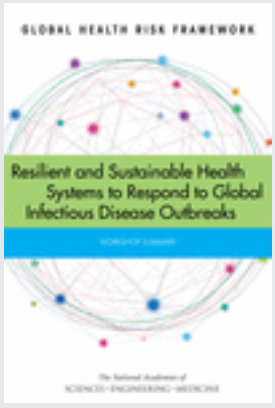

Global Health Risk Framework: Resilient and Sustainable Health Systems to Respond to Global Infectious Disease Outbreaks: Workshop Summary

DETAILS

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GLOBAL HEALTH RISK FRAMEWORK

Resilient and Sustainable Health Systems to Respond to Global Infectious Disease Outbreaks

WORKSHOP SUMMARY

Anna Nicholson, Megan Reeve Snair, and Jack Herrmann, *Rapporteurs*

Board on Health Sciences Policy

Institute of Medicine

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Reviewers

This workshop summary has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published workshop summary as sound as possible and to ensure that the workshop summary meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the process. We wish to thank the following individuals for their review of this workshop summary:

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Although the reviewers listed above have provided many constructive comments and suggestions, they did not see the final draft of the workshop summary before its release. The review of this workshop summary was overseen by **CLYDE BEHNEY,** Institute of Medicine. He was responsible

for making certain that an independent examination of this workshop summary was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this workshop summary rests entirely with the rapporteurs and the institution.

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Contents

Acronyms and Abbrevations

ACHEST	African Centre for Global Health and Social Transformation
CBI	Community-Based Initiative
CDC	Centers for Disease Control and Prevention (U.S.)
CHPS	Community-Based Health and Planning System
EOC	Emergency Operations Center
EPHF	essential public health function
ETU	Ebola treatment unit
EVD	Ebola virus disease
FELTP	field epidemiology and laboratory training program
FMT	foreign medical team
FUGI	Future Generations International
GHSA	Global Health Security Agenda
GOARN	Global Outbreak Alert and Response Network
ICS	Incident Command System
ICU	intensive care unit
IDSR	Integrated Disease Surveillance and Response
IHR	International Health Regulations
LMIC	low- and middle-income country

MERS	Middle East respiratory syndrome
MoH	Ministry of Health
NFP	National IHR Focal Point
NGO	nongovernmental organization
ODA	Official Development Aid
OpenHIE	Open Health Information Exchange
PHEIC	public health emergencies of international concern
PPE	personal protective equipment
QA	quality assurance
RIS	routine information system
SARS	severe acute respiratory syndrome
SDG	Sustainable Development Goal
SMS	short message service
VHT	village health team
WASH	water, sanitation, and hygiene
WHO	World Health Organization

1

Introduction[1]

Over the past decade or more, infectious disease outbreaks have demonstrated that an outbreak in one part of the world can threaten the health of the entire globe. These events have also pointed to the fact that in many countries and regions around the world, public health and health care capacities and capabilities vary. Even in the most developed countries planning and implementation of emergency response plans for large-scale public health emergencies are a significant challenge. In countries where the health care and public health systems struggle to provide services addressing noncommunicable diseases, and the corresponding social and economic costs, responding to infectious disease outbreaks becomes even more of a challenge due to limitations of these systems. Throughout the course of these outbreaks over the past several years, thousands of lives have been lost, the affected communities have suffered severe social and economic challenges, and the cost of responding to these incidents worldwide continues to climb into the billions. Multiple novel and evolving microorganisms have the potential to cause public health emergencies with international scope and since 2003, there have been several outbreaks of emerging and reemerging infectious diseases resulting in significant global health impact (see Box 1-1).

[1] The planning committee's role was limited to planning the workshop. This workshop summary has been prepared by the rapporteurs as a factual summary of what occurred at the workshop. Statements, recommendations, and opinions expressed are those of individual presenters and participants, and are not necessarily endorsed or verified by the National Academies of Sciences, Engineering, and Medicine and should not be construed as reflecting any group consensus.

BOX 1-1
What Are Emerging Infectious Diseases?

The U.S. Centers for Disease Control and Prevention (CDC) defines "emerging infectious diseases" as those that have increasingly affected humans over the past 20 years, or that threaten to do so soon. These include

- Changing or evolving existing organisms that give rise to new infections,
- Known infections that spread to new areas or populations,
- Previously unknown infections that arise in areas of ecological transformation, and
- Old infections that reemerge due to antimicrobial resistance or breakdowns in public health practices.

SOURCE: CDC, 2012a.

Ebola virus disease (EVD), formerly called Ebola hemorrhagic fever, was first identified in 1976 in remote villages in Central Africa. The recent outbreak in West Africa—the most widespread to date—began in Guinea in March 2014 and spread primarily to neighboring countries Sierra Leone and Liberia (WHO, 2015d). By the end of July 2015, there were nearly 28,000 confirmed, probable, and suspected EVD cases across those three nations, with the reported number of deaths exceeding 11,000. This total includes 880 confirmed health worker infections and 510 reported health care worker deaths (WHO, 2015c). The most recent global influenza pandemic, H1N1, which occurred between 2009 and 2010, originated in North America and spread throughout the world (Fineberg, 2014). The number of global deaths attributed to the Influenza A virus subtype H1N1 pandemic is estimated to be between approximately 152,000 and 575,000 (CDC, 2012b).

Middle East respiratory syndrome (MERS) is a viral respiratory disease caused by a coronavirus (MERS-CoV). MERS was first reported in the Kingdom of Saudi Arabia in 2012, with epidemiologic investigation confirming the first cluster of cases had originated in Jordan. An outbreak in the Republic of Korea emerged in summer 2015, with 185 confirmed cases and 36 deaths as of July 2015. Globally, there have been nearly 1,600 confirmed MERS-CoV cases and 567 deaths (WHO, 2015f). Another viral respiratory illness caused by a coronavirus is severe acute respiratory syndrome (SARS). In February 2003, a SARS outbreak originated in southern China and eventually spread throughout Asia, Europe, North America, and South America. By July 2003, just a few months after discovery of the

virus, 8,098 probable cases and 774 deaths had been reported to the World Health Organization (WHO) from 29 countries (CDC, 2003).

The 2015 Global Risk Report identified rapid spread of infectious disease as one of the top risks and second in terms of potential impact (NASEM, 2015). The notable infectious disease outbreaks described above are examples of the need for enhanced and sustainable capacity to plan for and respond to global infectious diseases and other public health emergencies, as well as an augmented framework for identifying and effectively responding to the contemporary challenges and realities presented by these emergencies.

INTERNATIONAL HEALTH REGULATIONS: PROMOTING GLOBAL HEALTH SECURITY

The International Health Regulations (IHR), a 2005 agreement among 196 countries designed to improve global health security (WHO, 2005a), was entered into force in June 2007. It is a legally binding framework to promote the global community's capacity to "better manage its collective defenses to detect disease events and to respond to public health risks and emergencies that can have devastating impacts on human health and economies" (WHO, 2005b). WHO serves as the coordinating body in implementing IHR and assisting countries in building their health systems' capacities for detecting, assessing, reporting, and responding to public health emergencies.

The IHR agreement codifies the commitment of member states to building their core capacities to the standards set by these regulations. Member states' surveillance and notification capacities and responsibilities are key stipulations of IHR. States are obligated to notify WHO of events that qualify as potential "public health emergencies of international concern" (PHEIC).[2] A PHEIC is declared if an extraordinary event or emergency represents an international public health risk through cross-border spread of disease, and that potentially requires an immediate coordinated international response (i.e., it is serious, unusual, and/or unexpected) (WHO, 2015e). Member states are required to notify WHO of any incidence of smallpox, wild-type poliovirus poliomyelitis, new-subtype human influenza, or SARS (WHO, 2015a). Other illnesses or events are potentially notifiable (including EVD, yellow fever, and cholera) based on a decision support algorithm (CDC, 2015b). Since the inception of IHR, WHO has declared three PHEICs: the influenza A virus subtype H1N1 outbreak in 2009, the

[2] As designated by the IHR emergency committee, which provides technical assistance to the WHO Director-General.

outbreak of wild-type poliovirus poliomyelitis in 2014, and the most recent EVD outbreak in West Africa in 2014.[3]

Member states are also required to have additional technical capacities for preparedness, response, dissemination of risk communication, human resources, and laboratory services. Required administrative capacities include national legislation, policy, financing, coordination, and establishment of a National IHR Focal Point within each country to communicate directly with WHO. However, as of 2014, only 64 of the member states had achieved the required core capacities, with the remainder requesting an additional 2-year extension until 2016 (Katz and Dowell, 2015). These statistics are of utmost concern, because they suggest that only about one-third of the world's health systems are prepared to respond effectively to a public health emergency. At present, there are no enforceable sanctions in place to penalize countries for noncompliance with the IHR agreement past the deadline, which has already been extended several times.

Lessons learned from the 2003 SARS outbreak helped to shape IHR. Critical weaknesses were exposed in both the capacity of national health systems to respond to public health emergencies and the global capacity to effectively coordinate on an international scale. For example, the first cases of SARS were not detected or reported in a timely manner to WHO, and during the interim months before WHO assistance was requested there was already international spread of the disease. Although the outbreak was eventually contained with limited international public health impact (primarily due to its relatively low transmission rate), it is estimated to have cost the global economy $40 billion (Sidorenko and McKibbin, 2009) and up to $18 billion separately in terms of international trade and travel (Hitchcock et al., 2007). Since the implementation of IHR in 2007, the H1N1 and EVD outbreaks have further revealed gaps and fragilities in national and international-level response capabilities, as well as in the IHR mechanism itself, and underscored the importance of prioritizing health systems strengthening to comply with IHR standards.

A retrospective analysis of the 2009 H1N1 pandemic, which was the first activation of IHR, described how the response to the outbreak exposed: "vulnerabilities in global, national, and local public health capacities; limitations of scientific knowledge; difficulties in decision making under conditions of uncertainty; complexities in international cooperation; and challenges in communication among experts, policymakers, and the public" (Fineberg, 2014). The 2014 EVD outbreak in West Africa has been similarly instructive; a WHO report summarizing lessons learned asserted that a country with a weak health system and limited public health infrastructure is unable to withstand a "sudden shock" like an infectious

[3] The MERS-CoV outbreak has not officially been declared a PHEIC by WHO.

disease outbreak. In addition to the health impact of the epidemic itself, its consequences can escalate rapidly into a social, economic, and humanitarian crisis that affects not only the country, but its neighbors and the entire global community. Much of the economic costs of outbreaks arise not from direct effects, but from public anxieties because of misinformation about the spread or lack of a clear leadership response (NASEM, 2015).

THE GLOBAL HEALTH RISK FRAMEWORK INITIATIVE

Since the 2014 Ebola outbreak many public- and private-sector leaders have seen a need for improved management of global public health emergencies. The effects of the Ebola epidemic go well beyond the three hardest-hit countries and beyond the health sector. Education, child protection, commerce, transportation, and human rights have all suffered. The consequences and lethality of Ebola have increased interest in coordinated global response to infectious threats, many of which could disrupt global health and commerce far more than the recent outbreak.

With encouragement and input from the World Bank; WHO; and the governments of the United Kingdom, the United States, and West African countries; and support from various international and national organizations (Ford, Gates, Moore, Paul G. Allen Family, and Rockefeller Foundations; Dr. Ming Wai Lau; the U.S. Agency for International Development; and the Wellcome Trust), the U.S. National Academy of Medicine agreed to manage an international, independent, evidence-based, authoritative, multistakeholder expert Commission[4] on improving international management and response to outbreaks. As part of this effort, the Institute of Medicine convened four workshops in the summer of 2015 to inform the Commission report. These workshops examined questions of ***governance for global health, pandemic financing, resilient health systems***, and ***research and development of medical products.*** Each workshop gathered diverse perspectives on a range of policies, operations, and options for collaboration to improve the global health system. A published summary from each of the workshops has been independently written and reviewed and their release will be coordinated.[5]

[4] For more information on the Commission, see http://nam.edu/initiatives/global-health-risk-framework (accessed October 20, 2015).

[5] Summaries from the other three workshops can be found at http://iom.nationalacademies.org/reports/2016/GHRF-Governance; http://iom.nationalacademies.org/reports/2016/GHRF-Finance; http://iom.nationalacademies.org/reports/2016/GHRF-Research-and-Development.

MEETING OBJECTIVES

To focus on the characteristics of and optimum approaches to building sustainable and resilient health systems that are responsive to emerging infectious disease threats and other public health emergencies, the Board on Health Sciences Policy within the Institute of Medicine of the National Academies of Sciences, Engineering, and Medicine convened Global Health Risk Framework: A Workshop on Resilient and Sustainable Health Systems to Respond to Global Infectious Disease Outbreaks, held August 5-7, 2015 in Accra, Ghana. This document is a summary of the presentations and discussions that took place at the workshop, and is not meant to be a comprehensive overview of how to best build sustainable and resilient health systems. Achieving compliance with the core capacities of IHR and instilling resilience within all sectors in countries to positively impact the health of a population is a multifaceted and very complex goal. Due to limitations of participants' availability and the timing of this workshop, this summary captures suggestions and ideas from individual speakers and participants on how to accomplish these goals, but they may not be complete or all encompassing. For workshop objectives, see Box 1-2.[6]

RESILIENCE AND SUSTAINABILITY IN HEALTH SYSTEMS

Two fundamental principles underpin strong health systems: resilience and sustainability. Michael Myers, Managing Director, The Rockefeller Foundation, introduced the concept of resilience in health systems by defining it as the capacity of health actors, institutions, and populations to prepare for and effectively respond to crises, thus maintaining core functions when a crisis hits (see Box 1-3). Resilient health systems are continually informed by lessons learned during a crisis and are able to reorganize as needed; they protect human life and produce good health outcomes for all during a crisis, as well as in its aftermath; and they deliver everyday benefits and generate positive health outcomes. Kumanan Rasanathan, Senior Health Specialist, UNICEF, elaborated that resilience is not useful for its own sake; rather, it is useful because it allows for more effective delivery of health care to patients and is flexible enough to respond to unexpected health threats.

Sustainability is the second essential principle of a strong health system, Myers said. Health systems are sustainable when their capacity for day-to-day care delivery is maintained even during periods of increased demand and emergencies, such as an emerging infectious disease outbreak. For systems that lack such sustainability, outbreaks can expose existing gaps, exacerbate problems, and leave behind a weakened and depleted system

[6] A full statement of task for the workshop is included in Appendix B.

BOX 1-2
Workshop Objectives

- Deliberate on suggestions and opportunities to build and maintain a sustainable, resilient health system for times of emergency, especially in resource-limited settings;
- Synthesize lessons learned from past case studies about potential threats posed by fragile health systems and ways to restore and maintain health system resilience and sustainability;
- Discuss the key priority areas for Disease Surveillance, Workforce Capacity, Public Health and Health Care Infrastructure, Community Engagement, and Leadership and Management, and their integration to achieve resilient and sustainable health systems;
- Discuss varying types of cross-sector partner engagement in building resilient and sustainable health systems and how these partners are incorporated into the overall health care delivery system;
- Consider the value proposition for resilient and sustainable health systems, and the impact on the economic sector nationally and globally due to ineffective and inefficient health systems; and
- Synthesize best practices and recommendations for translating research and lessons learned into public health action for holistic health system resilience and sustainability.

BOX 1-3
Characteristics of a Resilient Health System

Myers outlined five characteristics of a resilient health system:

- Aware: the system needs to have surveillance capacity and be aware of its limitations
- Diverse: the system must be multidisciplinary and provide adequate training for health care workers
- Self-regulating: the system has the authority to make changes in a timely manner and has flexible infrastructure
- Integrated: the system has integrated health and public health capacities, with coordination during crisis as well as peacetime (this is essential to building trust)
- Adaptive: the system can make changes and adapt to unanticipated challenges

SOURCE: Myers presentation, August 5, 2015.

that can no longer deliver day-to-day health care to the population. This ability to achieve sustainability and withstand internal threats is a key goal for health security for developing countries, while developed countries are often more concerned with securing against external threats. As some participants argued, having different preparedness goals (i.e., internal threats versus external threats) makes it difficult to synergize energy and funding to build sustainable systems that are satisfying to all parties. Educating donors on effectively prioritizing allocations to build public health infrastructure can help to address routine threats like dengue fever and maternal mortality—while simultaneously building innate capacity to redirect efforts to an emergency response when needed, said P. Gregg Greenough, Research Director, Harvard Humanitarian Initiative, Harvard School of Public Health.

A health system's capacity to function comprehensively and effectively on an everyday basis while also being able to respond effectively to—and recover from—public health emergencies is the hallmark of both its resilience and its sustainability, he noted. Further, Ben Adeiza Adinoyi, Africa Zone Health and Care Coordinator, International Federation of Red Cross and Red Crescent Societies added, that having a strong health system is dependent on economic development, and a prerequisite for that is to have strong governance in place. So, while the focus of conversations is often improving fragile or weak health systems in countries to be stronger, he said, any reasonable intervention needs to also look at the governance and leadership challenges that exist in these countries, and not just examine the health facilities in a vacuum.

One important real-world application showing the importance of a health system having the equipment and day-to-day capabilities to function and thrive during an emergency response, is reflected in the comments of Marie Claire Tchecola, a Guinean nurse and EVD survivor, sharing her perspective from Conakry (see Box 1-4).

ORGANIZATION OF THE REPORT

This workshop report summarizes the proceedings of discussions in the Ghana workshop, and comprises information presented, concerns raised, priority areas for improvement highlighted, and solutions suggested by the participants during the plenary sessions and the focus area discussions. Chapter 2 covers foundational principles for implementing resilient and sustainable health systems. It includes priorities and principles for leadership and management, such as accountability, ensuring IHR compliance, donor management, and communication. The section on fostering cross-sector engagement spans the topics of integrating public health, mental health, and health care services, and engaging with communities, nongov-

BOX 1-4
Reflections of a Health Care Worker and EVD Survivor

"My name is Marie Claire Tchecola and I'm an ER [emergency room] nurse at Donka hospital; that's the main public hospital in Conakry. I am an Ebola survivor. I was infected in July of 2014 while I was on duty, and I was infected by a patient who came from Liberia. This patient ended up infecting nine people at the hospital. One of the reasons I contracted Ebola at the time was because I did not have any gloves to protect myself. I became sick and I went to the hospital and I was hospitalized. Meanwhile the patient died and the test confirmed that she had contracted Ebola. Afterward the Ebola treatment center conducted an investigation to find out all the contacts. After that, all nine people went to the Ebola treatment center to be tested for Ebola. Unfortunately, the test was positive for all nine people. Six people survived and three of them ended up dying.

