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Abstract

Capacity-building initiatives related to public health are defined as developing laboratory infrastructure, strengthening host-country disease surveillance initiatives, transferring technical expertise and training personnel.

In 2007, the Government Accountability Office issued a report describing the global infectious disease capacity-building efforts of U.S. government (USG) entities [2]. At the time, three USG entities were identified as providing capacity building for emerging infectious diseases (EID), including the U.S. Centers for Disease Control and Prevention (CDC), the U.S. Agency for International Development and the Department of Defense's Global Emerging Infections Surveillance and Response System (DoD-GEIS). Their efforts included laboratory-based disease surveillance, development and testing of diagnostics, and training such as Field Epidemiology Training Programs, the international version of the famed Epidemic Intelligence Service [3]. Currently, many other USG agencies are engaged in building disease surveillance capacity, including the U.S. Department of State, the Defense Threat Reduction Agency and the U.S. National Institutes of Health [4]. In addition, numerous state, non-state and non-governmental organizations, such as the Bill and Melinda Gates Foundation, the World Bank and Médecins sans Frontières, contribute substantially to capacity-building efforts around the world [5-7].

With the establishment of the Armed Forces Health Surveillance Center (AFHSC) in late 2008, the DoD-GEIS program was transitioned to a division and renamed "AFHSC-GEIS"; however, its mission of working to promote and facilitate national and international preparedness for EID was maintained. Strengthening of U.S. military and host-country disease surveillance and public health laboratory capacity represents a critical step for contributing to compliance with the IHR (2005) detection, reporting and response requirements. During 2009, capacity-building efforts were undertaken in a variety of formats, including enhancement of diagnostic capabilities, expansion of surveillance for militarily relevant infectious and tropical diseases, and deployment of electronic surveillance platforms. These efforts were coordinated with local host-country health officials and geographic Combatant Commands to ensure they addressed country and regional medical priorities as well as to ensure better surveillance and response to disease outbreaks and EID threats to U.S. forces abroad. These efforts focused on influenza and other respiratory diseases, malaria, dengue and other vector-borne illnesses, acute diarrheal diseases, antimalarial and antimicrobial resistance, sexually transmitted diseases, and bacterial wound infections.

Accomplishments

Table 1 2009 Major Laboratory Capacity-Building Initiatives by Geographic Region

Geographic Region	Major Laboratory Capacity Building Initiative	Countries Supported
Southeast Asia	NIC & military influenza lab equipment, reagent & training support; EID laboratory diagnostics & disease surveillance systems	Bhutan, Cambodia, Lao People's Democratic Republic, Nepal, Singapore, Thailand
Far East	NIC & military influenza lab equipment & reagent support; EID lab proficiency & equipment support	Japan, Korea, Philippines
East & Central Africa	NIC & VHF lab equipment, reagent & training support; EID laboratory diagnostics	Cameroon, Kenya, Tanzania, Uganda
West Africa	NIC & MoH influenza lab equipment, reagent & training support; VHF lab diagnostics & military EID lab diagnostic testing capacity	Benin, Burkina Faso, Cote d'Ivoire, Ghana, Liberia, Mali, Niger, Nigeria, Sierra Leone, Togo
North Africa, Middle East & Southwest Asia	NIC lab equipment, reagent & training support	Afghanistan, Egypt, Iraq, Jordan, Kuwait, Oman, Pakistan, Sudan, Syria
Central Asia	EID & influenza lab equipment, reagent & training support	Azerbaijan, Georgia, Mongolia
Europe	Military & academic influenza lab equipment, reagent & training support	Poland, Romania
Central & South America	NIC & MoH influenza lab equipment, reagent & training support; leishmania military reference lab equipment, reagent & training support	Colombia, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, Peru

Abbreviations: NIC, [illegible]; EID, [illegible]; VHF, [illegible]; MoH, [illegible].

Army Military Health Research Center, supported by Global Viral Forecasting Initiative in Yaoundé and at the University of Buea (Figure 2). Both facilities will greatly improve the ability to conduct influenza and EID diagnostic work, as well as potentially advanced pathogen discovery work in hard-to-reach locations in Africa.

Efforts were also undertaken to improve laboratory capability for global influenza surveillance and diagnosis, especially regarding the novel A/H1N1 influenza pandemic. To this end, AFRIMS established viral/bacterial pathogen culture and molecular diagnostic capability in their Nepal detachment to support the National Public

Table 2 2009 Capacity-Building Initiatives by Major Regional AFHSC-GEIS Supported Partners and Type

