Regional Infectious Disease Surveillance Networks and their Potential to Facilitate the Implementation of the International Health Regulations

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KEYWORDS

• Surveillance • International health regulations
• Infectious disease • Global health • Health security

Work described in this paper is supported by the Governments of Thailand, Laos, Cambodia, Myanmar, China, the Palestinian Authority, Jordan, and Israel. Asia-Pacific Economic Cooperation Emerging Infections Network (APEC EINet) is supported by the APEC Secretariat and the United States Centers for Disease Control (CDC); AMK is Director of APEC EINet; HMF and YA are employed by this project. Project support for Mekong Basin Disease Surveillance and Middle East Consortium on Infectious Disease Surveillance is provided by Global Health and Security Initiative (GHSI). TT is GHSI Director; MM is employed by RAND Corporation, which carried out regional tabletop activities funded by GHSI and the CDC.

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Med Clin N Am 92 (2008) 1459–1471
doi:10.1016/j.mcna.2008.06.001 **medical.theclinics.com**
0025-7125/08/$ – see front matter

The implementation of the new International Health Regulations (IHR) requires the proactive establishment of competence within all World Health Organization (WHO) member countries to control infectious diseases within their territories. Some investigators have contended that the establishment of regional networks for disease surveillance actually may diminish the ability of low resource settings to establish such competence.[1] This article examines this theoretic possibility by closely describing the experience of regional networks, focusing on two such networks, the Middle East Consortium on Infectious Disease Surveillance (MECIDS) and the Mekong Basin Disease Surveillance (MBDS) networks. These two cases clarify the contribution of such networks to the successful implementation of the IHR.

The past 2 decades have witnessed increasing globalization of commerce, travel, financial flows, production chains, and services. The market forces behind this globalization do not always apply to public safety and protection; thus, the public health sector has been slow to globalize and too few within the economic and trade sectors embrace the urgency of supporting the transnationalization of public health. While globalization of the health sector inches along, extension of production chains and intensification of agriculture stress public health security at the point of origin (commonly in resource poor settings).[2] High-profile pandemics (eg, HIV/AIDS and severe acute respiratory syndrome [SARS]) point to the lack of an effective global public health safety net. **Fig. 1** illustrates the challenge of transnational infection and the need for transnational response. Resource poor settings continue to struggle with high levels of preventable and treatable endemic and epidemic diseases. Given the lack of economic incentive to globalize public health protection, the task of realizing this global public good rests with national governments, international agencies, and philanthropic interests.[3] As travel and commerce so thoroughly interconnect the globe that an outbreak in Asia today may be an outbreak in North America tomorrow, or vice versa, the rhetoric of global disease security has become more urgent.

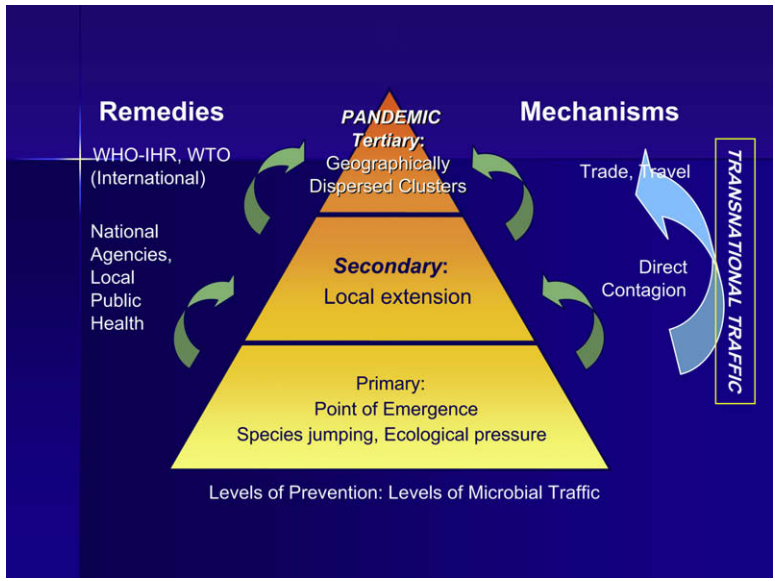

Fig. 1. Transnationalization of infection through trade and travel.