I stayed at the Ebola treatment center for 2 weeks and I left the center on August 7, 2014. I survived and I was cured. When I went back to my house my two daughters were standing outside because we had all been evicted by our landlord. A friend of mine took us in and gave us lodging. Two weeks later I went back to work at the emergency room. Ever since then I make it my mission to testify to end stigmatization and also to prove that you can survive and get cured from Ebola. Because of my personal story and my experience, I have some recommendations that I would like to share with you.

My first recommendation deals with communication. You have to let the subject-matter experts speak and also those who know the topic. You also have to involve natives of the communities into the response, people like the mayors, the religious leaders, and the women. My second recommendation deals with training of health care workers. The training should be provided while you are in school and also while you're working with continuing education courses. As a French proverb says, it is better to prevent than to treat.

In conclusion, when we have reached our objective of zero Ebola cases we will still have a lot of work to do. We will have won the battle against Ebola but the war against infectious diseases will continue."

SOURCE: Marie Claire Tchecola presentation, August 7, 2015.

ernmental organizations, civil societies, and the business and private sectors. Chapter 3 presents strategies for strengthening health systems through building countries' capacities for everyday health care delivery as well as public health infrastructures. Chapter 3 also touches on the needs for robust and resilient supply chains and improved research and clinical guidance. Chapter 4 reports on practical approaches for enhancing information management capacities, including health information and disease surveillance systems. Finally, Chapter 5 addresses the principles and strategies for strengthening outbreak management and emergency response systems.

2

Fundamental Principles of Strong Health Systems

Highlights and Main Points Made by Individual Speakers and Participants[a]

- Good health care leadership requires training and flexibility on a country-to-country basis, with a focus on the needs and resources available in each country. (Agyepong, Hanfling)
- A crucial step toward building health system resiliency in a country is the achievement of the World Health Organization's International Health Regulations core capacities; achievement should be monitored using a country-specific "roadmap," which evaluates feasibility and progress for each capacity. (Anyangwe, Fitter, Kimball, López-Acuña, Tomori)
- Donor management must change, such that countries receiving aid can use money more independently and ensure that incoming aid goes toward areas in need of critical relief without pressure from donors. (Greenough, Kimball, Tomori)
- Health care and epidemic response must go far beyond the health care sector; rather, it requires a multisectoral response and cooperation between different actors, including but not limited to government, private companies, and civil society/nongovernmental organizations. (Omaswa, Rasanathan)

- The integration of public health and health care can occur through improved public health training across areas of health care service, and this integration could also prevent the diversion of resources from areas of need during an epidemic or health care emergency. (Greenough, López-Acuña)

[a] This list is the rapporteurs' summary of the main points made by individual speakers and participants and does not reflect any consensus among workshop participants.

This chapter presents a range of suggestions made by participants in the workshop with respect to the fundamental principles and approaches underpinning the practical systems-strengthening strategies presented in subsequent chapters. Many participants throughout the workshop also highlighted the importance of effective leadership and management, and the need for more concerted efforts to foster better engagement among all sectors and stakeholders.

LEADERSHIP AND MANAGEMENT

"Leadership and decisions should be directed in the context of existing structures and take into account where we need to strengthen those structures to produce effective outcomes."

—Daniel López-Acuña, Former Director for Recovery and Transition, Cluster of Health Action in Crisis, World Health Organization

Several participants returned frequently to the need for strong and effective leadership in order to steward efforts to strengthen health systems, and to manage emergency responses, by working within existing structures at all levels. Dan Hanfling, Contributing Scholar, UPMC Center for Health Security, reported that top areas of discussion to emerge included

- Principles of leadership in response to public health emergencies;
- Accountability, including International Health Regulations (IHR) compliance;
- Donor management; and
- Communicating and disseminating information.

Regarding leadership and management, some participants noted that sometimes leadership is defined by what you bring to the table, and

the absence of leadership—or bad leadership—can make things worse. Ann Marie Kimball, Associate Fellow, Royal Institute of Foreign Affairs, Chatham House, cautioned that different cultures have different definitions of leadership, so it is important to be mindful of cultural assumptions when assessing leadership styles.

Principles of Leadership in Response to Public Health Emergencies

Delanyo Dovlo, Director, Health Systems and Services Cluster, World Health Organization (WHO) Africa Regional Office, cautioned that leadership during an emergency response cannot occur in a vacuum and must take into account the existing health system; he noted that when external groups converge on a country during a crisis, it can destroy that country's leadership structure. Multiple participants noted that leadership should be involved in all aspects of the emergency management cycle and that predictable national structures and systems should be established for response to public health emergencies, with the caveat that each infectious disease has unique characteristics that may evolve over time. Trish M. Perl, Division of Infectious Diseases, Department of Medicine, Johns Hopkins University, suggested incorporating a bilateral decision structure to build trust, augment response activities, and ensure accountability; a further investigative component would inform an emergency response that is situated appropriately within its particular political and social context.

Hanfling noted that the availability of resources can influence the ability to lead—the response to an event needs to be constructed by local emergency management authorities, with the affected country setting the requirements for what is needed. López-Acuña warned about the tendency to fall into a one-size-fits-all response, which could be mediated by building the necessary relationship between outbreak response and the national response plan. Acknowledging that every response is unique, both Perl and Rob Fowler, Physician, University of Toronto, Canada, advised country leadership to leverage relevant experiences from countries around the world that have gone through similar outbreaks.

Training Leaders to Lead

Hanfling reminded participants that they have some responsibility for identifying and training leaders about how to lead, how to support adaptability, and how to ensure accountability. Irene Akua Agyepong, University of Ghana, called for more investment in capacity building with respect to the "soft skills" of leadership, particularly for leadership in cross-sectoral work, which should encompass skills in listening, negotiation, conflict reso-

lution, engagement, observation, and taking the time to understand people's interests and cultures within countries and organizations.

Various participants discussed the need for leadership to work within and support existing functional structures at the global, national, regional, and district and local levels to strengthen systems and create strong models of emergency preparedness that maintain the integrity of the local context. While the ultimate goal would be the alignment of all of the partners in achieving capable systems that can deal with emergencies, Hanfling suggested that other beneficial outcomes could include

- Building and strengthening capacity
- Promoting emergency management systems and implementing a national emergency management plan (focus on process)
- Building a systems approach to managing emergencies
- Optimizing interemergency periods to build capacities and capabilities
- Instilling leadership with the attitude and accountability to make good decisions and fulfill expectations, and
- Strengthening of civil societies

Joan Awunyo-Akaba, Future Generations International, Ghana, strenuously urged the African Academy of Sciences to take a much stronger leadership role in bringing together the top professionals and scientists in the continent to create roadmaps, set clear agendas, and seek out people and organizations with available resources to solicit support. Many participants discussed how achieving the aforementioned desired outcomes would require intergovernmental ministries and partners across all sectors to be willing to work together and recognize the benefits of coordination. Incentives to motivate leaders to act in the way the people want and need them to would also need to be identified in order to realize progress.

Accountability

> "How we can engender better stewardship and governance of health systems, both nationally but also at a local level, in a way that builds stronger accountability for results, holding the people responsible for our health to account for the results that they bring?"
>
> *—Delanyo Dovlo, Director,*
> *Health Systems and Services Cluster*
> *World Health Organization Regional Office for Africa*

Throughout the workshop, the importance of building in measures of accountability was reiterated not only for leadership but also for many other components of the health system, including health care providers, disease surveillance and reporting, private-sector actors, nongovernmental organizations (NGOs), and donors. Much of the discussion concerning accountability centered on the issue of IHR compliance, but some participants also considered the use of peer-reviewed publications that describe emergency management capabilities as an independent measure of accountability. Such publications could include scientific analysis, descriptive reports, and lessons learned. Increased access to published data, experience, and response lessons learned could contribute to both accountability and performance improvement, though resources would be needed to fund, conduct, and disseminate the reports.

Ensuring Accountability and Commitment to IHR Compliance

López-Acuña characterized lack of accountability to IHR compliance as a "global failure" of member states, WHO, investment banks, and bilateral cooperation that should be a priority to rectify. Oyewale Tomori, President, Nigerian Academy of Science described it as a "toothless" document that gives assessed targets to countries but does not take any action if they are not achieved.[1] Stella Anyangwe, Honorary Professor in Epidemiology at the School of Health Systems and Public Health at the University of Pretoria, South Africa, noted similarly that WHO does not currently "name and shame" countries for not signing or ratifying IHR, or take any real action against countries that fail to comply with the regulations, which needs to change.

Kimball of Chatham House remarked that countries are not given adequate operational guidance about how to achieve IHR core capacities. Myers of Rockefeller noted that the modalities for achieving compliance should be contextual to each country, taking into consideration the resources available to support the member state's compliance. While there are minimal requirements to implement IHR, country specificity in capabilities can create different variations, meaning that the baseline systems for laboratory capacity, risk community, surveillance, and emergency operations centers can be responsible for country-specific differences in timing and accurate response. Gabriel Leung, Dean, Li Ka Shing Faculty of Medicine, The University of Hong Kong, suggested implementing a program of peer assessment by a national, unaffiliated team of technical experts invited in to provide an assessment using a continuous quality improvement approach. He further proposed making Official Development Aid (ODA)

[1] He noted that WHO has set up a new committee to look into making IHR more effective.

contingent on certified IHR adherence. He noted that "certified" is key in this context, because there are some countries whose self-certified compliance does not actually adhere to the established standards.

A Roadmap for IHR Compliance?

During one of the panel discussions, David Fitter, Epidemiologist, Emergency Response and Recovery Branch, U.S. Centers for Disease Control and Prevention, raised the possibility of a "roadmap" to achieve IHR core capacities, which might include a country-specific assessment of the feasibility and requirements for compliance. He explained that one component of IHR is that its goals are accomplished in day-to-day systems, so funding opportunities need to come with the guidance and further support. Kimball replied that the capacities are basic-level and were heavily negotiated after the severe acute respiratory syndrome (SARS) outbreak before IHR ratification in 2005, but WHO operational research tools have not been tested fully and financial research still needs to be conducted on a country-to-country basis. She remarked that efforts to ensure and facilitate IHR adherence have thus far primarily been driven by global leadership, and she encouraged local leadership to take a more active role in advocating for compliance. Because of the importance of implementing IHR capacities as currently established (and any further stipulations that are agreed to), she suggested devising a financial roadmap for IHR and encouraging countries to maintain the safety they provide for the benefit of their own populations. Adinoyi, of the International Federation of Red Cross and Red Crescent Societies (IFRC), concurred that drawing a roadmap is a very important first step. From the Red Cross perspective, after Ebola virus disease (EVD), there was agreement to support disaster response and IHR compliance in the African region. Aba Bentil Andam, Ghana Academy of Arts and Sciences, contended that IHR involves policy makers: whatever the extent of the resources that providers and researchers try to invest, policy makers must work harder to ensure compliance. She suggested campaigning to engage politicians and the media for support.

Donor Management

The need for leadership to more effectively steward and manage donor funding was highlighted throughout discussions. Many participants explained how establishing long-term, sustainable financing solutions is a key part of alleviating long-term dependence on donor funding and moving away from the donor-directed allocation of resources. They suggested that ultimately, countries should be able to self-regulate and audit their systems, and to maintain accountability to themselves, the people, and

invested stakeholders. López-Acuña argued that health financing should be "home grown," and that the quantum of health expenditure matters, noting that there is a current overreliance on out-of-pocket expenditures. He also noted that there is very little accountability and external scrutiny of good donor practices in terms of effective systems strengthening. Some of the platforms that have been created in recent years are still operating at a very conceptual level, without getting down into the necessary granularity to take action.

Kimball described how donor funding can fall into a trap of accidentally forcing country dependency; to address this, there needs to be a turnover of skills and resources to in-country investors and participants. Fitter suggested that donors should try to avoid initiating programs; rather, they should work to strengthen and improve on existing resources. Ring-fencing[2] of donor funding was another concern raised by some participants. For instance, Tomori remarked that in some cases, the giver actually benefits more than the receiver in donor relationships and the biggest benefactor in system building is often the donor. Anyangwe attributed the lack of essential infrastructure-building in some countries to donors providing money that could not be used for infrastructure or any purpose other than the donor's chosen one: "beggars cannot be choosers, and so those begging for funds flex and bend to the whims of those giving the funds." This results in fragmentation that undercuts horizontal system-strengthening efforts. Kimball noted that the concept of a "code of ethics" for donors had emerged during several conversations. The opportunity would allow the donor community to become part of the process of sustaining health systems in the intercrisis period rather than contributing to fragmentation, and the self-interest needs of businesses can be brought to light ahead of a disaster.

A few participants called for leadership to provide better guidance to donors to channel funds to where they are most needed; funding should focus primarily on public health priorities and infrastructure, not the "emergency disease of the day." As an example, Greenough of Harvard School of Public Health noted that while people are dying of EVD in Sierra Leone, children under 5 years of age are also dying of diarrheal illnesses, which will continue after the EVD outbreak is over. He encouraged government and leadership to educate donors about funding allocation priorities while also striving for transparency and openness. Koku Awoonor-Williams, Regional Director of Health Service for the Upper East Region of Ghana, highlighted the need for a paradigm shift in the sense that donors should provide fund-

[2] A ring fence is a protection-based transfer of funds from one account to another; it is often used to separate assets from an account and protect them against certain restrictions, or to lower tax consequences on the assets. See more at http://lexicon.ft.com/Term?term=ring-fence (accessed October 20, 2015).

ing to developing countries even during inter-crisis periods, to help those countries improve their health systems even when there is no imminent outbreak present. Peter Lamptey, Distinguished Scientist and President Emeritus, FHI 360, pushed for considering an additional health services tax, or VAT, in addition to every funded vertical program (e.g., immunization) or any money devoted to improving just one part of the infrastructure. Such a tax would ensure that the rest of the system is maintained as well.

Communicating and Disseminating Information

One of the primary responsibilities of leadership and management identified by several participants is the facilitation of clear and open communication among all partners, providers, and the community—a trustworthy health system is not possible without sharing information. Communication gaps between care providers, patients, their families, government officials, public health officials, and the community are common. Creating informed and sensitive communication channels to country leaders and politicians can be just as important as communicating information to the public. Anyangwe noted that all stakeholders should receive the information they need in a timely and transparent way. Greenough remarked that system breakdown at the local level occurs when there is a lack of two-way communication, for instance, when local officials do not receive the information they need from higher levels of government. He suggested that relationships, relationship building, and other forms of communication between different agencies and levels of response are crucial because they can provide short-term solutions to health systems concerns before considering long-term change.

One of the topics explored was the development of short-, medium-, and long-term communication plans to address the need for sustained, coordinated, and continuous communication between health care providers and the population at the national, regional, and local levels that is maintained during and between emergencies. Lamptey specifically called for the use of social media for effective outreach. Multiple participants throughout the workshop echoed this strategy, in addition to recommending the use of short message service (SMS) alerts to deliver a range of health-related messages, especially in developing countries where SMS alerts can be a primary method for message dissemination. Andam and other participants also noted that governments often fail to adequately employ the media as a communication tool. Suggestions for engaging the media include having frequent meetings and training about how to report on outbreaks, and a general strategy of forming close ties with the media to "bring them on board" and help to reduce the amount of false information spreading.

FOSTERING CROSS-SECTOR ENGAGEMENT

> "If we talk about resilience, it isn't something that can exist in a silo in a single system in the health system. If you really want to talk about resilience it requires efforts of all the society. So that's not just the state sector; it also very much needs the contribution of the private sector and civil society, but it also needs us to think beyond the health sector to the contribution of other sectors than health. And often in the health sector perhaps we underplay that contribution. For too many people health just equals health care. Health care is very important, but health care itself can't be delivered without the contribution of other sectors."
>
> *—Kumanan Rasanathan, Senior Health Specialist, UNICEF*

During discussions on cross-sector engagement in building systems to support health, participants were asked to identify and engage the broad array of stakeholders spanning multiple sectors: public health; health care; mental health; NGOs and civil societies; the business and private sectors; and communities. Discussion centered on finding ways to effectively integrate all sectors in health care delivery and response to crises. Francis Omaswa, Executive Director of the African Centre for Global Health and Social Transformation (ACHEST), commented that bringing people together between outbreaks is difficult but should remain a priority until the various players can be united as a cohesive whole. Referencing Canada as an example, Fowler of the University of Toronto highlighted the creation of the Public Health Agency of Canada following the SARS outbreak in 2003. Looking even further, Rasanathan urged participants to think beyond the health sector and recognize how other areas contribute to overall health. He drew a distinction between two understandings of cross-sectoral engagement. One is how different sectors such as government, civil society, and the private sector engage with each other; the other is how the different thematic sectors work together, such as water and sanitation, nutrition, education, energy, transport, and finance. As an example of poor cooperation between the health sector and other sectors, he cited the fact that 38 percent of health care facilities in low- and middle-income countries (LMICs) have no water, 19 percent do not have improved sanitation, and 35 percent lack water and soap for hand washing (WHO, 2015b). He questioned how settings that lack basic sanitation could realistically have the capacity to build health systems. Demonstrating this even further, Accra was facing an ongoing cholera epidemic at the time of the workshop, affect-

ing more than 20,000 people and compounding already existing health care workers' fears surrounding the lack of personal protective equipment (PPE) available for infection control and a looming Ebola epidemic very closeby (Nyarko et al., 2015).

While other sectors provide opportunities for direct health care delivery and provision of services, Rasanathan cautioned against instrumentalizing other sectors for health, because the core business of other sectors is not defined by health outcomes. Other sectors bring different core values and interests to the table that need to be respected in a collaborative effort, rather than one sector imposing its own values on the others. But he remarked that because outbreaks create fear, they do create a fruitful opportunities for cross-sectional collaboration. However, he noted that for such collaboration to lead to joint action it will require new competencies from the health sector in terms of understanding the interests of other sectors,[3] paired with joint accountability for indicators and targets that is government-enforced. He concluded by remarking that while command-and-control efforts are needed in certain outbreak situations, they are not always conducive to cross-sector collaboration. He called for national leadership to think about ways to bring all of society's players to the table "to build resilience in health systems and to build resilience in societies, because without that collaboration we're certainly not going to achieve this important task." Participants discussed the need for clear communication and coordination among stakeholders across sectors at the national, regional, and district levels. As Hanfling declared, there is a moral imperative and social responsibility of all partners to ensure the health of a population.

