parts of the world have demonstrated deficiencies in actually using surveillance for management and action (43–46). Regional networks are well suited to ensure that surveillance data are not only shared from their own local to national levels, but also across sectors and borders.

Innovation in disease surveillance network business models: Create new, flexible models to attract resources and foster sustainability

CORDS regional disease surveillance networks exemplify owner-driven, donor-supported agendas, which are significantly different from the typically donor-driven agendas of yesteryear. Each network has established its own governance structure, and network member countries participate actively in setting priorities for their cooperation. For example, MBDS development partners have supported network efforts based on the countries' own collective master plan of action (47), which also helps to improve donor coordination; MECIDS countries decided to cooperate initially around surveillance for foodborne pathogens (40); and SACIDS institutions decided to focus on zoonotic diseases (48).

Sustainability of the networks will depend on multiple factors: owner-driven agendas, the enduring trust among network members and their commitment to remain engaged even through times of political turmoil and resource challenges, fruitful partnerships to support network priorities, alignment with international standards, and a culture of accountability (5). While the networks featured here have built strong platforms for cooperation, sustainable cooperation requires conscious action. The networks are evolving as centers of excellence for regional cooperation. As such, they are well positioned to seek research grants, technology investments by the private sector, and support from other sources interested in utilizing these established regional population laboratories as models for further development and study. The establishment of the MBDS Foundation as a permanent entity agreed upon by the six countries is one approach to this. Publication of regional network activity (4, 12–17, 48–51) further increases their visibility and credibility, enhances opportunities to attract further investment, and thereby strengthens their prospects for sustainability. A shared interest in the health security of each country and global health diplomacy across countries are further foundations for regional network sustainability into the future.

The Role of CORDS

CORDS was established to link existing regional disease surveillance networks and foster new cross-border and cross-sectoral learning and innovation (18, 19, 52). As such, CORDS is strategically poised to catalyze progress along the five promising pathways described here and to help these surveillance networks harness their full potential to improve global health.

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