Although there are potentially several drivers for the rise of regional networks for surveillance, at least two are in play. First, as markets globalize, consolidation and scale of activity gain importance. Increasingly active trading economies have come together in larger economic groups (eg, the European Union and the Asia-Pacific Economic Cooperation [APEC]). As blocs of trading economies have emerged, new common concerns about health security also have come to the fore. Second, in postconflict areas divided by war, common geographic zones of activity come together for mutual economic benefit during recovery. As commerce and travel increase economic integration, population health security becomes an important issue. This article provides a brief review of the rise of regional groupings of countries that have created networks for disease surveillance and examines theoretically and through the experiences of these regional networks how they may facilitate the implementation of the revised IHR (2005). Although this article offers a catalog of several of these systems (**Table 1**), the universe of networks described is not exhaustive. Discussion focuses on the regional networks of MECIDS and MBDS, which illustrate the challenges and opportunities these networks afford.

The emergence of novel infectious disease threats has increased in the modern era, raising the need for new surveillance capabilities. Zoonotic origin accounts for the majority of these events,[4] and the increasing need to coordinate human and animal health is an additional challenge for nascent surveillance systems. With the renewed appreciation for the speed of transmission of agents given modern travel volumes and rates, speed and accuracy of information become more important. Additionally, with the broad geographic dispersal of pathogens in products and people, the ability to sensitively, specifically, and promptly identify particular strains or subtypes of organisms using modern diagnostic techniques becomes important. Such identification is critical for (1) effective disease investigation to detect the source, (2) vaccine development, and (3) tailoring treatment regimens for individual patients affected.

THE REVISED INTERNATIONAL HEALTH REGULATIONS

In the early 1990s the return of old epidemics, such as cholera in South America, and the emergence of new infectious agents, such as Ebola hemorrhagic fever, sparked a landmark study by the United States Institute of Medicine.[5] The study, chaired by the late Dr. Joshua Lederberg, identified new pathogen emergence as a cross-cutting theme in global infectious disease and began to identify the anthropogenic factors behind such emergence. The ongoing occurrence of emergent infections provoked a resolution calling for the revision of the IHR (1969) at the 1995 World Health Assembly. In 2001, the World Health Assembly adopted a resolution on global health security epidemic alert and response in which WHO was to support its member states in identifying, verifying, and responding to public health emergencies of international concern. In 2002, the World Health Assembly reiterated the need to revise the IHR to reflect the changes in its resolution, global public health response to natural occurrences, and accidental release or deliberate use of biologic, chemical, or nuclear agents that affect health. The outbreak of SARS, however, prompted the World Health Assembly, in 2003, to decide on establishing the Intergovernmental Working Group on the Revision of the IHR to accelerate the process.

The revised IHR (2005) were adopted, by consensus and after 18 months of negotiation, in May 2005 by the 58th World Health Assembly.[1] They focus on strengthening global surveillance, improving communication between WHO and member states, and ensuring that each country has the laboratory capacity to identify outbreaks rapidly.[6] The revised regulations encourage governments to participate in an international network of surveillance networks through reviewing their current surveillance strategies

Table 1
Select examples of regional surveillance networks

Network Name	Date Founded	Legal Basis	Membership
Early regional networks			
OCCGE: Organisation de Coordination et de Coopération pour la lutte contre les Grandes Endémies	1960 (now merged into WAHO)	Multilateral agreement	Benin, Burkina Faso, Côte d'Ivoire, Mali, Mauritania, Niger, Senegal, and Togo
WAHO: West African Health Organisation	1987 (merger of OCCGE and WAHC)	Multilateral agreement	Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo
CAREC: Caribbean Epidemiology Centre	1975	Multilateral agreement	American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kirbati, Marshall Islands, Nauru, New Caledonia, Niue, Commonwealth of the Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna
OCEAC: Organisation de Coordination pour la lutte contre les Endémies en Afrique Centrale	1963	Multilateral agreement	Cameroun, Republic of Congo, Gabon, Equatorial Guinea, Central African Republic, and Chad
Trade cooperation based networks			
APEC EINet: Asia-Pacific Economic Cooperation Emerging Infections Network	1996	Informal	Australia, Brunei Darussalam, Canada, Chile, People's Republic of China, Hong Kong (China), Indonesia, Japan, Republic of Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, Peru, Philippines, Russia, Singapore, Chinese Taipei, Thailand, United States, Vietnam
ECDC: European Centre for Disease Prevention and Control	2005	Treaty	Members of the European Union