Lessons from Past Outbreaks

Because EVD and other recent emerging threats are not the first time many countries have experienced these types of challenges, the discussion also included references to lessons learned from other past disease outbreaks in these countries, such as HIV/AIDS. Having spent much of his career focused on HIV, Lamptey offered some parallels between the response to the emergence of HIV 30 years ago and the disease groups that are the focus of this workshop (see Box 2-1). Both are emerging infectious diseases with high morbidity and mortality rates that engender stigma and fear, he said, and they are both perceived threats to high-income countries that generate irrational political and emotional responses. Both have also had a devastating impact on health services in affected countries, especially at

[3] He made particular reference to the need to engage members of the private sector with their own core interests explicitly expressed, as well as appreciating the range of contributions that civil societies make as advocates of and agents for their communities.

BOX 2-1
Lessons Learned from the Response to the HIV Epidemic

Lamptey outlined some of the key factors that drove the global response to HIV:

- Political commitment,
- National- and international-level leadership,
- Advocacy by people living with HIV in the United States,
- Successful resource mobilization,
- Civil society and community partnerships, and
- Cross-sector engagement.

He further offered a set of instructive lessons relevant to emerging infections and suggested that responses should

- Be more horizontal than vertical,
- Be sustainable,
- Be cost effective,
- Primarily be the responsibility of governments in partnership with civil societies and communities, and
- Avoid damaging the health system via distorted prioritization of resources.

SOURCE: Lamptey presentation, August 7, 2015.

the outset as global health professionals struggle to understand the disease with only trial and error methods available for treatment options. Finally, the responses to both types of outbreaks have primarily been vertical, and without the horizontal aspect including the various sectors described in this report (community, civil society, and the private sector, among others), it becomes difficult to mount a successful, comprehensive response to a threat as pervasive and complex as HIV or EVD.

Integration of Public Health and Health Care

Many participants called for better integration of the public health and health care delivery divisions. Greenough highlighted the false dichotomy between the sector that provides health care and the public health infrastructure that should drive population-level health improvements. Resolving this fragmentation, not only between these two sectors but also among governments and donors as well, will require reciprocal efforts from both sectors. A key concern echoed by multiple participants is that health care professionals, as well as leadership, generally lack sufficient grounding in

the basic tenets of public and population health. As López-Acuña noted, effective treatment is often the most important step toward the prevention of a disease or outbreak. Poor infection control and prevention practices are also widespread in both high- and low-resource settings, leading to amplified nosocomial transmission. Education and training in basic public health principles within and beyond the health care delivery sector was a key highlight.

Improved, early-stage education and training for health care workers and clinicians could also serve to help them understand the importance of tasks they may be less willing to devote time to, such as surveillance and reporting, as well as the serious public health consequences of failing to carry them out diligently. Convincing health care providers, including community health workers and traditional healers, of their important role in the greater public health infrastructure is critical, according to Greenough. Perl suggested that risk assessment could be bolstered by integrating the distinct types of knowledge and experience that clinicians "on the ground" in health care facilities have with that of public health academics and experts. Public health experts could also further benefit from epidemiologic field experience, according to Anyangwe.[4]

Greenough emphasized the need to put resources toward the integration of public health and health services delivery, to build a system that can respond to crises without diverting resources away from routine care geared toward preventing the most prevalent causes of mortality in the community. In Guinea, health care workers do not have access to sufficient PPE and have limited isolation rooms and other methods of infection control, making even day-to-day diseases difficult to address. Perl noted that hospitals and health care facilities are in fact part of the public health infrastructure—despite not often being recognized as such—due to silos in the system. Hanfling called for recasting public health at the governmental level—currently hampered by fragmentation and system failures—to be inclusive of emergency preparedness and response; however, recognizing the prerequisite of solidifying fundamentals of care, such as care for noncommunicable diseases prior to achieving emergency preparedness capabilities.

Educating the population and community health workers to dispel myths and misconceptions about emerging infectious diseases is another component of this process. However, as Anyangwe remarked, every outbreak is unique; different myths are pervasive for different diseases, so it is important to engage with communities at the outset of an outbreak and in the interepidemic period to learn about the specific beliefs they may hold about the disease and its causes. Given that public health often measures

[4] Specific strategies and practices that emerged for educating and training the health care workforce are presented in Chapter 5.

success or failure in terms of the number of fatalities, Lewis Rubinson, Director, Critical Care Resuscitation Unit, University of Maryland, recommended using different types of metrics to determine the number of preventable deaths, thus exposing the opportunities available for improvement. This plan would facilitate a crossover between public health and clinical approaches, because clinical approaches with this mindset should look toward improvement in care across time. Greenough added that the bulk of this work will need to be done during interoutbreak periods, but that the system's ability to cope with a crisis is not the only metric for the success of the integration efforts—measuring success in delivering care to the population is also valuable. Public health outcomes and their benefits should also generate data to inform and test potential frameworks for future integration efforts.

Community Engagement

> "Community engagement is crucial and it must lead to mutual respect and a sense of trust between two parties; experts must realize that they are sometimes wrong and that local approaches are correct."
>
> *—Fred Martineau, London School of Hygiene & Tropical Medicine/Ebola Response Anthropology Platform*

A prevalent topic throughout the workshop was the concept of effective engagement with local communities. Several participants proposed that sustainable health systems could be aimed toward reducing poverty and improving the livelihoods of the people in the communities they serve. This involves a wide range of partners, including regional and national governments, NGOs, civil societies, private businesses, and local leaders. Some participants explored strategies for integrating and coordinating with community partners to improve public health and health care delivery both during and between disease outbreaks. Two potential strategies for community engagement emerged: one designed to foster community engagement over the longer term between outbreaks, and the other to guide immediate short-term response to outbreaks.

At the most fundamental level, the first strategy (pre-outbreak identification and engagement) seeks to establish trust and equity within the community. To do so requires a keen understanding of the community's particular structure and leadership—for example, who the formal and informal leaders are. Mosoka Fallah, Co–Principal Investigator: Ebola Natural History Study, and U.S.–Liberian Research Partnership/National

Institute of Allergy and Infectious Diseases, Liberia, emphasized that communities need to be clearly informed, by sources they know and trust, of the potential disease threats that they face. Janet Nakuti, Senior Program Officer, Monitoring and Documentation, Raising Voices, Kampala, Uganda, suggested that health education and training should be provided at all community levels, with tools and resources for taking action tailored to the specific community in terms of language, literacy (or lack thereof), cultural practices, and customs. Partners involved in this effort would be wide ranging and ideally "close to the ground": youth, colleges of medicine and public health, local NGOs, faith-based organizations, professional associations, health facilities, philanthropic organizations, and the media. Central bodies such as Ministries of Health would assist in coordination and governance, as well as facilitating channels of communication, financing, and training. Financial, logistical, human, and motivational resources would be required for implementing and maintaining the program. The second strategy, offered by Paul Biondich, Research Scientist at Regenstrief Institute, Inc., encompassed establishing evidence-based "archetypes" of successful community engagement, providing communities with templates to guide their responses to outbreaks that are designed especially for settings that lack established resource centers. A few participants suggested that key components of the frameworks might include prevention/continual behavior change, rapid communication and information dissemination, and collective or group action.

The discussion was informed by two presentations describing effective community-based initiatives in Liberia and Uganda, and offering lessons learned. Nakuti related her experience in Uganda with SASA! (start/awareness/support/action), an activist kit for mobilizing communities to prevent HIV and violence against women. She described how working within communities intensely over the long term is more effective than sporadic initiatives. Working with a cross-section of the community (e.g., men and women, leaders and nonleaders) through a combination of communication channels is important. For instance, the program adopts an approach of critical consciousness raising and questioning to stimulate discussions with community members, rather than preaching or teaching, coupled with benefits-based inspirational framing to avoid negative critiquing of existing behaviors. The aim is to guide communities through a change process that transitions to support and action. She stated that by investing in social norm change interventions at the community level, prevention is possible.

Fallah described how a community-based initiative was able to eradicate EVD from the West Point Slum in Liberia, which comprises 70,000 residents in 5,000 houses with just 7 public toilets and 1 health center. These conditions led to very high rates of EVD transmission and death: 92 cases with a 90 percent case fatality rate in a 4-month period. He explained how

the behavior of the community—covert burials, hiding the sick, incomplete contact tracing, mistrust of outsiders—drove the high transmission rate of EVD. By engaging community leaders and developing a community-based lead council to drive the initiative, the West Point Slum was the first community to be declared free of EVD in Liberia. In the absence of experienced community leaders and workers, cultural anthropologists often play a leading role in understanding and altering community behavior to ensure that medical professionals and communities understand each other and can work together to end outbreaks of disease. During the 2014 Ebola epidemic in West Africa, the American Anthropological Association and other societies urged governments and aid organizations to bring anthropologists to affected areas for support (Lydersen, 2014). Sharon Abramowitz writes that anthropologists are able to "make sense of local ideas, beliefs, and behaviors in ways that are actionable." Cultural anthropologists are able to interpret local ideas and ensure that outside medical professionals become sensitive to them (Abramowitz, 2014).

Community-Based Initiative Philosophy

Fallah emphasized that adequately empowered communities can engage in a surprisingly effective fight against EVD or any other public health emergency. He outlined one such strategy for empowerment, the Community-Based Initiative (CBI) philosophy: engaging communities in mass meetings, planning community mapping, conducting training in simple messages, active case finding, providing logistics, and setting up a case-reporting structure. He outlined what he terms the "five strategic pillars of CBI":

1. Door-to-door awareness,
2. Daily search for the sick,
3. Daily search for the dead,
4. Daily search for potential contacts coming in as visitors, and
5. Social support and counseling for affected homes and for those returning from the Ebola treatment unit (ETU).

Engaging NGOs and Civil Society

Small NGOs are uniquely situated to strengthen health systems and respond to infectious disease outbreaks in rural and remote areas, according to Saran Kaba Jones, Founder and Executive Director, FACEAfrica, Liberia. FACEAfrica works to provide safe water, sanitation, and hygiene (WASH) facilities in Liberia. Jones explained that despite the vital role that WASH serves in preventing the spread of disease (e.g., EVD, diarrhea, cholera,

typhoid, etc.), WASH remains a low priority for the Liberian government.[5] Even though every dollar invested in WASH represents a $4 return on investment in terms of reduced health care costs, it accounted for only 0.4 percent of the Liberian budget for the 2013-2014 fiscal year.

> "International partners, whether private-sector or large donor agencies, need to understand the importance of engaging with communities and local groups in a meaningful, respectful, and equitable way, as well as the importance of empowering and supporting these groups so that they have the tools and resources to sustain their work. Local groups need to have their voices heard, they need to have their approaches evaluated and their structures and capacities improved and enhanced to scale their impact . . . they must be offered a seat at the table."
>
> *—Saran Kaba Jones,*
> *Founder and Executive Director, FACEAfrica, Liberia*

FACEAfrica's efforts are concentrated primarily in rural Rivercess County where 80 percent of households lack access to safe water.[6] Due to its remote location, lack of road access, and limited communication networks, this area is not attractive to larger international NGOs who tend to focus more on intervening where accessibility is better, such as in urban centers. Jones argued that small NGOs can have a powerful effect in these types of marginalized communities, which are often the last to receive external assistance. Particularly in such circumstances, groups that have a long-term and consistent presence in affected areas have the advantage of being able to:

- Employ existing on-ground resources
- Foster trust within underserved communities
- React quickly and flexibly during crisis situations

For instance, Jones contended that FACEAfrica's work with WASH-related community engagement in Rivercess allowed the launch of an EVD awareness campaign more quickly and effectively than an international organization with no community ties. Similarly, during the EVD outbreak, the local groups were the ones that were eventually able to slow trans-

[5] Ghana has also suffered a high incidence of cholera in recent years, see more at http://reliefweb.int/sites/reliefweb.int/files/resources/Cholera%20regional%20update_W52_2014%20West%20and%20Central%20Africa.pdf (accessed November 4, 2015).

[6] FACEAfrica has implemented more than 50 projects since 2009, with all projects still functional to date due to aggressive follow-up mechanisms.

mission by developing their own autonomous protection and quarantine measures.[7]

To work toward improved partnerships with civil society, she called for empowering local organizations and groups on the ground by involving them in coordination and outreach in a more meaningful and equitable way. She characterized the undermining of local nonprofit and civil society groups by governments and funding partners as a form of institutional racism, which parlays into systematic challenges in funding and resource allocation that are not faced by their international counterparts. She concluded by calling for all sectors to recognize, respect, and support organizations working within communities; these groups promote the long-term health and strength of the communities they serve and will continue to do so when international players have left.

Integrating Mental Health Care

While mental health is in fact part of the health sector, it is a crucial component of a resilient and sustainable health system that often lacks sufficient resources and emphasis—particularly during infectious disease outbreaks. Inge Petersen, Professor of Psychology, University of KwaZulu-Natal, South Africa, explained how living through an outbreak can increase a person's risk of developing mental disorders. Experiences such as witnessing and caring for severely ill, death and bereavement, perceived life threat, food and resource insecurity, and discrimination directed toward the affected and infected can all have a negative impact on a person's mental health (Shultz et al., 2015). Compounding this is the effect that mental disorders can have on multiple dimensions of disease management, remarked Petersen (Prince et al., 2007). People with mental health issues—such as depression—are generally less likely to seek help and more likely to engage in unsafe behaviors, which can compromise prevention and propel transmission. Poor adherence to treatment and immune suppression can compromise treatment and propel disease progression. The mental health of care providers themselves is also an issue of concern; outbreaks are also associated with increased incidence of psychiatric morbidity among care providers, which of course impedes their ability to provide care for others. Thus, "caring for the caregivers" needs to be a priority, according to Petersen.

Petersen cited WHO projections that in the 12-month period after an emergency event, there will be a 50 percent to 100 percent increase in the number of severe (e.g., psychosis, severe depression, and anxiety) as

[7] During the discussion, Awunyo-Akaba suggested finding ways to measure the input of civil society, such as indicators or technology to measure involvement.

well as mild or moderate (e.g., mild to moderate depression, and mild to moderate posttraumatic stress disorder) mental disorders among affected adults (WHO, 2013). Further evidence that mental health is a neglected sector is that more than 75 percent of people with severe mental disorders in LMICs do not receive treatment (Demyttenaere et al., 2004). Mental health care needs to be strengthened generally during interoutbreak periods, she emphasized, in order to foster the resilience health systems need during crisis periods. However, she noted that health emergencies can also serve as opportunities to strengthen mental health care in fragile states through approaches such as WHO's Building Back Better framework (WHO, 2013), particularly when coupled with leveraging interventions from donor agencies.

Petersen recommended the use of a platform approach to decentralize and integrate mental health care into the health care system, as well as other service delivery platforms, to strengthen mental health overall and improve emergency response. She also noted that this type of approach allows for the identification of both of the roles played by different sectors and of areas where resources are needed. Specific interventions suggested for each platform and subplatform are provided in Table 2-1.

Peterson concluded by urging countries to leverage leapfrogging opportunities to accelerate the development of mental health services by adopting innovations and technological advances, as well as incorporating the evidence-based experiences of other countries to advance mental health practice.

Business and Private-Sector Engagement

> "The business sector exists to support in building resilient systems, but the content and the leadership and the ideas and the strategies must be something which are led by the health sector . . . we are not the experts, we are only available to facilitate the process."
>
> *—Nana Yaa Afriyie Ofori-Koree, Foundation and Sustainability Manager, Vodafone Ghana Foundation*

Graham Davidson, Managing Director, Simandou Project, Guinea, RioTinto, and Ofori-Koree both related experiences from the perspectives of private-sector organizations situated on the ground in areas affected by infectious disease outbreaks. In considering ways to engage the private sector effectively in cross-sector efforts to strengthen health systems, both presenters underlined the importance of effective leadership, seeking oppor-

TABLE 2-1 Interventions to Strengthen Mental Health by Platform

HEALTH CARE PLATFORM	
Primary health care	• Decentralize and integrate mental health into general health care using a task-sharing approach • Provide mental health services in general hospitals • Train nonspecialists in mental health care • Provide orientation to patient-centered care and clinical communication skills training • Provide psychosocial support for the service providers • Ensure sufficient psychosocial workers and specialists to provide referral pathways and supervision • Ensure adequate supply of psychotropic medication at public health care facilities • Ensure sufficient indicators for mental health in the health information services
Specialist care	• Diagnosis and management of acute and severe conditions within a stepped care model
COMMUNITY PLATFORM	
Schools	• Information and awareness • Identification and case detection in schools of children with mental disorders
Neighborhood and community groups	• Training of gatekeepers • Gender equity and/or economic empowerment programs for vulnerable groups
Workplace	• Integrate mental health awareness and promotion strategies such as stress reduction into occupational health and safety policies
POPULATION-WIDE PLATFORM	
Policy, legislation, and regulation	• Mental health policy and laws that are in line with the best practice and human rights standards • Laws and regulations to reduce availability and demand for alcohol use • Laws to restrict access to means of self-harm and suicide
Information and awareness	• Mass public awareness campaigns to increase mental health literacy and address stigma and discrimination

NOTE: Interventions drawn from lessons learned from the Emerging Mental Health Systems in LMICs and the Programme for Improving Mental Health Care research consortia.
SOURCE: Petersen presentation, August 6, 2015.

tunities to leverage nonfinancial private-sector resources, and enhanced clarity with regard to government strategies and how the private sector can help to facilitate their implementation. Rio Tinto is a British-Australian multinational metals and mining corporation that operates in 40 countries; Davidson is the managing director of Simandou, Rio Tinto's iron ore min-

ing and infrastructure project based in southeast Guinea, which employs thousands of local people and contractors. The organization is currently building and facilitating the country's transportation infrastructure through railways, tunnels, ports, and trucking routes. He projected that the project's impact will double Guinea's gross domestic product each year for a number of years, in addition to employing up to 5,000 local people overall.

Davidson described the emphasis that Rio Tinto places on the health and safety of its employees, as evidenced by the fact that none of its 3,000 employees in Guinea at the time contracted EVD during the 2014 outbreak in West Africa.[8] To illustrate the impact that private-sector companies can potentially have in safeguarding the health of their local employees and contractors, he outlined the four main principles that they implemented in response to the epidemic to keep their employees safe (see Box 2-2).

Davidson explained that Rio Tinto strives for a holistic, joint, and open approach to contribute in building resilient health systems, stressing that its role—and that of others in the private sector—is not just that of "financier." For instance, the majority of financial support they provided during the EVD outbreak was in kind. He stressed that the company is in a strong position to help to build on, facilitate, and manage existing capacities and health strategies set forth by countries, but that it is not their role to create those strategies or systems. But in order to add value to a government's strategic plan, the design of the plan must be adequately transparent.