Partner (see text)	Type of Infrastructure/Capacity Building*	Centers/ Hospitals	Field Sites	Countries*
AFRIMS	Influenza & malaria/MDR labs (KH, PH); enteric & influenza lab upgrade (NP, TH); blood culture (NP); influenza testing (BT); influenza antiviral resistance (TH)	22	51	5
NAMRU-2	Malaria, FVBI, enteric, blood culture & AMR testing (KH); influenza & AFI testing (ID, KH, SG); surveillance data management (LA)	4	73	4
NAMRU-3	Influenza, blood culture & AMR testing (EG, JO); Influenza PCR/culture & antiviral resistance testing (32 countries); Joint Biological Agent Identification & Detection System (5 deployed US military sites-CENTCOM**); zoonotic disease & entomology (EG, DJ); AFI, blood/cerebrospinal spinal fluid culture & serology testing (AZ, GE); Leishmania PCR & culture (EG, LR); rotavirus testing (6 countries); cholera & other ADD testing (7 countries); FVBI testing (EG, DJ, AZ, GE)	37	42	34
NMRCD-Peru	Influenza PCR/culture & antiviral resistance testing support (10 countries); AFI & viral culture & serology testing (PE, BO, EC, PY); Leishmania PCR, MDR, urine/vaginal PCR-STIs, Rickettsial PCR & culture (PE); enteric culture, PCR & AMR testing (PE, EC, PY); Alerta electronic disease surveillance system (PE, PA, EC)	23	102	11
USAMRU-Kenya	Malaria/MDR, microscopy & PCR, rotavirus, cholera & other ADD testing, arboviral/VHF PCR & culture, AFIs, blood culture & serology testing, STIs culture (KE); influenza PCR, culture &genotyping (KE, UG, CM); influenza, AFI, FVBI, cholera & other ADDs (KE, TZ, NG)	7	69	5
PHCR-South	Influenza PCR, culture & indirect immunofluorescence assay (US, HN, SV, NI, GT, PA); malaria, Leishmania, & dengue PCR testing (HN)	4	7	6
Univ Iowa CEID	Respiratory & other zoonotic respiratory EID testing & epidemiology (US, TH, KH, NG, RO, MN)	6	~30	6
JHU/APL	Influenza military treatment facilities (PIPM) modeling (US); SMS text & ESSENCE Desktop edition system (PH); Open source Interactive Voice Recognition software surveillance (PE); OpenESSENCE website software surveillance (US, PE); SMS text (PH)	1	~125	3

Abbreviations: MDR, [illegible]; FVBI, [illegible]; AMR, [illegible]; AFI, [illegible]); PCR, [illegible]; ADD, [illegible]); STI, [illegible] *Neisseria gonorrhea*; EID, [illegible]; PIPM, [illegible]; SMS, [illegible]; ESSENCE, [illegible].

*[illegible] (ISO 3166) [illegible] (URL: [illegible]_3166_[illegible]=CPS[illegible] 5KQCFQ P5[illegible]8A); [illegible]; U.S. [illegible] U.S. [illegible] U.S. [illegible].

**CENTCOM, U.S. [illegible] U.S. [illegible]).

Health Laboratory and also established real-time reverse transcriptase polymerase chain reaction (rRT-PCR) diagnostic capacity for influenza at a main tertiary-care hospital of the Department of Health within the Visayas region of the Philippines.

Developing influenza diagnostic capabilities at other NICs was also supported by the U.S. Naval Medical Research Unit No. 3 (NAMRU-3) in Afghanistan, Iraq and Jordan; by the U.S. Naval Medical Research Center Detachment in Peru (NMRCD-Peru) in the countries of Colombia, Ecuador, Paraguay and Venezuela; and in Kenya, by the U.S. Army Medical Research Unit-Kenya. Finally, in conjunction with the CDC's Central America and Panama center, the U.S. Army Public Health Command Region-South (PHCR-South) provided laboratory technical assistance, reagents and supplies to the Ministries of Health (MoHs) in El Salvador, Guatemala, Honduras, Nicaragua and Panama, resulting in the certification of the Guatemalan NIC and the testing of over 5,000 specimens for novel A/H1N1.

In collaboration with the Peruvian Navy, NMRCD-Peru has built a robust shipboard disease surveillance infrastructure with detection capability modeled very closely on the NHRC shipboard surveillance system. The early detection aspect of this system involves equipping participating ships with real-time PCR diagnostic capability for emerging infectious diseases, such as influenza or adenovirus. Short-term storage of samples allows for more in-depth, follow-up testing at the laboratory in Lima or at other collaborating regional laboratories. Since 2007, this system has successfully identified and responded to numerous outbreaks of respiratory, gastrointestinal and sexually transmitted infections among active-duty Peruvian personnel aboard ships [12]. More recently, this capability was instrumental in identifying and responding to a large outbreak of novel A/H1N1 on board a large deck ship in the Pacific [13].

This investment in laboratory infrastructure development has directly impacted the number of outbreak investigations that the AFHSC-GEIS network has been able to support. The capacity-building efforts contributed to outbreak responses in 76 instances in 53 countries, representing every major populated region of the world, including support for the confirmation of the first cases of novel A/H1N1 in 14 countries (United States, Bhutan, Cambodia, Colombia, Djibouti, Ecuador, Egypt, Kenya, Kuwait, Lao People's Democratic Republic (PDR), Lebanon, Nepal, Peru and the Republic of the Seychelles) [12]. The laboratory infrastructure allows for acute response capability and the ability to monitor ongoing epidemics or shifting EID patterns, such as the identification and continued monitoring of artemisinin-resistant malaria in Southeast Asia by partners from AFRIMS [14] and at the U.S. Naval Medical Research Unit No. 2 (NAMRU-2) or the search for genetic mutations within influenza viruses that may indicate resistance to antiviral medications.