Alert networks			
GOARN: Global Outbreak Alert and Response Network	2000	Informal	Scientific organizations in WHO member states, United Nations organizations, international humanitarian nongovernmental organizations, surveillance and medical initiatives, and regional technical networks
ProMED	1994	Informal	More than 20,000 in 160 countries
Regional networks			
SEEHN: South-eastern Europe Health Network	2001	Cooperation (initiative of the Stability Pact Social Cohesion Initiative)	Albainia, Bosnia and Herzegovina, Bulgaria, Croatia, Moldova, Romania, Serbia and Montenegro, and Macedonia
PPHSN: Pacific Public Health Surveillance Network	1996	Voluntary (coordinating body)	American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kirbati, Marshall Islands, Nauru, New Caldonia, Niue, Commonwealth of the Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna
MECIDS: Middle East Consortium on Infectious Disease Surveillance	2003	Informal	Palestinian Authority, Israel, Jordan
MBDS: Mekong Basin Disease Surveillance	1999	Memorandum of understanding	Cambodia, China (Yunnan and Guangsi Provinces), Lao PDR, Myanmar, Thailand, Vietnam
EAIDSNet: East Africa Integrated Disease Surveillance Network	2000	Treaty (Treaty for the Establishment of the East African Community)	Kenya, Tanzania, Uganda

and implementing programs capable of contributing to global outbreak intelligence.[1] Member states are required to notify WHO and neighboring countries of all events potentially constituting a public health emergency of international concern and to maintain a national focal point, available at all times, to mediate communication between WHO and the government.[6] The revised regulations, a broader binding pact than before, thus call for actions by member states and the WHO.

The passage of the IHR puts the world on a fast track to implementation. Networks, such as MECIDS and MBDS, have reinforced national compliance efforts. The regulations dictate minimum requirements for surveillance and response, although their explicit agenda is to upgrade these systems on national levels and provide specific measures to prevent disease spread at airports and other entry points.[6] WHO maintains that surveillance is the cornerstone of efficient disease control and the key to mounting an effective response,[6] and the revised regulations provide some mechanism for WHO to collaborate with member states after notification.[7] In an era of globalized infectious diseases, all countries are believed to have a stake in the success or failure of surveillance and response capacity development in any one country.

Although global surveillance programs often are based on existing disease-specific cooperation of regional networks (eg, WHO Global Influenza Surveillance Networks), the revised IHR provide a framework for mandating countries to coordinate their action through a universal network of surveillance networks (ie, a network of national and regional networks).[8] The regulations also provide a binding legal structure and raison d'être umbrella to regional networks for solving practical issues near and within national borders. Thus, regional surveillance networks, such as MBDS and MECIDS, can facilitate the IHR and play an important role in their implementation. For example, in 2007, MECIDS members convened a workshop on implementing the IHR in the event of an influenza pandemic. This event was held in cooperation with WHO headquarters and WHO offices in the Eastern Mediterranean and European regions. As pathogens do not respect national borders, regional outbreaks require collective regional surveillance, response, accountability, and responsibility.

The perception is that if the revised IHR facilitate early detection and rapid implementation of effective control measures,[7] most health emergencies will be dealt with at a regional or national level and never become a global threat; hence, a regional approach to surveillance may further strengthen the goals of MECIDS and MBDS and help realize the greater goal of global health security. Lastly, as WHO is to be notified only of public health events of international concern,[7] discussions by regional members may be useful in determining the notification threshold or procedures.