In that vein, Ofori-Koree described the Vodafone Foundation's work in the health sector in Ghana to enact social change through partnerships and technology. She concurred that support from the private sector should not always be about funding; there are many other resources one can leverage as another form of financial capital, such as human resources and technology. For instance, she described a Foundation medical call center in Ghana staffed by physicians that is available to everyone in the country, 24 hours per day. The center partnered with WHO during the EVD outbreak to train staff health workers and to engage the community at large with social mobilization activities related to the disease. They also partnered with the Ghana Medical Association to deliver relevant content and important updates to Vodafone subscribers. She pointed to the key issue of scale, noting that many piloted projects are never scaled up: a project's ability to deliver the right impact is predicated on its being at the right scale.

Ofori-Koree also highlighted the central role of effective leadership in driving cross-sector collaboration in general and engaging the private sector specifically: "the private sector will be coming with its own culture, its goals, its vision; but I think in order for it to be successful, there has to be

[8] He estimated that the Ebola outbreak cost the project more than $100 million in direct costs.

BOX 2-2
Rio Tinto's Four Pillar Response to EVD Outbreak

I. Keeping people safe
To help ensure the safety of its employees, Rio Tinto introduced a large-scale health education effort with rigorous procedures for health screening, distributed 250,000 sanitation kits, reduced the company's activities and footprint, and maintained multiple lines of communications with employees (e.g., SMS, phone, call centers, and briefings).

II. Practical support for front-line organizations
To support organizations on the ground, Rio Tinto donated $3.4 million, with $2.9 million of that in-kind in critical equipment and logistics: vehicles, including helicopters; a fuel-pumping system and mobile camps to increase treatment capacity; food rations; and large-scale communication and awareness campaigns.

III and IV. Focus on business continuity and economic resilience
At the peak of the epidemic, employees were given paid leave to support their families, in order to sustain economic resilience. Rio Tinto also worked extensively with the seafarer trade and air carriers to maintain business continuity.

SOURCE: Davidson presentation, August 6, 2015.

a shared vision developed by all across the table." She explained that the private sector can bring its own tools, resources, and potential solutions to bear on collaborative efforts to improve health systems. As an example, she described Vodafone's emergency instant network box, a tool that can provide 3G services even when all cellular systems are down.

Cross-Sectoral Communication Gap

Addressing the participants representing the private sector and NGOs, Aceng, of the Ugandan Ministry of Health, contended that private sector actors often do not make it adequately clear to governments as to how they can offer support. She remarked that when governments do try to reach out, private industry often becomes uncertain with what they can and cannot offer; she challenged the private sector to more closely align their work with government plans and strategies by communicating in a more clear, explicit manner.

Ofori-Koree replied that it is not the private sector's core responsibility to develop health systems—"We are solutions, not strategy"—thus, until they know what the plans are, they cannot support them. During the EVD

crisis in Ghana, her company reached out to organizations to see what was needed and how they could help, but it was difficult to get answers, and no one could clearly tell them what sort of help was required. She pointed to a lack of engagement prior to emergency situations, contending that it is only when disaster strikes that people think about calling the private sector. She stressed the importance of bringing the private sector to the table during the preparedness stage.

Jones highlighted the issue of leadership as critical. Small NGOs such as her own work independently of government in the sense that they cannot take the lead on a country's national health or WASH plan, but they can plug into it once it is established. Davidson said that his organization goes to extra lengths to say they are transparent, though that message may not be reaching the population effectively enough. They need the support of the governments in Africa and they need them to be transparent about what is needed: "We don't know what to do if a clear strategy is not articulated."

3

Health Systems Strengthening: Building Day-to-Day Care and Public Health Capacities

Highlights and Main Points Made by Individual Speakers and Participants[a]

- Health system strengthening must occur during interoutbreak periods; establishing a strong day-to-day health system should be the first priority, as well as establishing emergency capacity and a functioning public health system. (Campbell, Fowler, Panjabi)
- Building a strong professional national health care workforce by investing in the "white economy" is a critical step in building day-to-day and public health systems capacity; once professionalized, health care workers must receive job incentives such as fair compensation. (Awunyo-Akaba, Campbell, López-Acuña, Panjabi)
- Workforce development and training should focus on public health concepts. (Fowler, Nasidi, Nguku, Perl)
- Medical product, drug, and vaccine supply chains should be nationally managed and demand-driven to ensure that the appropriate stakeholders can deliver and receive products; multiple supply chain routes should also exist to ensure efficiency. (Matowe)
- Clinical guidance must improve through increased research on medical products and drugs during interoutbreak periods;

doing so will ensure more evidence-based interventions during outbreaks of infectious disease and other health emergencies. (Fowler, Rubinson)

[a] This list is the rapporteurs' summary of the main points made by individual speakers and participants and does not reflect any consensus among workshop participants.

The value of building local, regional and national health system capacities was a topic raised by multiple participants throughout the workshop and is discussed further in this chapter. Components of a strong, resilient, and sustainable health system, suggested several participants, should encompass functional day-to-day primary health care delivery, the infrastructure to implement essential public health functions, sufficient health care workforce capacities, and a reliable supply chain.[1] In addition to delivering best-quality care to populations, many participants suggested that a strong everyday health system should be resilient and flexible enough to respond quickly to disease outbreaks or other public health emergencies—and be able to receive assistance effectively from regional or international support systems as needed—without compromising or terminating its ability to continue delivering primary care.

López-Acuña remarked that these capacities should meet the core commitments of the International Health Regulations (IHR), which are fundamental to resilient health systems. Fowler emphasized the need to build these capacities during the interoutbreak period in order to establish a coordinated health systems response, guide clinical care, and carry out real-time practice-informing investigations to fully prepare for when an emerging disease, outbreak, or pandemic does occur.

STRENGTHENING DAY-TO-DAY HEALTH CARE DELIVERY

"When an aware, diverse, self-regulated, integrated, and adaptive community-based primary health system preexists—health care can remain resilient, mitigating effects of epidemics."

—Raj Panjabi, CEO of Liberian nongovernmental organization Last Mile Health

[1] However, these are all components of a resilient system, and not representative of many fragile health systems in low- and middle-income countries (LMICs) that struggle with routine needs and were the ones needing to respond to the Ebola virus disease (EVD) outbreak.

Several participants characterized a country's fundamental capacity to deliver everyday, primary health care as a key determinant of its ability to ability to respond to emergencies. Citing the 2006 World Health Report stating that many national health systems are weak, unresponsive, inequitable, and even unsafe (WHO, 2006), Jim Campbell, Director, Health Workforce, World Health Organization (WHO) Executive Director, Global Health Workforce Alliance, expressed concern over whether countries who struggle to provide even the most basic health services to their populations can realistically be expected to take part in the unbroken line of defense, constituted by strong national public health systems, on which global public health security depends. He argued that strengthening weak health systems in these countries is essential not only for delivering the best possible public health to their populations on the local level, but also for safeguarding public health on the global level. Similar to Rasanathan's comment in Chapter 2 regarding sanitation practices, Campbell highlighted the importance of first building a country's basic health capacities as the primary objective, followed by basic public health capacity and then its capacities for outbreak management and emergency response. A community can respond to extraordinary events when it is able to meet its day-to-day public health and health care challenges.

López-Acuña described the objective of universal health coverage as a prerequisite for a reliable and resilient health system. He noted that people with greater needs tend to use health services less than other population groups, and that when they do use those services, they incur high and sometimes catastrophic costs in paying for their care. Only one in five people in the world has broad-base social security protection, including lost income, and more than 50 percent of the global population lacks any form of social protection. Noting that 2 billion people across the world do not have access to equitable health care services, Campbell provided an overview of the concept of universal health coverage as defined by WHO (WHO and the World Bank, 2013). Its goal is that everyone in the population obtains the good-quality essential health services they need without enduring financial hardship. As expected, this is much more difficult to realize in practice than in theory, and many countries still struggle to cover all residents without burdening patients with enormous costs (Saksena et al., 2014). Regarding the distribution of health care coverage, Panjabi noted that it must extend even to the most remote and hard-to-reach areas—so-called blind spots—where people have no access to care. He emphasized that it is often in those extremely remote areas that pandemics originating in zoonoses start, and where they can be the most difficult to eradicate. Achieving coverage in remote areas, he suggested, can be facilitated by a community-based primary health care system.

Raphael Frankfurter, Wellbody Alliance, commented that a resilient

health system should draw patients to it, which necessitates interventions including logistical and functional support but also community engagement and attention to social dynamics, especially in communities with low health care utilization. Referring to the EVD outbreak in Sierra Leone, he noted that the health system was unable to adapt quickly enough in a humane and empathetic way to the complicated social dynamics at play in affected communities to draw patients into the EVD treatment and control system. He described this schism between community values and the sometimes "draconian" approach of the health care system as having profoundly systemic effects, given that there are continued cases of EVD persisting in Sierra Leone. Lamptey similarly warned against responding to disease on an ad hoc basis. A community's health needs are not only related to infectious disease; thus fully engaging with a community means engaging across the board and across time.

Several participants noted that strengthening day-to-day health delivery systems is a prime opportunity for "homegrown" solutions, and should serve as a platform to nurture and encourage local solutions to strengthen primary health care. They suggested that leadership should take an active and accountable role in establishing clear priorities to take responsibility for achieving primary health care health goals, considering alternative funding sources, and including a range of partners, such as the private sector, universities, and locally based domestic or international nongovernmental organizations (NGOs). They suggested that the creation of a network of resource centers could help to disseminate information, to support leaders, to mobilize funding, and to identify potential solution providers. Ideally, these strategies would lead to lower, more sustainable costs.

BUILDING PUBLIC HEALTH CAPACITIES IN EVERYDAY HEALTH SYSTEMS

Multiple participants highlighted the need to strengthen basic public health capacities and functions during interoutbreak periods and to integrate those capacities within health care delivery. López-Acuña advised that a health system's basic capacity for better public health practice is its ability to discharge the essential public health functions, which is contingent upon a strong public health infrastructure. Such an infrastructure comprises the fundamental elements of

- Information
- Skilled human resources and satisfactory working conditions
- Organization, including legal frameworks, managerial processes, accountability, and evaluation
- Indispensable physical resources

- Essential support and auxiliary services, such as public health laboratories, logistic systems, and physical infrastructure

Characterizing the public health workforce as too often neglected and undervalued, he called for prioritizing the development of a workforce that is trained and prepared for carrying out public health tasks. Ian Norton, Foreign Medical Teams Working Group, WHO, Australia, remarked that building a global health workforce is contingent on first developing the national public health capacities that feed into it. As outlined in Chapter 2, multiple participants called for the health care and public health system to be integrated and interoperable. A key component of this strategy is the education of clinicians and health workers in public health concepts. As a part of developing national public health capacities, using similar models in a region could also help countries harmonize some of the indicators to better understand what they are measuring and when something should be a "red flag" or more of a routine detection. For many countries just beginning this process, information sharing across borders could help to alleviate variations in detection and response when the threats are geographically similar.

Understanding Public Health Capacities and Capabilities Within a Country

In order to build public health capacities in a country, accurately assessing the system's current capacities to pinpoint priority areas of need is a potential first step. Several participants highlighted the importance of accurately assessing and monitoring the public health capacities and capabilities within each country, in order to focus initially on strengthening areas of weakness in preparation for emergency response. Fowler noted, for instance, that the health system's ability to respond to the severe acute respiratory syndrome (SARS) outbreak in Toronto was compromised by lack of knowledge about the system's actual capacity. Campbell described how in countries most affected by recent outbreaks, basic information about their respective national health workforces was very often lacking: records were not available in terms of the clinical capacity of the health workforce or its managerial support, its public health capacity, the location of health care workers, where they were deployed, and so on.

To accurately gauge national health workforce capacity, Campbell reported that participants suggested using a census of national capacity to evaluate the workforce in its broader sense, followed by assessing the specialized areas of laboratories, surveillance, and public health management. Campbell noted that this actually reflects already agreed-upon IHR stipulations for member states, who have a duty to support those countries

with inadequate capacities. He called for international duty bearers, in addition to international donors or partners, to assume the responsibility for supporting this national process.

BUILDING HEALTH WORKFORCE CAPACITIES

Campbell referenced David Heymann's recent recommendation to the World Health Assembly (Heymann, 2015), which stated that the foundation of a global health emergency workforce is the national health workforce in every country. He offered a global perspective on national health capacity status, referring to data comparing the distribution of skilled health professionals by level of health expenditure and burden of disease in 2006 with recent data. He noted that while some regions and countries are making progress, Africa has stood still: it represents 24 percent of the global burden of disease but has just 3 percent of the global health workforce (see Figure 3-1).

He suggested that not only is the number of health professionals in Africa failing to keep pace with the population, the number may actually be falling due to forces such as labor mobility and labor migration pulling them away from their home countries and contributing to "brain drain." During the EVD outbreak, there were additional brain drain concerns as many frontline health care workers feared for their own safety at work, lacking any guarantee of health insurance or disability pay for themselves if they were to get sick. Noting that the data captures the number of skilled health professionals specifically, he called for better understanding of the respective roles and contributions of advanced clinical practitioners, mid-level health workers, and community-based practitioners in devising better ways to build health workforce capacities.

Bolstering the "White Economy"

Campbell remarked that multiple World Health Reports over the past 10 years have highlighted the role of health care workers as a fundamental component of health care systems. To strengthen this capacity in national health systems, he suggested investing in the so-called white economy,[2] a job-rich sector comprising:

[2] The "white economy" is the economy related to the uniforms of health professionals. "White jobs" include those in all sectors of health care—public health, pharmaceuticals, nursing, health care delivery, etc.—with the exception of volunteer workers. Campbell argues that this industry has untapped potential for economic growth, especially in Africa where health care workers often operate on a volunteer basis.

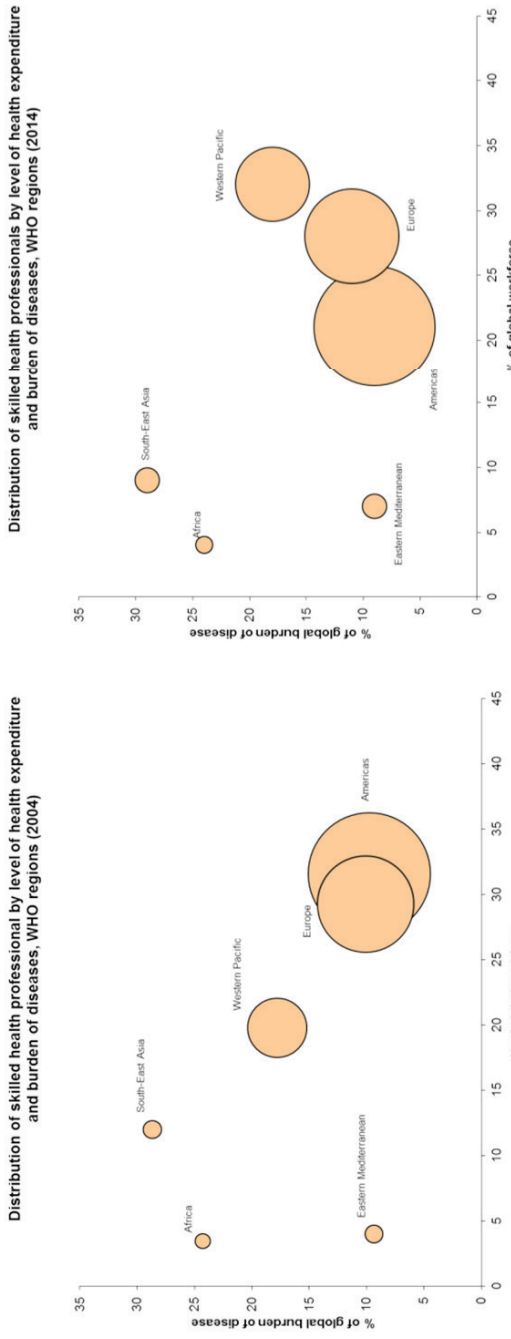

FIGURE 3-1 Distribution of skilled health professional by level of health expenditure and burden of diseases (WHO Regions), 2004-2005 versus 2013-2014.
SOURCE: Campbell presentation, August 6, 2015.

- Health workers in the public, private, faith-based, and defense sectors
- Anyone involved in delivering health care services (e.g., doctors, nurses, midwives, pharmacists, dentists, and allied health professionals)
- Public health professionals
- Health management, administrative, and support staff
- Health care industries and support services, including residential and daily social care activities for the elderly, disabled, and children; pharmaceutical industry; medical device industries; health insurance; health research; e-health; occupational health; and spa workers
- Salaried and self-employed workers (but not volunteers)

Campbell explained that the white economy offers a triple return on investment, driving economic growth, social development, and global health security. Strengthening the health and social sectors, as well as the scientific and technological industries, acts as an engine of economic growth and thus boosts skills, innovation, jobs, and formal employment, especially among women and youth. It serves as the foundation for the equitable distribution of essential promotive, preventive, curative, and palliative services that are required to maintain and improve population health and remove people from poverty.

Where countries are unable to achieve prevention and control by themselves, they need rapid international and regional support for disease surveillance and response (WHO, 2007). Campbell suggested that investing in the white economy is a key foundational step in meeting the core capacity requirements of IHR and ensuring global health security. IHR Core Capacity 7 is its human resource capacity; Campbell called for its integration within the health labor market to move toward the objective of universal health coverage, and advised against global health security becoming the next vertical agenda. Campbell suggested that incorporating universal health coverage efforts with the Open Working Group Proposal for Sustainable Development Goals (UN Sustainable Development, 2014) could provide a new paradigm for health care human resource development. By linking public health to the other elements in health resources funding, it could demonstrate how investment in health resources can have a much broader impact, for example, on gender equality, trauma, poverty, employment, education, child health, and nutrition. Campbell outlined the objectives of WHO's Global Strategy on Human Resources for Health: Workforce 2030 (WHO, 2014) as a potentially useful model (see Box 3-1).

BOX 3-1
Global Strategy on Human Resources for Health: Workforce 2030

- Optimize the existing workforce in pursuit of universal health care and the Sustainable Development Goals (e.g., education, employment, and retention).
- Anticipate future workforce requirements by 2030 and plan the necessary changes (e.g., a fit for purpose, needs-based workforce).
- Strengthen individual and institutional capacity to manage human resources for health policy, planning, and implementation (e.g., regulation).
- Strengthen the data, evidence and knowledge for cost-effective policy decisions.

SOURCE: Campbell presentation, August 6, 2015.

Engaging Community Health Workers in the Primary Health Care System

To address the previously mentioned gap in remote health care delivery, Panjabi called for creating a new workforce to save lives of people living in extremely remote areas by professionalizing community and frontline health workers to extend the reach of the primary care system. He charted a multifaceted strategy for doing so:

- Recruitment combines community input with high standards, including screening, practical assessment, and a probation period.
- Preference is extended to unemployed women and youth.
- Training involves rigorous and continuous theory coupled with practical training, with a component on surveillance, diagnosis, and treatment of the top mortality-causing diseases.
- Trainees continue to receive regular evaluation and on-the-job mentoring.
- Diagnostic, curative, and nonmedical equipment is reliably stocked at points of care to enable high coverage and facilitate supervision.
- Workers receive clinical and nonclinical supervision, weekly peer supervision, and district- and county-level management.