Training

It is important to recognize that capacity building not only involves renovating laboratories and providing diagnostic equipment and supplies, but most important, building human capacity. Through training public health and laboratory personnel, the physical infrastructure could be properly leveraged for optimal support of IHR (2005) compliance. During 2009, AFHSC-GEIS supported 18 partner organizations that conducted 123 training initiatives in 40 countries involving at least 3,130 people, including many host-country personnel, in direct support of assisting with compliance with IHR (2005). Significant expansion of training activities was attained in the areas of pandemic preparedness, outbreak investigation and response, EID surveillance, and pathogen diagnostic techniques.

By engaging local health and other government officials and civilian institutions in training endeavors, the U.S. military's role as a key stakeholder in global public health has improved; and many opportunities for EID-related surveillance, research and capacity-building initiatives have been leveraged to provide a platform for public health training, described elsewhere in this supplement [11].

Electronic s▪r eillance initiati es

Electronic disease surveillance, another important component of a comprehensive global public health disease prevention and control strategy, contributes significantly to capacity building and support for IHR (2005) compliance in partner countries. Using electronic methods for data collection and analysis has the potential to improve the accuracy and timeliness of outbreak detection, as well as to provide situational awareness during, or in the aftermath of, an outbreak or pandemic. The AFHSC-GEIS network has supported numerous initiatives in electronic disease surveillance during the past several years, in partnership with several DoD overseas laboratories, host-country Ministries of Health and Defense and our technical partner, the Johns Hopkins University Applied Physics Laboratory (JHU/APL).

AFHSC-GEIS has relied on the extensive experience that JHU/APL acquired in the design and implementation of the Electronic Syndromic Surveillance for Early Notification of Community-based Epidemics (ESSENCE) system [15]. This electronic disease surveillance

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model for a toolkit approach to deploying electronic

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In addition to supporting laboratory infrastructure development and new surveillance initiatives, AFHSC-GEIS provided technical expertise in support of capacity-building efforts. In 2009, one of the largest such efforts was the network's global response to the novel A/H1N1 influenza pandemic. For example, NAMRU-3 provided training on laboratory techniques for 73 scientists and technical personnel from 32 countries in western and northern Africa, the Middle East, and central

accomplished by pursuing the following strategic goals: 1) adopting objective metrics of evaluation, such as timeliness of disease detection and reporting to higher levels, proportion of sites submitting timely weekly or monthly reports, proportion of investigated outbreaks with confirmed laboratory results, and proportion of confirmed outbreaks with nationally recommended public health response [18]; 2) ensuring future standardization of genetic and molecular-based testing platforms (e.g., PCR-based assays) across the network of partners; 3) establishing electronic sequence data repositories for more effective information sharing with the CDC, WHO and local regional health authorities (especially for influenza and other respiratory pathogens); 4) continuing emphasis on collaborative work with host-country partners to empower them to reach IHR (2005) capacity-building milestones by 2012; and, 5) achieving standardized reporting schemes for all AFHSC-GEIS partners in the areas of influenza, enteric diseases, febrile and vector-borne illnesses, sexually transmitted infections, and antimicrobial resistance monitoring. In this manner, the AFHSC-GEIS network will continue to contribute to the global efforts in disease control and prevention through the DoD's laboratory-based surveillance and by enhancing harmonization of efforts with other key USG stakeholders, such as the U.S. Department of Health and Human Services, the U.S. Agency for International Development and the U.S. Department of State.

Many challenges exist to building capacity for public health in resource-limited settings, including achieving sustainability of efforts after support is withdrawn, containing the departure of highly-trained, capable scientists after training, and minimizing the duplication of efforts among multiple sponsor agencies within the USG and with other organizations. Data sovereignty and data sharing are also key issues that require transparency on the part of both the sponsor and recipient in order to optimally conduct disease surveillance that satisfies the spirit of IHR (2005). Solutions to many of these challenges are sometimes difficult and frequently require continuous re-evaluation of best of practice solutions for individual settings.

Through the development of active, mutually supportive relationships with local health officials and the establishment of important protocol-driven clinical and laboratory surveillance projects, AFHSC-GEIS supported scientists have become relevant stakeholders within host-country public health communities and are able to continue to work in the critical development of surveillance, laboratory and communications infrastructure within partner countries. In addition to the IHR (2005), the AFHSC-GEIS global network recognizes the recently released National Strategy for Countering Biological Threats (PPD-2) as another guiding framework for alignment of our program with the larger USG initiatives [19], keeping the maintenance of the U.S. military's health (known as "Force Health Protection") as our unique niche in the setting of improving global public health. Meaningful public health initiatives taking place in any one of the partner countries within the AFHSC-GEIS global network must aim for incremental, albeit sustainable, development of capacity on behalf of their partner host countries and do so in line with the specific PPD-2 objectives and IHR (2005) competencies. In this manner, small improvements in capacity, improved testing abilities, and ultimately, compliance with reporting will lead to benefits for the health of U.S. servicemembers and for the health of the world.

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