CORE CAPACITIES OF SURVEILLANCE AND RESPONSE

To build, maintain, or improve regional surveillance networks, it is important to have a defined set of core capacities. Core capacities include the establishment of common laboratory standards, an effective surveillance system (based on disease, syndromic, or rumor reporting), and effective response capabilities (eg, contact tracing and monitoring through field epidemiology). For example, each member state has to ensure that it has the laboratory capacity to rapidly identify outbreaks;[1,6] to do so, provisions for technical support and extra resources for less-developed countries also are written into the revised IHR (2005).[1] The core response capacity requirements apply at all public health response levels—from local to intermediate to national.[9] Strengthening national public health capacities contributes to improving national and international readiness to detect, verify, investigate, and control disease outbreaks that have the

potential to spread internationally.[7] Importantly, the revised IHR specify measures to prevent disease spread at designated points of entry.[6,9]

Operational and technologic communications and trust across countries are central tenets of regional surveillance networks. Moreover, each country's particular strengths can be leveraged across regional network partner nations. MECIDS and MBDS have acted as catalysts for the introduction and spread of new communications and laboratory technologies. For example, MBDS members are working with several international funding and technical partners to increase technical capacity for surveillance and disease control through computing; high-speed Internet access recently has been enhanced by the Trans-Eurasia Information Network 2 effort in Vietnam. When Vietnam lacked such Internet capacity in 2006, Thailand facilitated Vietnam's participation in the multinational videoconference on pandemic preparedness (organized by APEC Emerging Infections Network) by hosting the Vietnamese representatives at their videoconference center. As another example, tabletop exercises in individual MBDS countries and a regional MBDS exercise suggest that each country has unique strengths that can be considered for application across the region, such as electronic surveillance reporting in China; epidemiology training in Thailand; laboratory capacity in Thailand, China, and Vietnam; community surveillance in Cambodia; and government organization for national influenza preparedness in Lao People's Democratic Republic (PDR) (Dr. Moe Ko Oo, MBDS Coordinator, personal communication, 2008).

Given the focus on food safety in the Eastern Mediterranean,[10] MECIDS has elected to share food-borne disease information. Laboratory capacity has been reinforced with the introduction of pulsed-field gel electrophoresis technology for pathogen identification (eg, PulseNet). This effort has been facilitated through the MECIDS collaboration with donors, coordinated by GHSI (the World Bank, the government of the United Kingdom, the Bill and Melinda Gates Foundation, the Nuclear Threat Initiative, IBM, and Becton Dickenson). Financial and other forms of support were carefully used to enhance capabilities, particularly in early detection and identification, and to bring the partners' differing capabilities to a level at which they can operate efficiently together in sharing data and other cooperative activities. Thus, the regional network provides a forum for sharing lessons learned and, over time, harmonizing such efforts to assure systems (and operator) interoperability.

CORE COMPETENCIES OF SURVEILLANCE AND RESPONSE

Of equal importance to core capacities are core competencies, which entail appropriate training of qualified workers and maintenance of necessary human resources. Training in applied epidemiology, informatics, and laboratory methods for key surveillance personnel is essential, and such training needs to be conducted at the frontline level (eg, routine surveillance with regular reporting)[11] and at the supervisory, senior level (eg, field epidemiology training program [FETP] trainers and trainees). It is important that the local frontline workers be included in surveillance, disease investigation, and response training. Doing so empowers the community,[1] evidenced by success stories of local volunteer workers and disease control officers participating in surveillance and response activities (eg, Thai avian influenza preparedness and response system in response to human case from across the border in Lao PDR in early 2007).

The key to a strong surveillance and response system is effective training and development of core competencies. More than 30 national FETPs around the world are patterned after the United States Centers for Disease Control and Prevention Epidemic Intelligence Service;[12] a similar program, European Programme for

Intervention Epidemiology Training, is conducted in Europe.[9,13] MECIDS partners are establishing the Middle East Program for Interventional Epidemiology Training, following the European model. Thailand has a mature FETP, which benefits its neighbors in regional outbreak control. Surveillance competencies are central to these programs, similar to competencies developed for applied epidemiologists in the United States.[9]

Given the rapidly evolving nature of modern surveillance approaches with links to public health informatics, additional efforts are underway to include training in technologic aspects of surveillance systems.[9] These informatics skills are critical emerging competencies for surveillance workers.[9] At a practical level, imported models must be tailored for local use and new solutions may be found by local innovators as informatics skill levels increase. Thailand, for example, has taken the lead in MBDS to create a Center of Excellence in Public Health Informatics in collaboration with the University of Washington.