Emphasizing that professionalizing entails not just training, but also funding, Panjabi explained that the program creates career opportunities for workers and recognizes their life-saving work. Payment enables more accountability for performance and greater likelihood of retention. Panjabi described a 2011 project launched by his organization, Last Mile

Health, together with Liberia's Ministry of Health. The project provides community-based primary health care to residents of Konobo District through professionalized community health workers and nurse mentors (Kenny et al., 2015). At baseline, 22 percent of mothers had full maternal care cascade (antenatal care visit, facility delivery, and postnatal care visit) and 23 percent of children under 5 years of age had never sought health care for fever-related illnesses at a health facility. Prior to the EVD outbreak in 2014, the community health care workers had increased antenatal coverage to 97 percent and facility deliveries to 82 percent; 100 percent of children were covered by services for malaria, pneumonia, and diarrhea treatment. Panjabi reported that the program was resilient despite the EVD outbreak.

Sustainability

Panjabi stated that community health workers have an economic return of up to \$10:1[3] that is due to increased productivity from a healthier population, the potential for reducing the risk of epidemics such as EVD, and the economic impact of increased employment among community members (Dahn et al., 2015). During outbreaks, the workers can play an active and vital role, as well as sustaining life-saving primary health services both during and between those outbreaks, such as treatment of pneumonia, HIV, malaria, tuberculosis, and maternal, adult, newborn, and child conditions (Perry and Zulliger, 2012). He reported that such services are estimated to prevent up to 3 million maternal, perinatal, neonatal, and child deaths annually.

Lloyd Matowe, Director, Pharmaceutical Systems Africa, queried how the community health workers obtain needed medications on a sustainable basis, and Panjabi replied that while facility-based delivery was maintained for community case management, vaccine coverage dropped regardless of what system was in place. The system is currently centralized with the Expanded Program on Immunization group in Monrovia, and has not been decentralized at the county level. He remarked upon the need to bring in supply chain specialists for the national program to help address ongoing national- and local-level issues. He noted that when health care is initiated in areas not previously served, demand changes immediately (because predictions were based on previous demand), although in remote areas many diagnoses and subsequent demand are still missed.

David Sarley, Senior Program Officer, The Bill & Melinda Gates Foundation, characterized community health workers as being "at the forefront

[3] During subsequent discussion, he clarified that the cost of the program at that scale is \$8 per capita, including overhead, management, support, and recruitment training.

of identifying problems and also serving their communities." In that context, some participants also suggested strengthening alternative channels, such as civil society and local NGOs, in an integrated and sustainable way. Another idea to arise was that the government could have specific roles in setting the training curriculum and supply train protocols, contracting out service needs to local district and county health teams to strengthen capacity. Furthermore, community health workers could be linked into national sources of supply by utilizing multiple communication channels to ensure comprehensive data sharing.

Building a Strong Workforce: Education, Training, and Retention

Participants, including Perl and Fowler, recognized the need to better educate clinicians and health care workers regarding the essential concepts of public health and emerging infectious diseases, which are not generally covered in medical school or other training programs. Anyangwe highlighted the requirement to educate and train relevant workers on IHR compliance according to need. She further suggested that training health workers on all levels about the basics of disaster risk management is imperative; she noted that despite epidemic and emergency response, a health system must continue to maintain its regular functions or system growth will not occur.

Patrick M. Nguku, African Field Epidemiology Network, Nigeria Field Epidemiology and Laboratory Training Program, and Abdulsalami Nasidi, Director General, Nigerian Centre for Disease Control, offered a set of recommendations with respect to workforce development for a sustainable and resilient health system. Training should augment existing systems through education in the basics of prevention, detection, and response. It should span multiple diseases and be contextual and adaptable to current and future needs. It should align with government structures at the district and state levels to help ensure that all states are covered according to their population and public health needs. Conducting surveillance and response activities through regular drills and exercises is critical, as is the ability and authority to mobilize quickly during emergencies. Countries should be empowered to devise local solutions to local problems, with the government leading and coordinating while incorporating appropriate support from partnerships. Ultimately, they advised, vertical disease funding should parlay into horizontal system strengthening.

Needs-Based and Competency-Based Training Strategies

Fowler remarked that another important task, sometimes overlooked, is general education and training in the basics about how to care for

people—at all levels of practice—which can be done through good development of nursing with a physician team. These basic skills include recognizing people who are sick early on, learning how to place an IV, hydrating people, and providing existing treatment therapies. Perl described educating health care professionals as a key component of developing infrastructure and sustainable response, and pointed to some operational challenges of doing so. She noted that while distance learning has its benefits, it limits the mentoring experience that is critical for growth; professionals should thus be mentored in a way that imparts experience and the exposure that they apply to their theoretical knowledge. Matowe commented on the tendency to train people based on perceived need rather than actual need, or training people in the wrong areas. He recommended that any training component needs to be specifically tailored to those affected, on competencies specific to the particular setting.

A participant mentioned that the need to improve training is intensified by fact that the most undertrained health care workers tend to work in the facilities that have the most needs. Further, she suggested that training programs should include traditional health practitioners and those from the private sector. Devising training and education programs requires partnerships with government at the local, national, and regional levels and data collection about the current state of the health workforce and its future needs (as well as providing metrics for the success of the program). Anyangwe noted that training requires both adequate infrastructure as well as targeted funding; in many cases, countries plan to increase training but do not commensurately increase the infrastructure to cater for the increased numbers that they want to train. Replying to a suggestion about training the heads of health teams in local communities, she remarked that a training strategy should also depend on the cadre being trained. For example, for a team consisting of medical doctors, nurses, and midwives, uniform training for the whole group may not be appropriate: again, she said, training should be based on identified need. Frankfurter made a direct call for investment in African formal training programs in academic centers across African universities, to encourage concrete means of collaboration to explore how international universities can play a role in building resilient health systems.

Field Epidemiology and Laboratory Training Program's (FELTP's) Role in Nigerian EVD Outbreak Response

Nguku and Nasidi explained FELTP's important role in implementing the response to the EVD outbreak in Nigeria.[4] It was able to make available

[4] Imported case in July 2014; 20 cases with 8 deaths; rapid response; 899 contacts / > 97 percent contact tracing daily rate; controlled within 8 weeks.

personnel for training workers (e.g., residents who had graduated from the program were ready to be deployed to train others[5]) and a highly skilled workforce for:

- Rapid response (due to FELTP trainees' outbreak investigation competencies, interpersonal communication skills, and epidemiology background)
- Case identification and investigation
- Contact identification and monitoring using real-time, geographic information system (GIS)-enabled smart phone technology system, Open Data Kit[6]
- Surveillance
- Operational research to identify specific response gaps and make evidence-based decisions
- Deployment to other countries

Nguku and Nasidi remarked that the positive impact of FELTP extends beyond Nigeria and to other countries as well (see Box 3-2 for an overview of the program). Data are shared countrywide in publications documenting successes and lessons learned, as well as informing predictive models to prepare for future events (e.g., FELTP's role during the 2007 East African Rift Valley fever outbreak in identification, risk analysis, cross-border collaborations, and modeling). Aceng described how Uganda has been training health care workers on the management of viral hemorrhagic fever and other epidemics for years, directed by continually updated training guidance. An inventory of all trained health workers is maintained so that the workers can be quickly contacted and deployed as needed. At new outbreak locations, workers who have been trained deliver training to other workers to increase capacity.

> "We need to look at the differentiation between salaried, nonsalaried, and community-based practitioners. One is a worker; one is a volunteer; one is a contradiction in terms. If you try to run a health care system on a volunteer basis that's not a resilient health system."
>
> *—Jim Campbell, Director, Health Workforce WHO*

[5] One hundred graduates were involved; within 1 day of suspicion at least 15 were deployed.

[6] All contacts identified and followed up; more than 18,000 contact visits and interviews in 3 states with > 97 percent coverage rates.

BOX 3-2
Case Study: Nigeria's Field Epidemiology and Laboratory Training Program

In the context of public health workforce development, Nguku and Nasidi described Nigeria's field epidemiology and laboratory training program (FELTP), initiated in 2008. It is a closely supervised, competency-based, tiered, multidisciplinary training[a] (certificate or degree) program that is delivered via formal instruction, mentoring, and field work in affiliation with two universities. Its objective is developing a workforce to strengthen public health systems and delivery. A concomitant objective is fostering a science and evidence-based culture for the management of public health programs (Oyemakinde et al., 2014). Program participants are trained in the fundamentals of responding to public health emergencies, which enables them to contribute in terms of integrated disease surveillance, outbreak response, and zoonoses control (e.g., Ebola virus disease and dengue fever). They can deliver public health services by responding to specific disease needs and by defining hard-to-reach populations and implementing strategies to reach them. Their work further contributes to evidence-based system improvements for decision making and action by documenting, publishing, and disseminating information. Being trained and ready to deploy to neighboring countries facing public heath emergencies, they also serve to foster intersectoral and cross-border collaboration.

[a] Including outbreak investigation, surveillance, planned study, communications, epidemiology, biostatistics, computer technology, leadership, and management.
SOURCE: Nasidi and Nguku presentation, August 5, 2015.

Workforce Protection, Compensation, and Retention

Patrick Kelley, Director, Board on Global Health, Institute of Medicine, U.S. National Academies of Sciences, Engineering, and Medicine, remarked that needs-based training is not a solution for everything; what happens after training should be taken into consideration, that is, how to enable the workforce to maintain performance and how to improve workforce retention rates. Campbell similarly commented on the challenge of recruiting and retaining workers in the health care sector. He noted that not enough health care workers are being produced to meet the need, there is not an adequate labor pool, and health care workers who are trained are very often lost due to lack of compensation or other factors. He reported that 41 percent of the health workforce are not in the public sector, and attributed this to weak performance, management, and accountability. He called for a more integrated approach to understanding what the health workforce needs.

Ensuring workforce safety, fair compensation, and better retention rates were areas highlighted for improvement by multiple participants.

Improving Conditions of Service and Retaining Health Workers

Multiple participants suggested that health workers should be provided with incentives, such as fair compensation and improved conditions of service. In many cases, they noted, health care professionals do not have these proper conditions of service, including the provision that if they get sick while on duty, they are paid and care would be provided for them. As mentioned previously, personal protective equipment (PPE) in LMICs is often scarce, and workers also do not have sufficient protections from lethal diseases, making the probability of falling ill while working much higher and making the absence of disability or life insurance that much clearer. Fundamental to improved conditions of service are sustained, regular, baseline salaries and benefits, including life insurance. Doing so may mean shifting costs in a prioritized way or seeking funds from outside the system. Campbell remarked that models and strategies for community engagement are often prepared but not funded or sustained until an emergency, such that volunteers are expected to facilitate meaningful engagement on the basis of 1 week's worth of training. He recommended formal employment, including salary, supervision, and a career pathway. Awunyo-Akaba of Ghana referred to the many volunteer health workers who have died and suffered without salaries, highlighting the moral imperative to examine benefits to families as well when workers become sick due to employment. Panjabi recommended providing volunteers with the opportunity to become professionalized community health workers held to the same standards as employed personnel and further commented that, "even if they are not literate they can still play a valuable role in care provision." He also suggested paid referrals as economic incentives.

Aceng of the Uganda Ministry of Health commented that many countries have a trained workforce but face retention problems, particularly with the most qualified workers. Campbell cited the scale of labor mobility as a huge concern for health systems resilience, one which will need to be addressed by training as well as properly supporting workers through provision of adequate PPE as well as compensation and insurance policies. He added that economic costs arose during the Ebola outbreak because many health care workers refused to work under subpar conditions during the outbreak. These conditions, including lack of PPE and unpaid salaries left them extremely vulnerable and often led to the neglect of many health conditions, both chronic and acute. Dovlo of WHO's Regional Office for Africa (WHO-AFRO) also agreed that a critical problem is the protection of health care workers, both in terms of economic stability (through consistent, fair

compensation) and workplace safety. He argued that health care workers are critical resources to the country and must be protected.

To address this problem of "brain drain," Sarley suggested creating opportunity for talented individuals to return. Campbell described a framework (Sousa et al., 2013) for how the education sector and the dynamics of the labor market can combine to drive the push for universal health coverage. It would be guided by IHR policies that may serve to address migration and emigration, attract unemployed health workers, bring health workers back into the health care sector, and retain health workers in underserved areas.

Ensuring Workforce Safety and Mental Health

In the context of safety, a few participants highlighted a key impediment for bringing teams into the EVD response efforts: lack of access to health care if they became ill themselves. Thus, they highlighted providing access to safe environments (such as having available personal protective equipment or proper hospital isolation and ventilation measures), and appropriate safety training to ensure that workers were empowered to go back to work and to care for other frontline health care workers. A related concern is ensuring that countries continue this support and care for workers after international partners have left. Anyangwe of the University of Pretoria highlighted the importance of a long-term plan for continuous education of the entire health workforce—including traditional healers—about personal safety, infection control, hygiene practice, and transmission prevention for common critical diseases such as cholera and tuberculosis, and using that to bridge additional education on global health security and emerging disease safety.

As Petersen described, it is common for health workers to develop mental health conditions for a variety of reasons arising from their work. These conditions could potentially impact their ability to treat patients. A set of participants offered regular, deliberate assessments of health workers with risk categorization and implementing systems of care and support for them as a way to address this issue.

Strengthening Systems for Coordinating a Health Care Workforce

Several participants discussed ways to identify, mobilize, and coordinate workers across levels. They suggested the possibilities of a functional database of allied health professional bodies and of registries of traditional health practitioners. This would require adequate information technology (IT) infrastructure for the maintenance of databases, but it would help to promote cohesion and organization among health care providers. A par-

ticipant described one such politically supported plan in Ghana to identify, locate, and coordinate providers, as well as to identify anyone working outside of the group.

Norton described a further potential benefit of global registries for health teams, citing WHO-verified foreign medical teams as an example. For member states and affected populations, such registries ensure that teams have appropriate training and equipment, and that they are able to coordinate and attain established standards. From the perspective of the teams, he said, they are more likely to be well received by member states if they are on the registry. He noted that donors are also more likely to encourage teams to be registered for the purposes of quality assurance and accountability. Campbell remarked that Brazil has a strengthened capacity for outbreak response, because it does have a registry like this that identifies and locates each health care worker. Aceng described the multilevel coordination structures in place within Uganda's health system (see Box 3-3). Because they are strong and well established, she said, they are able to respond quickly in both day-to-day and emergency situations.

STRENGTHENING SUPPLY CHAINS

Matowe of PharmaSyst Africa explained that in the Southern African Development Community member states, there are relatively few in-country pharmacists relative to the population, with many pharmacist responsibilities falling to other types of health care workers such as nurses. As a consequence, the supply chain for medicines was overwhelmed by the EVD crisis, with pharmacists ill-equipped to manage the disease and supply chain managers unable to determine what was needed.

> "Despite years of investment in supply chain systems, particularly by the well-meaning and well-funded programs, systems remain weak in many resource-limited countries. . . . This then begs the question: is there need to change our approaches to capacity development?"
>
> *—Lloyd Matowe, Director, Pharmaceutical Systems Africa*

He outlined four key components of the access framework for safe, efficacious, quality, cost-effective drugs (MSH, 2008): geographic accessibility, acceptability, affordability, and availability. However, he explained, many developing countries lack some or all of these features, due to factors such as poor dispensing practices and product management or essential medicines simply not being available at all. Substandard medicines are a pervasive problem in developing countries; he recounted the breakdown of data

BOX 3-3
Coordination Structures in Uganda

National Level

Uganda has a standing multisectoral and multidisciplinary task force on epidemics (The National Task Force) coordinated by the Ministry of Health that includes experts from various fields, such as epidemiologists, laboratory scientists, communication experts, psychiatrists and psychologists, physicians, and veterinarians. Members are drawn from the Ministries of Health, Agriculture, and Education; uniformed personnel; the Office of the Prime Minister; and partners including research institutions, universities, WHO, CDC, UNICEF, the African Field Epidemiology Network (AFENET), Uganda Red Cross, and Médecins Sans Frontières. The task force generally meets monthly but meets daily during an epidemic.

District Level

Each district has a task force composed of political, civic, and health leaders, as well as technical advisors from different partners working in the districts. Both the national and district task forces have subcommittees responsible for overseeing and implementing the task force decisions and different components of epidemic response: coordination, resource mobilization, surveillance and laboratory systems, case management, social mobilization, logistics, and psychosocial support.

Community Level

All have community health workers called village health teams (VHTs), trained in disease surveillance and reporting, who are each responsible for 20 to 30 households, depending on the size of the village. If there are any unusual occurrences in terms of death or disease, VHTs report to the nearest facility or to the surveillance focal person in the health subdistrict. Over the years, communities have been educated and sensitized to alert VHTs immediately upon detection of any such unusual occurrences. VHTs act as a link between the facility-based surveillance system and the community, functioning as an early warning system at community level.

Other Supporting Coordination Structures

National Rapid Response Teams and District Rapid Response Teams are trained and remain on standby to be activated immediately if an epidemic is notified. They conduct investigations and support the establishment of an appropriate response in collaboration with the task forces.

SOURCE: Aceng presentation, August 5, 2015.

on 325 cases of substandard drugs (including antibiotics, antimalarials, and antituberculosis drugs) reported to WHO. Of those, 16 percent had the incorrect ingredient, 17 percent had an incorrect amount of the ingredient, and 60 percent contained no active ingredient at all. Matowe provided a

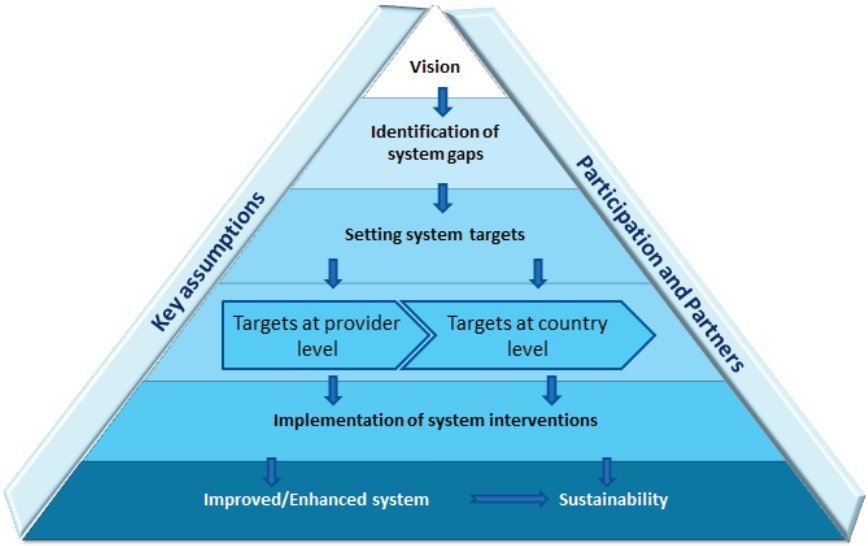

FIGURE 3-2 Supply chain management system strengthening framework.
SOURCE: Matowe presentation, August 6, 2015.

model framework for strengthening the supply chain management system (see Figure 3-2).