MIDDLE EAST CONSORTIUM ON INFECTIOUS DISEASE SURVEILLANCE AND MEKONG BASIN DISEASE SURVEILLANCE

MECIDS and MBDS illustrate that effective regional surveillance can be realized even in difficult and disparate political environments. Both groups provide a forum to share information, develop relationships, and build capacity, and they have proved effective during recent regional outbreaks. These two networks have similar goals and focus on many of the same threats to public health, yet their structures and the political climates in which they exist are different.

The capitals of Jordan, Israel, and the Palestinian Authority are located within 80 km of each other. The constant flow of goods, family ties among Palestinians residing in the three countries, and human travelers that pass over their borders each day has led Tulchinsky to refer to these inexorably related countries as one ''epidemiologic family''.[14] Before the Palestinian uprising (intifada), which began in 2000, a young but healthy cooperation existed on health matters between Israel and the Palestinian Authority. With the conflict, communication and collaboration came to be low profile as far as public health issues were concerned.[15,16] In this political climate, two international nongovernmental organizations, Search for Common Ground and the Global Health and Security Initiative (GHSI), which operates within the Nuclear Threat Initiative, facilitated the establishment of MECIDS in 2003. MECIDS is considered a unique model of trilateral sustainable activity. This intergovernmental partnership among the Ministries of Health in Jordan, Israel, and the Palestinian Authority has been effective on many levels, including harmonizing diagnostic and reporting methodologies; common training; data sharing and analysis; improving detection and control of infectious diseases; facilitating cross-border communication; dealing with avian influenza outbreaks in the three countries;[15] and, finally, creating the potential for the trust and cooperation fostered through this collaboration to translate into cooperation on other issues.[17]

Using the layered structure of the public health services in each of its member countries, MECIDS currently gathers data on food-borne illnesses caused by two pathogens, salmonella and shigella, at the district, national, and international levels. At the district level, a network of clinical laboratories covers the many districts of each country; the national level includes a national center for disease control and a national laboratory; and the international level consists of one regional health information center—the Cooperative Monitoring Center in Amman, Jordan. National centers for disease control collect data from their district laboratories and report important information to the regional center in Amman. This hierarchic architecture allows for

systematic disease reporting that helps identify potentially dangerous situations before they become serious epidemics.[18]

The second example of regional surveillance is MBDS, a collaboration between Cambodia, China (Yunnan and Guangsi provinces), Lao PDR, Myanmar, Thailand, and Vietnam. Southeast Asia experienced intense conflict during the Cold War era but has since made enormous strides toward peace and economic development. Implementation of trade liberalization policies, such as the Association of Southeast Asian Nations Free Trade Area, the Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy, and the entry of Vietnam and Thailand into APEC, have greatly increased the ease with which goods, services, and capital flow throughout the region.[19] With support from the Rockefeller Foundation, WHO, and other organizations, MBDS was established in 1999 to deal with the public health challenges of high-volume regional trade and travel. Its activities include epidemiologic training, cross-border exchange of information, joint epidemic response and investigation, and joint tabletop exercises on pandemic influenza preparedness.[20] Because some MBDS member countries belong to WHO's Western Pacific region (Cambodia, China, Lao PDR, and Vietnam) whereas others belong to the Southeast Asian region (Myanmar and Thailand), coordination under the WHO umbrella adds some bureaucratic burden. Based on trust and close friendships, built through many years of interactive learning and collective action, MBDS has played an important role in filling this bureaucratic gap.