Calling for a paradigm shift to drive supply chain system strengthening, Matowe explained that traditional technical assistance is supply- and donor-driven, focused on short-term needs and filling gaps in capacity, and hampered by a lack of in-country stakeholder participation and insufficient monitoring and evaluation. A more contemporary approach, he suggested, would be country-owned and demand-driven, with a focus on building the country's capacity and achieving long-term, sustainable changes. A mutual dialogue regarding performance between the country and technical assistance provider would underlie a results-based monitoring and evaluation; the program would be systematically designed and implemented to address broader institutional, political contexts.

Focusing on the element of country ownership, Matowe recommended that issues in the health supply chain system should be managed at the local or country level to ensure

- Engaged stakeholders and supply chain leaders are present in both policy and technical areas related to national health supply chains,
- Policies and plans are in place to support planning and sustainable approaches to system developments,

- Needs-based approaches are considered,
- Performance management approaches are in place and appropriately funded, and
- Professionalism of supply chain cadres is increased to demonstrate the importance of cadres working in supply chain management.

Responding to a comment from Sarley at the Gates Foundation about the identifying and supplementing the number of trained supply chain professionals in each country, Matowe commented that supply chain professionals are generally not recognized as such, and that such people in most countries are nonpharmacists only found in central medical stores in procurement. He suggested turning to people trained in supply chain management of vaccines and other commodities as a resource with the view to creating a new cadre of dedicated supply chain specialists. Another workshop participant noted the difficulty health care workers have in managing PPE supply chains and suggested that health administrators put a stronger focus on PPE supply chain management. Aceng commented that PPE supply chains in Uganda are strong because of support from the national government and external partners. Sarley highlighted the challenge of many countries having legislation that requires a physician or pharmacist being present during the outlining of this process.

To Awunyo-Akaba's question about medical stores, Matowe responded that in-country medical stores are very diverse, pointing to state stores in Nigeria and Tanzania as working well. He noted less success in smaller countries, with centralized systems working from the National Drug Service down to difficult-to-reach areas. He highlighted the key question of which type of system is more efficient—one that is decentralized or one that is distributed from a central level—because the results of both are diverse. A centralized system enables better tracking of commodities such that gaps can be more quickly identified and addressed. In a decentralized system, regions are better equipped for their own specific needs, thus improving efficiency.

Noting that "stock outs," or consistently having supplies out of stock, can cause a community to doubt the health system, Fallah asked about innovative examples to move drugs rapidly. Sarley cited the Gates Foundation's development of unmanned aerial systems for this purpose (early experiments suggest that delivery may be provided within a 75-kilometer radius within 30 minutes of a drug request). However, he cautioned that the technological and operational components remain a challenge. Dave Ausdemore, Liberia Country Director, eHealth Africa suggested seeking initial funding from public–private partnerships to jumpstart this type of innovation. Jones of FACEAfrica added that countries like Liberia inevitably have longer wait times for validation and implementation of this type

of new innovation, and urged seeking concrete local solutions to address these concerns in the short term.

Government Collaboration with the Private and NGO Sectors

> "When you rely on a single central medical store as your sole source of supply in a country, and you have an emergency, you have literally put all of your eggs in one basket. If you want to build a resilient supply chain—like any commercial supply chain that companies work with—you don't put all of your eggs in one basket; you have several channels."
>
> *—David Sarley, Senior Program Officer, The Bill & Melinda Gates Foundation*

Multiple participants suggested that governments could commit funding to contract out to private and NGO sectors. The aim of doing so would be to ensure quality product availability through the agile and resilient capacity to utilize different supply channels, geared toward increasing the availability of drugs, reducing expiries and the duration of stock outs, and establishing standards for identifying and eliminating all substandard drugs. Collaborating to this end would involve the public sector to manage and procure contracts, pharmacy chains, quality medicine vendors, and local, quality providers from NGOs, civil societies, local agencies, and the private sector. As Sarley presented, resources for implementation could include

- Operational funding for transportation, supervision, and warehousing
- Trained supply chain professionals, pharmacy assistants, and technicians
- Quality business supply chain education and processes
- Solar energy and long-holdover off-grid cold chain equipment for vaccines

Sarley noted that while having a central medical store is an important part of the supply channel for public safety and security purposes, a country should not have all of its commodities in a single channel. If there are available options run by a private-sector or NGO operation that would enable faster delivery of products to a particular district because of their existing transportation or management facilities, governments should contract out the work, according to Sarley. However, he cautioned that multiple channels should not be parallel channels: the objective should be to invest in a single supply chain with several component channels.

RESEARCH AND CLINICAL GUIDANCE

> "Unless we start before these outbreaks are upon us with observational studies and clinical trial protocols we will never be ready to learn anything from these outbreaks that is durable, and we really must start in the interoutbreak period to figure out what we want to study when these things are upon us, otherwise we will not advance."
>
> *—Rob Fowler, University of Toronto, Canada*

Remarking that "outbreaks and pandemics are unpredictable but predictably recurrent," Fowler and others highlighted the need for improvements in research and clinical guidance. During outbreaks, the lack of preexisting protocols can delay both studies and needed clinical trials, according to Fowler (e.g., the median time to initiate research on severe acute respiratory infections between 2013 and 2014 was 335 days). He urged that protocols designed to address unanticipated outbreaks and pandemics must be initiated during interoutbreak and inter-pandemic periods, cautioning that a reactive approach will not allow sufficient time to begin research before most outbreaks are advanced or completed. A further concern cited by Fowler and others was the use of non-evidence-based treatments in epidemic response due to a lack of available clinical guidance about how to treat patients. As Rubinson observed, when data are limited, opinion reigns. Thus, improving clinical guidance was suggested as a priority during interoutbreak periods, supported by collaboration with international partners and continually updated as new research- and field-based information becomes available.

From the perspective of a clinician on the ground during an outbreak, Rubinson of the University of Maryland remarked that while some disease features are predictable, such as sepsis/septic shock, the particular organs involved and its impact on disease course can be more difficult to determine. He noted that supportive care generally plays a major role until disease-specific therapeutics are available, and co-infection with endemic diseases or clinical features may overlap with those seen in endemic disease. He described how prior to 2014, clinical guidance about EVD care was based on limited data and care in very challenging environments. For example, decisions about oral versus parenteral fluid resuscitation and additional supportive care regimens were opinion based. Nevertheless, even postoutbreak with tens of thousands of patients treated, he stated that there continue to be more questions than answers regarding care. Currently, most guidance about EVD management largely relates to how to manage

general sepsis syndromes. He called for translating resource-rich strategies to resource-limited environments for high impact.

Fowler described the efforts of the International Severe Acute Respiratory and Emerging Infection Consortium,[7] a global federation launched in 2011 of more than 40 existing clinical research networks. Its aim is to change the approach to global collaborative patient-oriented research about rapidly emerging health threats between and during epidemics, in order to generate new knowledge and maximize the availability of clinical information. Fowler was optimistic that this would provide a common and standardized basis for new observational research and clinical trials.

[7] See https://isaric.tghn.org (accessed October 2, 2015).

4

Strengthening Information Management Systems

Highlights and Main Points Made by Individual Speakers and Participants[a]

- Health information systems should be flexible and broadly encompassing, including mechanisms that allow for scaling up or down of information, an ability to combine information sources, and interoperability with preexisting platforms. National ownership of these systems can augment uptake and success. (Frankfurter, Greenough, Wilson)
- National promotion of education of health care workers in using and configuring health information systems can be done through vocational training, university and higher education training, and incentivized learning and use. (Biondich, Greenough)
- Countries should not only promote surveillance capacity building through technological advances, but also through the reapplication of preexisting and accessible technologies such as short message service (SMS) services. (Wilson)
- Health information systems should operate under common, standards-based, open technology platforms. In the long term, these platforms are less costly and more sustainable, while also allowing for greater global interoperability and flexibility during an outbreak or epidemic. (Biondich, Kesse)

- Strengthening day-to-day country surveillance systems, primarily during the interoutbreak period and integrating them as part of the larger health information system can allow for a more efficient response to an outbreak or epidemic. Uganda provides an excellent example of the value of interoutbreak system strengthening. (Aceng, Fitter)

[a] This list is the rapporteurs' summary of the main points made by individual speakers and participants and does not reflect any consensus among workshop participants.

Chapter 4 focuses on the topic of priorities and strategies for strengthening information management systems. Health information and digital health solutions are available to improve day-to-day systems and to prepare for and improve epidemic response. The critical capacity for disease surveillance can also be augmented by both new and existing technology solutions.

HEALTH INFORMATION SYSTEMS

Improving Epidemic Response Using Digital Health Solutions

Kate Wilson, Director of Digital Health Solutions at PATH, focused on possible options for improving epidemic response using digital health solutions. She suggested a shift in focus away from specific products, functions, or solutions and toward how people actually utilize the information and technologies that are available to them. Striving for a broader health information system and improved functional applicability would enhance flexibility: for example, situating a surveillance function within a health information system, rather than implementing a separate surveillance system. Broadly, she called for improved usability in making health information systems designed to be easier and more accessible for their users.

Institutionalizing Digital Health Services

Despite the proliferation of digital health services that have launched over the past 10 years,[1] only few—if any—have yet scaled, reported Wilson. She defined a digital health intervention as being at scale when its routine

[1] A reported 728 services were active as of August 2015, with an increase of more than 30 percent in the number of mobile health launches per year between 2005 and 2011 (Sources: The Bill & Melinda Gates Foundation, based on Groupe Speciale Mobile Association [GSMA] Mobile for Development Intelligence data; GSMA Mobile for Development deployment tracker, accessed October 4, 2015).

use is institutionalized by either governments or end users as an approach to delivering health impact. She suggested that the goal of institutionalizing digital health services could parlay into a range of advantages from various stakeholders' perspectives. For example, most health care providers have already adopted a standards-based suite of digital tools; most major nongovernmental organization (NGO) programs and donors' health-related investments leverage those nationally endorsed, sustainable tools. For technology providers, products and services become more economically sustainable and for mobile operators, digital health services can drive long-term value creation.

Lessons Learned About Health Information Systems During Previous Outbreaks

Regarding past instructive experiences during an outbreak, Fitter mentioned that after the Ebola virus disease (EVD) outbreak, the U.S. Centers for Disease Control and Prevention (CDC) viral hemorrhagic fever database did not include enough information beyond patients' names to recognize individual records, given that thousands of affected people had their data input at facilities in different locations. Frankfurter remarked that based on his experiences with EVD response, health information systems were not optimized to be scaled down to the individual level. He explained that while the purpose of informatics is to take individual patient-level data and scale it up for population-level analysis, for smaller organizations it is important to be able to scale down to make decisions on the individual level. He suggested information technology (IT) systems be structured in such a way that makes it easy to go either up or down the chain to broaden or narrow the picture. Greenough commented that following the 2010 earthquake in Haiti, the health information system had the advantage of being able to combine information from more than 50 separate sites, because they all used the same platform. However, he noted that population-based data were important in Haiti, but they also needed to geocode the data, and questioned whether this was a security risk that warranted further consideration.

Suggested Principles for Digital Health Solutions and Investments

Wilson offered a set of guiding principles related to the implementation of digital health solutions and information systems. She described how ensuring sustainability requires partnering with countries to derive a realistic picture of costs that they can sustain in the future and those they would be unable to maintain. In the context of creating country-owned systems built on existing capacities and infrastructure, she suggested that open-source

products should be adapted, built on, and informed by related products, thus being structured and tailored to be optimal for each country. She further called for attention to the misrepresentation that the developed world can do a better job of implementing projects than the developing world can, remarking that in fact, the developing world is often more innovative in their use of these types of products.

Wilson emphasized that health information systems should be interoperable, in that they work with a country's previous investments, within its existing infrastructure, and will continue to operate with systems put in place in the future.[2] She explained that regardless of the specific system being implemented, it is very important to establish an agreed-upon way to collect and digitize various kinds of data elements at the beginning. Having a standard set of data elements in place can obviate most future problems, because it becomes relatively straightforward to implement different platforms and create a coordinated system (see Box 4-1).

"Systems that are built to be interoperable from the outset and designed to last in the long term have the advantages of enhanced flexibility and repurposing potential."

—Kate Wilson, Director of Digital Health Solutions, PATH

Wilson outlined a set of characteristics that, in her opinion, should ideally apply to every digital health investment. The initiative should be triggered and selected according to the health system's needs, and then mandated and delivered by the Ministry of Health. It should be underpinned by committed, realistic long-term funding and robust program management so solutions have time and support to iterate, evolve, and integrate into existing systems and practices, she continued. It should be designed to conform to agreed-upon standards, but also created with the participation and input of the end users and long-term implementers.

Potential Levers for Implementing Effective Health Information Systems

Paul Biondich, Research Scientist at Regenstrief Institute, Inc., suggested that once stakeholders agree on the "destination" for an effective health information system and develop the roadmap for reaching it, there are two concurrent streams that can accelerate the process—catalyzing national digi-

[2] She noted that the United States provides an example of what not to do, because its health system has multiple platforms that do not allow for interoperability (i.e., the U.S. Department of Veterans Affairs compared to another electronic medical records system).

BOX 4-1
Case Study: Open Health Information Exchange and the Better Immunization Data Initiative

The Open Health Information Exchange (OpenHIE) is designed to support the open, collaborative development of large-scale health information-sharing architectures by enabling interoperability and incorporating freely available, standards-based approaches and reference technologies.[a]

Paul Biondich, Research Scientist at Regenstrief Institute, Inc., described how OpenHIE incorporates different components of health information systems into a larger platform that can be used by third-party systems, as well as other users. Doing so involves devising common "blueprints" for various technology areas—for example, mobile applications, laboratory information, and clinical records—and uniquely defining each area in such a way that its information can be stored at both the individual and population levels (for statistical purposes). Elements are connected and integrated through common "plumbing" that allows for subsequent building and alterations in the future; third-party systems already in use can be incorporated if they comply with OpenHIE standards. Biondich contended that there should be one information system architecture that can address many disease issues, and emphasized the importance of making this, or any other component, of interest to community members and involved stakeholders. For instance, OpenHIE seeks to engage with countries to find out what technology they already have, and find ways to build on and bring together what is already there.

The Better Immunization Data[b] Initiative is an example of a digital health approach that relies on OpenHIE's internationally recognized and tested standards, explained Biondich. Information systems are not generally designed to handle high volumes of data exchange, but OpenHIE is optimized for scale and large volumes of secure data traffic. Governance, privacy, and security are prioritized and enforced by an interoperability layer through which all data transactions must pass.

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[a] See https://ohie.org (accessed October 2, 2015).
[b] See http://bidinitiative.org/wp-content/uploads/BID_factsheet_02_Final.pdf (accessed October 19, 2015).
SOURCE: Wilson presentation, August 6, 2015.

tal health investments and investing in cross-market levers for scaling. He outlined seven components implicated in each of those two streams:

- Case for action
- Leadership
- Effective product
- Viable economic model
- Supportive policy, regulation, and standards

- Effective program management
- Human capacity

For each component, he offered examples of near- and longer-term potential country investments, as well as near- and longer-term possible cross-market investments for scaling digital health interventions (see Tables 4-1 and 4-2).

HEALTH INFORMATION SYSTEMS: HIGHLIGHTED OPPORTUNITIES

Biondich reported on three suggestions that arose out of the discussion around building health information systems and leveraging existing capacity within various countries.

TABLE 4-1 Potential Country Investments for Scaling Digital Health Interventions

	Near-Term Investments	Longer-Term Investments
Case for Action	Develop rigorous total cost of ownership (TCO) models and collect consistent health impact data on each implementation	Sponsor national advocacy and education efforts on the impact seen from digital health investments
Leadership	Require government and donor coordination before allocating investments	Invest in design and implementation of country-led strategies
Effective Product	Direct investments toward making products inter-operable with existing infrastructure	Evaluate more rigorously each project against agreed performance levels and health outcomes
Viable Economic Model	Identify the "gives" and "gets" for each product before rollout by stakeholder	Require that each rollout identifies a viable long-term business model after catalytic financing ends
Supportive Policy, Regulation, and Standards	Support national development of eHealth architecture and implementation plans	Provide incentives to adopt agreed standards and policy frameworks to national governments
Effective Program Management	Require new investments to have dedicated program management staff through national rollout	Capture and share best program management practices within a country
Human Capacity	Sponsor greater local university and entrepreneurs' participation from the outset	Embed national informatics capacity in projects versus using overseas staff

SOURCE: Wilson presentation, August 6, 2015.

TABLE 4-2 Potential Cross-Market Investments for Scaling Digital Health Interventions

	Near-Term Investments	Longer-Term Investments
Case for Action	Create better advocacy toolkits to educate national leaders and donors	Develop modeling tools to demonstrate return on digital health investments
Leadership	Call for a global action plan for digital health investments	Convene stakeholders to develop the action plan and oversee implementation
Effective Product	Direct investment toward a smaller pipeline of best-in-class cross-cutting platform	Cultivate private-sector technology firms to invest in digital health platforms
Viable Economic Model	Develop financial forecasting tools that any country can use to consider TCO and return on investment of new digital health tools	Develop innovative financing mechanisms (e.g., demand aggregation)
Supportive Policy, Regulation, and Standards	Continue more inclusive development of shared standards and best practices frameworks	Negotiate aggregated licenses for standards and agree on global standards for developing world (e.g., WHO/ITU for NCDs)
Effective Program Management	Capture and sharing of best practices in more digestible, practical forms	Investment directed toward most effective models for implementing digital health
Human Capacity	Sponsor regional peer networks and specialized capacity programs targeted toward practitioners	Develop the next cadre of eHealth leaders through university-level health informatics programs in emerging markets

NOTE: ITU = International Telecommunication Union; NCD = noncommunicable disease; TCO = total cost of ownership; WHO = World Health Organization.
SOURCE: Wilson presentation, August 6, 2015.

National Data Use and Health Information Systems Capacity Development

To build effective health information systems, multiple participants emphasized the importance of educating all health care and support workers, not only in how to use those systems but also in how to implement, configure, and customize them. Doing so involves combining two forms of capacity building: "strength at source" and "strength at scale." The former refers to long- and short-term training for workers already in the field and outside of traditional educational circumstances, for example, in the form of vocational training in fundamentals of information fluency. Biondich

cited examples of workers in the field who have not had the opportunity to use information to influence their care delivery, and that when it does become a routine part of their practice, it has the knock-on positive effects downstream of improving the quality of information and how it is gathered. "Strength at scale" in the context of this type of capacity development, according to Biondich, would involve working within countries' educational systems to embed health information systems training, health informatics, and data use skills within their curriculums on two tiers: health professional organizations and universities, as well as vocational training centers and polytechnic organizations. A further objective offered by multiple participants would be to create a peer-learning network among countries to build a common curriculum and to govern the priorities of the content that is developed.

Several other participants also suggested incentivizing and educating health care workers to use health information systems. Fitter noted that increased transparency of data can actually serve as motivation for people to use the system. Greenough suggested that developing the capacity to rapidly analyze data could also serve as an incentive for users to continue to use the technology.

Strategic Reuse of Common Open Technology Platforms

A second topic of discussion was the strategic reuse of common open technology platforms, reported Biondich. George Kesse of Mpharma noted that during a disease outbreak, it often happens that various partners arrive with a collection of specific information systems to support the response to that outbreak. However, after the outbreak, when the partners leave, the country is left to maintain those information systems in the absence of both context and adequate local capacity, leaving "yet another tool that needs to be locally maintained and sustained." Biondich advised that if countries had common, freely available, standards-based, open platforms for health information systems, it would prevent the duplication of effort, reduce costs, and support local sustainability. Having internationally standardized, adaptable, and open platforms for data collection across all levels (including the local level) would allow a country to build a platform on its current infrastructure and then locally customize and optimize it for the country's specific needs. Furthermore, Biondich speculated that these types of open platforms are by nature easier to build capacity around, as well as being potentially more flexible and responsive to outbreaks that emerge. Systems that meet certain qualities could then be strategically reused.

Systematizing a common platform is a complex adaptive problem that necessitates a multidisciplinary approach, cautioned Biondich. Partners involved would range from communities developing common open plat-

forms, to funders of health delivery activities, to workers on the ground, to the Ministries of Health. On the local level, resources required would be local representation within the governance of the open platforms, as well as local engineering support for technologies and training related to the common components. Appropriate documentation would make product consumption easier for new users, and financial support would be needed to sustain growth. Biondich argued that common platforms reduce the proliferation of redundant systems and encourage sustainability because they are collectively resourced public goods. These effects could further impact improved information sharing and surveillance activities within and between countries and regions.

Architectures Based on "Readily Malleable" Routine Information Systems

Biondich explained that a readily malleable routine information system (RIS) is one that allows for adaptation during emergency circumstances. Its foundational components are readily available for emergent outbreaks, coupled with a self-regulating RIS that is capable of serving as a signal detector and triggering itself during potentially emergent infectious events, thus reducing the timespan for alerts. It is an "urban plan" that facilitates leadership during emergency conditions and fosters ministry coordination toward reuse of common components and competencies. The aim of a malleable system is that in circumstances of disease outbreak, it allows for working with and within the existing environment, tools, infrastructure, and capacities rather than bringing in an entirely new system. The community is incorporated as a partner in the health system and the capacity for rapid analysis of data is enhanced.

DISEASE SURVEILLANCE SYSTEMS

The crucial role of effective disease surveillance—both within and between outbreak periods—was a key topic of discussion throughout the workshop. Nguku and Nasidi of the Nigerian CDC characterized disease surveillance as the "backbone of disease control."

Lessons from Surveillance Response to West Africa EVD Outbreak

Fitter contextualized the discussion of disease surveillance systems by detailing the problems that arose in response to the West Africa EVD outbreak. The Integrated Disease Surveillance and Response (IDSR)[3] frame-

[3] For more on the IDSR framework, see http://www.cdc.gov/globalhealth/healthprotection/ghsb/idsr/what/objectives.html (accessed October 20, 2015).

work, designed to strengthen health systems' core capacities for surveillance and response, was adopted by Guinea, Liberia, and Sierra Leone, but it was not fully implemented in any of those countries. Fitter noted that prior to the outbreak, the countries' health systems lacked the surveillance capacities for detection, reporting, supervision, and feedback mechanisms such that "as the outbreak engulfed the national health systems and hundreds of health organizations responded, the people and tools which comprised 'the system' could not keep up and became increasingly disorganized."

The affected West African countries' telecommunications, transportation, laboratory, and clinical infrastructures were too weak or compromised to facilitate the necessary outbreak response. Workforces lacked sufficient training or capacities to collect, manage, or disseminate information, despite the thousands of community health workers and volunteer responders who were engaged. Many of those responders were working across multiple domains, Fitter said: different laboratories were under different technical oversight, and providers from different groups were running various treatment units. A case-reporting surveillance tool was put in place but its efficacy was hampered by its length, incomplete data entry, and untrained staff. Alternate data sources and systems were put into place (e.g., decedent registries, call centers, logbooks and spreadsheets, and surveys) but a robust unique identification system bridging all services was still lacking. However, Fitter highlighted some of the innovations that did arise: mobile data collection for surveys, contact tracing, geocoding, supervision, and technical assistance; and cloud hosting for central data storage and integration, case and laboratory registries, and analysis.

Lessons from Uganda's IDSR Strategy

Aceng provided an overview of Uganda's integrated disease surveillance and response strategy, adopted in 2000, as an example of an effective day-to-day system that can respond to emergency situations. The strategy mirrors the health system's structure in its coordinated levels of response and responsibilities instigated from the community or village through the district, regional, and national levels. At each level, there are designated surveillance "focal persons" who routinely receive and disseminate information from health facilities and community health workers, on the basis of which they carry out investigations on priority diseases and report accordingly through the health management information system. With the support of the U.S. CDC, they have also initiated a field epidemiology training program to build a pool of epidemiologists to support surveillance efforts.

A set of standardized clinical and community case definitions was also developed to improve community health workers' ability to detect atypical

outbreaks. Information on any unusual occurrences or atypical outbreaks is remitted to the epidemiologist surveillance division of the Ministry of Health and the chair of the National Task Force. Verified information triggers further investigations, higher-level action, and daily task force meetings. Aceng identified contact tracing as another key component of the strategy, carried out by a team of surveillance officers deployed during outbreaks. Each officer is assigned a specific set of contacts (no more than 30 people) to follow daily for 3-6 weeks and report back on to the surveillance committee. Officers are provided with transportation and mobile communication support to facilitate their contact tracing work.

During interoutbreak periods, the ongoing surveillance system remains in place, she said, and the task force meets on a monthly basis to review disease surveillance data and continually updates epidemic preparedness and response plans with respect to the situation on the ground. There is constant communication between staff at each level of the health system regarding the current situation, and with the support of the World Health Organization (WHO), Uganda has also been working with its neighboring countries to strengthen cross-border communication and improve outbreak response. Aceng noted that the system relies strongly on radio announcements coupled with a mobile phone alert and call center system to keep people informed and to alert surveillance officers to early signs of potential problems. Community guidelines in various languages inform people about when and where they should call the toll-free alert service. Fitter noted that such alert call centers often receive calls unrelated to surveillance alerts or become overwhelmed. Aceng responded that they address this through an alert system management structure by having one officer receive and filter all calls, passing those deemed necessary of immediate response to a second officer. The center may receive up to 4,000 calls per day, and responds immediately to about 20 of those. She noted that this alert system runs continuously even between outbreaks and generates valuable tracking information even in the interepidemic periods.

Predictive Modeling

Predictive modeling involves building scenarios for analyzing and strengthening response systems across best- to worst-case scenarios, explained Campbell. The objective is to build sufficient capacity to respond effectively to all such scenarios. Reporting on the discussion of this topic among participants in the focus group, Campbell suggested that the first steps are better understanding of the challenge of disease outbreak response, learning from how other sectors respond to disasters, and predicting what to anticipate at various time points as the response matures. These analytical steps inform the plans for deployment strategies, competency and

capacity building, necessary skills, and operational logistics that are needed to underpin an effective response.

Building effective predictive models would benefit from in-kind contributions from leading technology specialists, suggested Campbell. Another key component is global consensus building based on lessons learned from other outbreaks; depending on scale of consensus achieved, recommendations could be presented to countries and regions to make sure that they are appropriately planning for an all-hazards approach with partners and appropriate national ownership.

Real-Time Data Analysis and Evidence

To improve modeling and monitor performance, real-time data analysis is fundamental; Campbell noted that continual improvement of modeling practices (and their underlying assumptions) depends on continuing data monitoring and reporting. Remarking that there is already a requirement for daily operational reporting in disaster management, he suggested that daily information sharing and reporting could be brought into disease management by institutionalizing real-time operational science and monitoring and evaluation practices. In addition to partnering with government, WHO, the United Nations (UN), and relevant specialists to do so, the private sector could be engaged for components such as IT mapping. He cautioned that implementing this strategy would require new considerations about data transparency and must emphasize data sharing from the outset (i.e., discouraging the tendencies protect data or be the first to publish it). Fowler noted that getting data early is important for generating case report forms that can be both standardized and generalizable. However, it is also worthwhile to consider the unintended consequences of continual requests for data monitoring and reporting of case counts and laboratory information. Once an outbreak has been established, the value of constant reporting could be weighed against using those same resources for other elements of a response. For assessment to inform the dynamic improvement of care, Rubinson called for it to be geared toward providing accurate assessments of functional status rather than only counting patients and deaths, for example. Additionally, making sure that countries susceptible to the outbreak are reporting indicators in a standardized manner, such as suspected cases or confirmed cases, can help to show the true picture of an outbreak's magnitude.

Key Gaps in Existing Surveillance Systems

Several participants highlighted gaps and challenges in existing systems, with the view to discussing strategies for capacity building and system strengthening. Some of the gaps Fitter highlighted included

- Building capacity in order to understand where the problem is and put the right resources in the right places
- Integrating surveillance training into broader health care education to enable the workforce to monitor systems, manage technology, translate information, and all other key components of surveillance
- Linking training, education, and research to promote the acquisition of information and outbreak tracking

Fitter also raised the issue of funding for training the workforce to carry out surveillance, and the challenge of convincing funders outside of the public health community about the importance of long-term surveillance training and capacity-building programs. Wilson suggested presenting health impact as contingent on reciprocal information sharing for a sustainable system and packaging them together; she noted that while an IT system is largely routinized, strategies and human connections are more challenging. Ellora Guhathakurta, Planning, Monitoring, and Evaluation Officer with the UN Development Programme, agreed regarding the strategy of linking a system's long-term capacity to the sustainability of its surveillance system.

Remarking that acquisition of resources and funding is a challenge in all countries, Aceng called for sensitizing all decision makers to the dangers of epidemics and urged governments to invest in the control of epidemics by having funding available and protected for immediate use in times of emergency. Omaswa of the African Centre for Global Health and Social Transformation (ACHEST) also commented that the appropriate channeling of funds into surveillance, and the alleviation of dependency upon donors, is critical to institutional capacity building in low- and middle-income countries (LMICs), and institutional capacity will require a universal preparedness approach focusing on all causes of mortality and morbidity. He explained that essential care provision can compete for funding in budgetary allocations and called for improved leadership within decision-making structures to ensure that surveillance is part of a basic health care package.

DISEASE SURVEILLANCE SYSTEMS: HIGHLIGHTED OPPORTUNITIES

Multiple participants highlighted several key areas for improvement in disease surveillance systems and sketched possible strategies for addressing them.

Using Existing Technologies and/or Knowledge in Innovative Ways

Wilson expressed concern about focusing too heavily on new technology innovation, calling for a shift away from thinking about existing

technologies as innovations just because they are being utilized differently. Citing examples raised by other participants, such as the use of SMS for alert systems and the use of satellites in Nigerian polio surveillance, she commented that neither SMS nor satellite imagery are innovative new technologies,[4] but they are being applied differently to strengthen systems and communication coordination. She remarked that while such ideas can be good and useful, emphasis should be placed on mechanisms that can use standardized, common technologies and to generate opportunities for innovative thinking in reapplying them to build an interoperable infrastructure. To illustrate, she suggested using standardized, existing technology to channel alerts into a national-level infrastructure, or to capture unique registration and identification data such as biometrics or fingerprints.

Participants discussed the challenges associated with the ability to disseminate the correct information, using the right resources, to the targeted people in such a way that results in actionable impact and a response that is both reactive and preemptive. To do so would require identifying which standardized technologies and reporting systems should be used in order to create a well-utilized system, with which stakeholders at all levels are aware and familiar. Myers suggested that using the same system for day-to-day communications as well as alert systems would be a way to help ensure user familiarity and comfort. Other participants proposed that the salient use of social media could provide a useful platform for disseminating correct and timely information. Multiple participants suggested that a promising way forward could be to integrate the existing technology infrastructure by ensuring it is linked together, institutionalized, and interoperable on a community, district, and national level. The aim in doing so is to build more cost-effective, sustainable systems that countries can take ownership of to improve their surveillance capacities.

Promoting Country Ownership of Institutionalized Surveillance Systems

A related topic discussed was the idea of building on existing capacities to allow countries to take ownership of institutionalized surveillance systems by instilling accountability and the abilities to self-audit, self-regulate, and report. Multiple participants noted that a challenge faced by efforts to establish more country-level autonomy is the lack of adequate supervision and management for reciprocal information acquisition, training, and reporting on the country and international levels. To address this, Agyepong of the University of Ghana suggested fostering better interagency collaboration (for example, among agricultural, vet-

[4] Ardalan cautioned that innovation is a relative concept that depends on the particular circumstances of each country, that is, what may be new in some areas may not be in others.

erinary, and health services) to address the lack of cohesion among agencies. In the context of governments leveraging their positions with private industries to better link into existing infrastructures, Kimball contributed the idea of turning over actions such as census collections and surveys to in-country private industries. Tomori called for equipping people at all levels to gather and analyze information on an ongoing basis, rather than retroactively. Many participants noted that this could provide a feedback mechanism, cultivate open and reciprocal communication, and foster trust; an associated benefit might be that if people at all levels are contributing data, the function and impact of surveillance programs can be measured on a broader scale.

Similar to donor issues mentioned in Chapter 2, funding issues represent further challenges to promoting country ownership of surveillance processes. Kimball suggested expanding the funding timeline—for example, from 2 years to 5 years—because sustained and longer-term funding would help countries to more clearly grasp how to deliver services effectively, and to better understand their assets and how best to manage them. Guhathakurta, Fitter, and other participants highlighted the issue of dependency on donor funding that is employed to effect short-term changes that are neither sustainable nor appropriately institutionalized. Warning that donor money can fall into a trap of unintentionally forcing dependency, they suggested a broad strategy of turning over skills and resources to in-country investors and participants. As an example, Rwanda took an innovative approach in requiring all donors to channel funds in support of their Vision 2020 strategy and to rebuild government systems, institutions, and processes by investing in them. It maintained the right to *decline* aid that was not aligned with the national strategy or had high transaction costs or conditionalities (Farmer, 2015). As Fitter reported, routing donor money into mechanisms that result in institutionalized, sustainable, country-owned surveillance systems could promote countries' abilities to self-regulate and maintain accountability to all stakeholders.

Engaging and Educating All Sectors in Disease Surveillance

Participants including Awunyo-Akaba, Myers, Greenough, and Tomori emphasized the key role of community health workers, NGOs, and civil society, traditional rulers, and religious leaders in disease surveillance, and suggested ways to more effectively engage them in that system. Building on ideas presented in the discussion on promoting country ownership of surveillance, several participants remarked that community trust could be fostered by interdisciplinary information sharing; for example, veterinary students and medical students could collaborate and contribute to understanding manifestations of certain zoonotic diseases.

Greenough noted that surveillance systems often break down because the people at the local level, who are conducting the groundwork of data gathering and due diligence, do not receive back the relevant, aggregate information from decision makers and analysts. Fitter responded by highlighting the importance of increased, bidirectional reporting and information sharing, with respect to both health care actors and the population at large; he shared that information is collected more effectively when everyone involved understands why it needs to be collected. With respect to communities in particular, several participants suggested that better transparency surrounding the benefits of strong surveillance systems (and the consequences of poor ones) would help to strengthen a community's trust of health care workers, NGOs, and government entities such as Ministries of Health. Several participants pointed to the related topic of better and earlier training and education about public health concepts for communities, health care workers (including veterinary students and pharmacists), NGOs, and civil societies in order to further facilitate improved and sustainable surveillance systems. These participants suggested that integrating public health and health care in training would allow for the implementation of institutionalized best practices. Fitter also noted that based upon basic analyses of IDSR, health care sites often suffer from lack of supervision and would benefit from more constant feedback to enhance trust.

Another suggestion was to facilitate better understanding and awareness of important considerations that could help make communities, health care workers, and other community-level actors more astute to the kinds of disease they should expect, and to be more sensitive to detecting them in specific circumstances. Aceng noted that in Uganda, for example, their alert system focuses on different diseases during different seasons. During the season when bats are returning to caves, they provide public alerts about avoiding them to prevent zoonotic transmission. During the dry season, the alert system focuses on spreading awareness about meningitis. Burkina Faso sends similar seasonal meningitis alerts to physicians, Fitter added.

Strengthening Routine Day-to-Day Surveillance Systems Between Outbreaks

The crosscutting principle of capitalizing on interoutbreak periods to strengthen surveillance systems in various contexts was also highlighted. One area of discussion focused in particular on the importance of strengthening routine day-to-day surveillance systems, echoing some of the advantages that were ascribed to strengthening routine information systems. Fitter characterized routine reporting and laboratory surveillance systems as foundational building blocks of an everyday system that is capable of detecting and responding effectively to outbreaks. Figure 4-1 illustrates

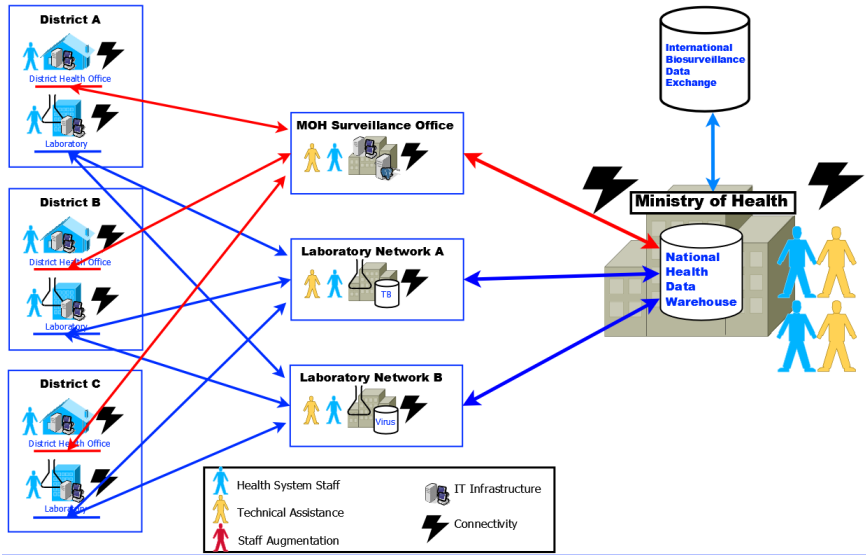

FIGURE 4-1 Expanding health data network.
NOTE: IT = information technology; MoH = Ministry of Health.
SOURCE: Fitter presentation, August 5, 2015.

how those components combine to facilitate data integration and use in an expanding health data network.