MBDS uses a reporting structure that links countries at the national, provincial, district, community, and village levels. Members have established communication links at parallel levels and rely on a system of periodic reports and cross-border meetings to facilitate information exchange and build trust between parties.[21,22] Dr. Suwit Wibulpolprasert, active member and former MBDS Executive Board Chair, commented, ''This network is an excellent example of effective implementation of the International Health Regulations, with rapid formal and informal reporting of diseases of public health emergencies across borders''.[20]

The stability of the Southeast Asian region allows for a formal partnership between countries of the Mekong Basin; the legal basis of MBDS is two memoranda of understanding signed by the ministers of health from the six countries. This organizational architecture creates a strong and durable partnership that has well-defined responsibilities and expectations. In contrast to MBDS, the volatile political situation among MECIDS countries has led to an informal memorandum of understanding agreement among partners. It is not bound by a formal decision-making process and, therefore, has the freedom and flexibility to respond quickly to changing priorities in infectious disease control.

MECIDS and MBDS have been tested by disease outbreaks. MECIDS, originally established to monitor food-borne infections, has provided a robust platform to broaden surveillance activities to include other serious emerging infections, such as avian influenza H5N1.[17] Avian influenza among poultry hit the region in March 2006, and although MECIDS had been active for only 3 years, the reporting system, open lines of communication, and cooperative control measures proved essential in mitigating the impact of the outbreak. The revised IHR, although initial implementation was not required until June 15, 2007, were put into practice by a joint decision among MECIDS partners and shown to be effective.[15] In 2007, MECIDS partners conducted a workshop on the implications of the revised IHR in pandemic influenza preparedness.

The year 2007 saw a large increase in the number of cholera cases in Northern Thailand and Southeastern Myanmar, with 877 cases resulting in seven deaths. From June to August 2007, an outbreak of cholera El Tor Inaba (344 confirmed cases) occurred in

Tak province, one of Thailand's northern provinces that borders Myanmar. As one fifth of the cases were found in migrant workers from Myanmar, the Thai MBDS country coordinator, who acts as the IHR focal point, informed his Myanmar counterpart. The source of the illnesses was not identified in this outbreak and officials of both countries in the border area responded by encouraging citizens to follow proper hand-washing procedures and boil their water. From mid-September to October of the same year, an outbreak of cholera El Tor Ogawa (235 confirmed cases) occurred in 12 provinces of the northeastern region of Thailand and crossed the border into Vientiane, Lao PDR. The disease control officer of Lao PDR notified WHO and the Thai MBDS counterpart. In this instance, with an increased disease surveillance and response effort, the Thai FETP and the surveillance rapid response team of several affected provinces, in collaboration with the Laotian authorities, were able to trace the infection to uncooked blood cockles. Identifying the source of the outbreak was a major factor in reducing illness and protecting public health.

The successful ongoing collaboration within MECIDS and MBDS provide two examples of effective regional surveillance systems implemented in areas historically, and even currently, embroiled in conflict. As Leventhal and colleagues[15] argue, ''Irrespective of political circumstances, the common threat of an emerging infectious disease serves as an opportunity to bridge disputes and focus on humanitarian and health matters for the common good of all bordering countries.'' WHO[23] maintains that international partnerships are essential in implementing the revised IHR; therefore, finding common ground in regions of conflict is especially important as it promotes health cooperation in areas where it is most lacking.

SUSTAINING EFFECTIVE REGIONAL SURVEILLANCE NETWORKS

To maintain surveillance core capacities and competencies, collaborative partnerships are critical and long-term investment strategies are needed. Supporting regional surveillance programs can be an efficient way for external partners to help resource-poor countries develop their own national surveillance infrastructure.[1] And, regional initiatives investing in surveillance programs on emerging infectious diseases may directly help developing countries meet the revised IHR's new core requirements.[1] These networks have the potential to enhance the transnational capacity for disease response (shown in **Fig. 2**).

Today, an increasing number of private sector foundations with a public health focus are funding disease surveillance programs in limited resource settings.[9] Such enhanced support can greatly assist in sustaining the core capacities and competencies necessary for successful regional surveillance networks. Public-private partnerships for infectious disease surveillance are becoming increasingly common. An encouraging effort has begun, with support from the Rockefeller Foundation and GHSI, to develop a process for the various operating and nascent regional infectious disease surveillance systems to share best practices on issues, such as governance and the technical aspects of cross-border surveillance.[22] This effort should have the effect of bringing more government and private sector resources into infectious disease surveillance capabilities, which, if sustained, will bring about an increase in overall global surveillance capacity. This complements the essential and more top-down efforts of the WHO's strategy for epidemic alert and response that also relies on collaborative partners, including WHO Collaborating Centres, nongovernmental organizations, and industry.[7] Countries, therefore, will benefit from the renewed impetus to strengthen national capacity in surveillance and response and from the

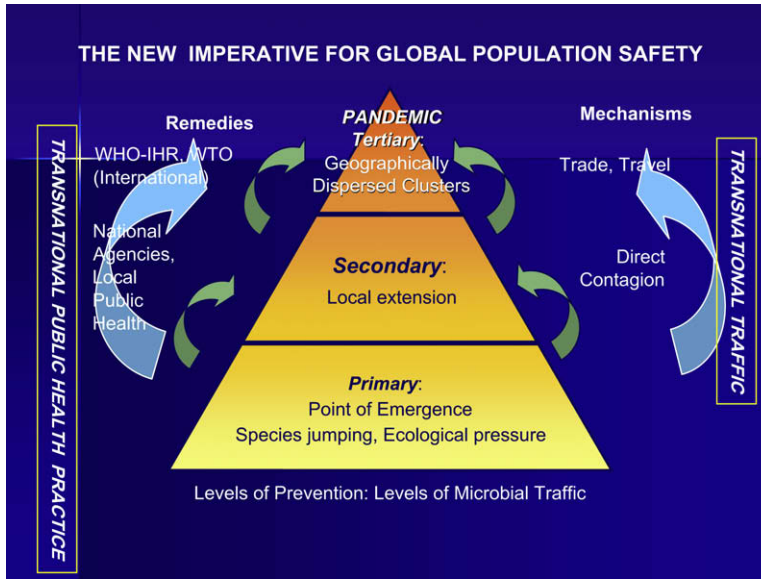

Fig. 2. Implementation of transnational disease response.

enhanced access to international investors interested in improving health in countries across the world, in the interest of global health and security.[7]

SUMMARY

The revised IHR (2005) encourage a new paradigm of global public health intelligence. With mandatory reporting procedures and requirements for building surveillance and response capacity, the revised IHR are a move toward more effective global health security. The revised regulations have broadened and diversified the effort for global infectious disease control. This article has addressed the rise of regional networks and focused on how two such networks have contributed to the implementation of the IHR. Specifically, through hosting regional workshops for IHR implementation, introducing and implementing communications and laboratory technologies in member countries, responding to regional outbreak events, and linking field investigation efforts to response, the networks have moved their member groups closer to the implementation goal. Far from diminishing the abilities of fragile public health systems, these networks have reinforced operational competence.

In resource-poor settings and regions of political instability, the need for cooperation is even more urgent. The examples of MBDS and MECIDS illustrate the benefits of regional cooperation, communication, and trust building. They demonstrate that historical conflict, and even current political strife, can be overcome by focusing on common interests. The trust and communication MECIDS and MBDS partners built were a foundation for upgrading the infectious disease surveillance systems in each country, in terms of training personnel and purchasing laboratory and information technology equipment. Through successful communication and capacity building, these networks have effectively responded to disease outbreaks (eg, MECIDS's response to the 2006 outbreak of avian influenza and MBDS's response to the cholera outbreaks of 2007) and increased their ability to address future emerging infectious

disease threats. As is true with MBDS and MECIDS, regional networks have greater access to international investors whose objectives are to strengthen the health of recipient countries while also improving overall global health security. Investment is a key concept in the new paradigm; it is an idea that the return on an investment in surveillance capacity and cross-border cooperation is the improved health of all nations and all global citizens. The revised IHR (2005) provide the impetus for change, and regional networks are one important way of achieving that change.

ACKNOWLEDGMENTS

The authors would like to thank Ms. Alicia Silva-Santisteban for her administrative support.

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