With a routine surveillance system embedded within a national health information system architecture, Fitter further described how the system can expand to increase capacity when the number of suspect cases increases, allowing for the incident management system to be activated earlier in an outbreak. According to the Global Health Security Agenda (CDC, 2015a), a national surveillance strategy should be both IDSR-based and International Health Regulations–compliant, combining routine indicator- and event-based surveillance across human and animal health systems for early outbreak detection and rapid response.[5] Implemented in a step-wise fashion and facilitated by routine progress monitoring, the strategy encompasses disease-specific protocols and an information communication technology infrastructure that encompasses a workforce trained in surveillance, an integrated surveillance and laboratory national health data warehouse, and data exchange that is interoperable across local, national, and international platforms.

[5] See http://www.cdc.gov/globalhealth/security/actionpackages/real-time_surveillance.htm (accessed November 9, 2015).

5

Strengthening Outbreak Management and Emergency Response Systems

Highlights and Main Points Made by Individual Speakers and Participants[a]

- Rapid case detection and response are key to ending a disease outbreak through efficient surveillance and laboratory work, effective coordination, and a strong workforce. (Fowler, Nasidi, Nguku, Perl)
- Without a strong system for receiving aid, foreign support is not fully effective. Properly matching a country with foreign medical teams, especially practicing clinicians, can help to ensure appropriate support. (Norton, Rubinson, Sarley)
- Community workers can serve as a trusted connector between the community and incoming foreign medical teams, and can support foreign teams in the identification of cases, care of patients, and their reintegration into the community following an outbreak. (Norton, Panjabi)
- Strategic operational planning requires a national framework with a strong command and control center. This center would be responsible for monitoring indicators and triggers of infectious disease outbreaks and other emergencies while also maintaining awareness to identify potential unknown threats. (Campbell, Hanfling)

- Access to and analysis of real-time data are necessary for successful modeling and strategic planning; improving access to such data should be a joint venture between governments, international governing bodies, and the private sector. (Campbell, Fowler)
- In cases where full capacity building is impossible on a national level, countries should build a regional capacity-sharing system, where less developed countries can utilize resources available in nearby countries without duplicating. Regional capacity sharing can improve response efficiency and promote a sense of global security and support. (Dovlo, Kimball, Myers, Norton, Tomori).

[a] This list is the rapporteurs' summary of the main points made by individual speakers and participants and does not reflect any consensus among workshop participants.

Chapter 5 gives an overview of the role of strengthening countries' day-to-day health systems and public health infrastructures in preparing for effective outbreak management and emergency response, also highlighted in Chapter 3. Speakers and participants in this chapter discuss how to best augment existing systems for surge capacity needs during an emergency response. Many participants advised that this strong foundation should be supplemented by having concrete plans for outbreak management and emergency response systems that can be activated quickly, flexibly, and systematically when the need arises. Lamptey of FHI 360 urged the public sector to prepare for potential sector-wide responses that are not limited specifically to infectious diseases. He advised that the entire sector should be ready to respond horizontally to any emerging infections, as well as having the built-in capacity for vertical action. An emergency scenario can impact any country and overwhelm its resources, according to Rubinson, to the extent that the country needs assistance in regaining control. He suggested identifying and formulating plans for multiple common emergency scenarios that countries might experience, including for example, bioterrorism events, natural disasters, or large burdens of death and injury from noncommunicable diseases, taking into account knowledge gained from lessons reexperienced in similar settings.

Campbell explained how early reporting and rapid response early in a disease outbreak can dramatically reduce the number of potential cases and prevent further disease transmission (see Figure 5-1). He posited that increased investment in improved importing and response early in the Ebola virus disease (EVD) outbreak in Sierra Leone could have had meaningful effect on the impact of the disease.

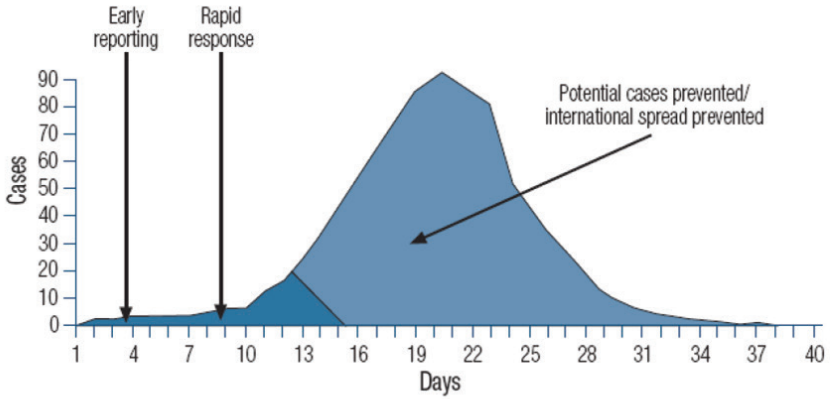

FIGURE 5-1 Global outbreaks, the challenge: late reporting and response.
SOURCE: Campbell presentation, August 6, 2015.

Echoing Campbell's point, Nguku and Nasidi termed this ideal sequence of events in an outbreak where surveillance and response are effective as the "left shift": the epidemic curve moves to the left, representing a significant reduction in case numbers, morbidity, and mortality when early detection, laboratory confirmation, and response occur within roughly the first 2 weeks of an outbreak. They suggested a set of factors that can contribute to shifting the epidemic curve to the left:

- A functional and effective surveillance and response system (including infrastructure with isolation rooms, ventilation control, soap and clean water, and adequate personal protective equipment [PPE])
- A skilled public health workforce
- A functional and networked laboratory
- Inter-sectoral collaboration
- A strengthened public health system
- Public health funding and leadership
- Effective coordination

OUTBREAK RESPONSE: PRINCIPLES AND STRATEGIES

Perl defined five key elements of health care outbreak response that other speakers commented on throughout this section: outbreak management; care of large numbers of critically ill patients; protection of health care workers, patients, and volunteers; communication with health care workers, patients, families, community members, and public health authori-

ties; and multidisciplinary advanced planning. Outbreak investigation is one of the key components of outbreak management that feeds into quality care and prevention of disease transmission.

Outbreak Investigation

Perl outlined the key components of outbreak investigation. To explain the fundamentals of outbreak investigation and how investigation informs disease transmission prevention, she described her experience as part of a team investigating a 2013 nosocomial, or intrahospital, outbreak of Middle East respiratory syndrome coronavirus (MERS-CoV) at Al Hasa hospital in the Kingdom of Saudi Arabia. The initial focus was on several specific units in the hospital, but after reviewing medical records and collecting surveys it became evident that there was intrahospital spread. The next task was to identify how the infection was transmitted, with human-to-human transmission considered to be the likely source. They created a transmission map that indicated that a single person could transmit the infection to multiple other people (see Figure 5-2).

The next steps were calculating the incubation period (time from exposure to symptom development) and genetically sequencing specimens from

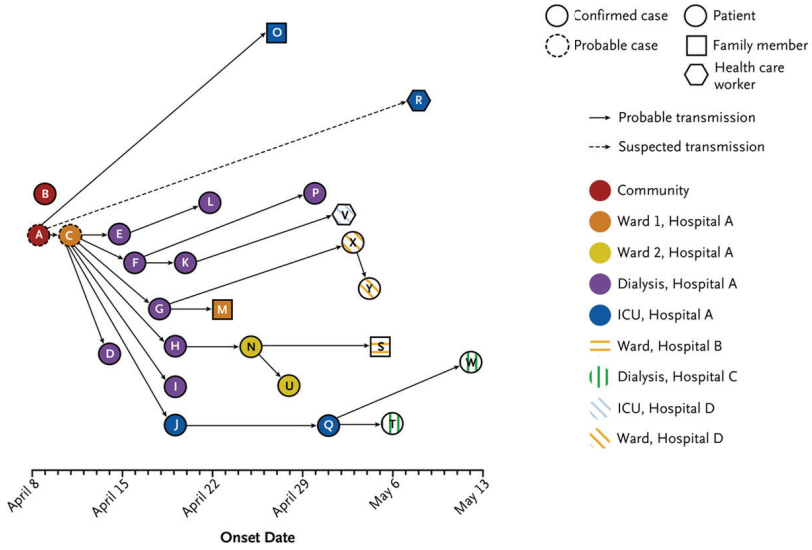

FIGURE 5-2 Transmission map of outbreak of MERS-CoV infection.
NOTE: ICU = intensive care unit.
SOURCES: Perl presentation, August 5, 2015; Assiri et al., 2013.

infected patients to determine whether the organisms were similar. Sequencing revealed four specimens to be essentially identical, which suggests nosocomial transmission. Thus, the sequencing data are consistent with the epidemiologic data in indicating that transmission can occur from human to human with close contact. Perl noted that bat viruses are very similar to the human MERS-CoV virus that has been identified, and about 3.5 percent of bats in Saudi Arabia have a MERS-CoV-like virus or have evidence of having been infected.[1] Similarly, there have been camel MERS-CoV infections with documented transmission to humans. Thus, their investigation suggested that the bat (as with severe acute respiratory syndrome [SARS]) may be the source of the virus, with the camel as a potential intermediary source in transmitting the virus to humans, as was the case in Saudi Arabia. She explained that this aspect of investigation is important because it has implications for infection control and limiting ongoing transmission of a particular organism.

A current challenge faced by outbreak investigations, according to Perl, is that most information about transmission, virulence, prevention, and vaccine effectiveness is still unknown during the investigation. Scientific responses have not been well-coordinated or have not utilized a translational approach with well-integrated and shared data. Available international resources are not effectively leveraged, and international laboratory capacity for testing is still limited. Determining the agent and mode of transmission are only part of outbreak investigation, as Perl explained; it should also serve to find ways to prevent transmission, terminate the outbreak, and prevent future occurrences. She noted that limited surveillance and case finding contributed to the outbreak, due to diagnostic and logistical delays as well failing to detect the spectrum of disease early enough. Poor internal and external communication also played a role, in the form of lack of transparency about the facts of the outbreak within country and to the World Health Organization (WHO). Communications problems also exacerbated what she pointed to as a key factor driving this outbreak and many others: the failure of infection control and prevention practices in health care.

Infection Control and Prevention

Perl stated that the outbreak at Al Hasa hospital was ultimately terminated when appropriate infection control practices were actually put in place, positing that the outbreak likely resulted from failure to adequately implement isolation and infection control measures. Isolation precautions

[1] There has been at least one bat in which the MERS-CoV sequence has been identical to a patient MERS-CoV sequence.

and the use of barrier precautions were not understood or followed[2] and the supply chain to support the materials needed for isolation precautions was inadequate. Intrahospital patient transfers led to ongoing transmission of undetected cases, which was also compounded by family visitations and crowding in the hospital. She emphasized the isolation precautions and infection control measures are highly effective when implemented properly, and as such should be a key priority.

Fowler characterized preventing outbreaks from spreading as even more important than the clinical work he performs. He described his experiences as a clinician during the 2013 SARS outbreak in Toronto, during which nosocomial amplification was a major problem. Of Toronto patients with SARS, 77 percent were exposed in the hospital and nearly half of the intensive care units (ICUs) in Toronto hospitals were quarantined, along with more than 1,000 ICU health care workers. Patients are not the only ones whose safety is compromised by nosocomial transmission: multiple participants highlighted the infection risk for health care providers. Campbell noted that health care workers bear the burden of infection, citing data regarding confirmed and probable health care workers with EVD in Guinea, Liberia, and Sierra Leone (880 cases and 510 deaths as of March 2015) (see Figure 5-3).

Fowler reported that 18 percent of SARS patients in Toronto were health care workers as well. He identified three risk factors that contributed largely to health care worker infection of SARS: dispersion of high-flow oxygen (Fowler et al., 2004b); risk to health care workers due to any involvement with intubation (Fowler et al., 2004a); and risk to health care workers ventilating patients with non-invasive positive pressure ventilation or high-flow oxygen (Fowler et al., 2004a).

Ensuring Health Care Workers' Safety in Disease Response

The importance of practices for ensuring the safety of health care workers responding to an outbreak was raised by multiple participants in the workshop. Campbell urged for protecting health care workers more effectively by providing them with better education and training regarding infection control and prevention. Rubinson similarly highlighted the importance of health care workers' safety and called for a commitment to disease transmission assessment that drives appropriate protection in terms of procedures, equipment, and training. He underlined the need for clinicians to understand how the disease is transmitted in the health care

[2] She noted that there was confusion about which recommendations for barrier precautions to be used, as the U.S. Centers for Disease Control and Prevention (CDC) and WHO guidelines were not consistent.

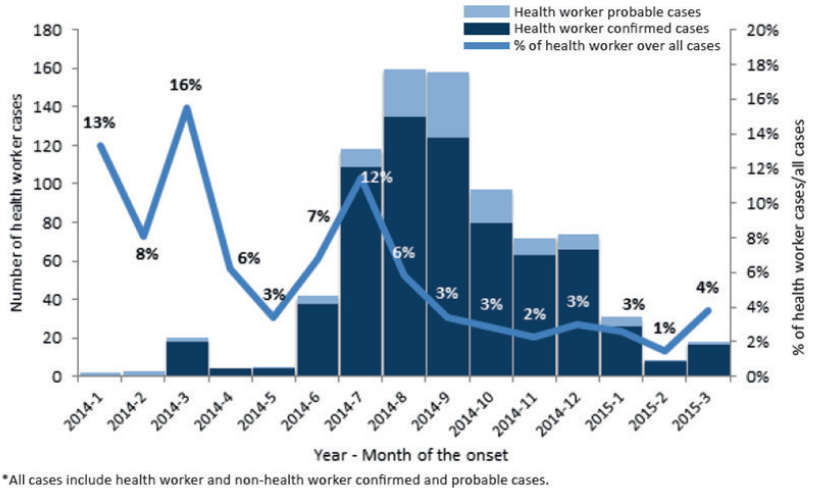

FIGURE 5-3 Number of confirmed and probable health worker EVD cases over time in Guinea, Liberia, and Sierra Leone (January 1, 2014, to March 31, 2015). SOURCE: Campbell presentation, August 6, 2015.

setting, cautioning that epidemic surveys alone are not sufficient: a transmission assessment function should be embedded early on in the response to determine whether clinicians are using the appropriate equipment to prevent transmission (such as PPE, intravenous [IV] equipment, and drawing blood). Fowler remarked that the sphere of infection control and prevention extends beyond clinical practice to the domains of social mobilization, community engagement, and dispelling myths and misconceptions. As an example, he cited the sentiment (still common in many areas, but perhaps not as widespread) that EVD is a curse—held even among health care workers—which requires ongoing education to address.

Isolation and Case Management

Norton remarked that of the classic pillars of EVD response—isolation and case management, safe burials, epidemiologic surveillance, contact tracing, and community sensitization—lack of capacity for the first component can consequently impede capacity for the other four components. Aceng described the structure of the case management system in Uganda for EVD, which begins with logistical support in setting up barrier nursing or isolation facilities and ensuring access to safe water and proper sanitation. The system provides triage for patients at health facilities, clinical manage-

ment, and supportive and nursing care. Isolation facilities are set up in health facilities close to the affected communities to minimize the transfer of patients. Families are briefed on the situation of each patient in isolation on a daily basis, with psychosocial experts counseling patients and their immediate families about the natural progression of the disease and the expected outcomes. Burial teams help to ensure safe burial procedures are being followed; homes and properties are disinfected. Further services include offering psychosocial support to patients and relatives, as well as to health workers to help them avoid burnout and depression.

EMERGENCY WORKFORCE CAPACITY: PREPARING FOR SURGES

Norton's presentation focused on strategies and principles for incorporating global health reserve teams on the ground in times of need. He remarked that surge capacity in public health and clinical response are synergistic and dependent on leadership and coordination by governments. Quality assurance and predictability of surge capacity allows governments and regions to adequately prepare for response; he observed that medical and public health practitioners are only as good as their logistics and operations support mechanisms. Global workforce capacity requires developing national capacities first, he emphasized.

Global Health Emergency Workforce

Turning to the global health reserve teams, Norton commented that response should be predictable, timely, and of appropriate quality to provide support to governments. Existing partnerships require clear mapping and streamlining; response should take into account lessons learned from previous disaster experience to engender an all-hazard approach to emergencies and outbreaks. Both individuals and team formats are required and it is important to understand the effectiveness and value of each. Norton detailed the components of the Global Health Emergency Workforce, comprising national teams (e.g., foreign medical teams [FMTs]); nongovernmental organizations (NGOs) in the form of FMTs as well as through the Global Health Cluster; the Global Outbreak Alert and Response Network (GOARN); the military; and standby partners. The workforce's objective is to support local health services and help them recover after an emergency, and he suggested finding new ways to shift from a "push" to a "pull" model for assistance, i.e., offering to assist countries rather than waiting for them to request help.

He described how FMTs grew out of the response in Haiti, but were not coordinated or organized well; thus, a new standardized classification for FMTs was established. Type 1 (mobile) are mobile outpatient teams that

can access remote areas (capacity: > 50 outpatients per day). Type 1 FMTs (fixed) are outpatient facilities, with or without a tented structure (capacity: greater than 100 outpatients per day). Type 2 FMTs are inpatient facilities with surgery capability (capacity: greater than 100 outpatients per day; 20 inpatients) and Type 3 FMTs are referral-level care with inpatient facilities and surgery (capacity: greater than 100 outpatients per day; 40 inpatients). Specialist cells are teams that can join national facilities or FMTs to provide supplementary care services, including rehabilitation, surgical, pediatric, and infectious disease specialists. Norton explained that FMTs require four capacities for outbreak response: staff, supplies, space, and systems to coordinate. Key facilitating factors include training; logistics supply; pay; medical care, insurance and evacuation; and Ebola treatment unit (ETU) buildings. Quality assurance (QA) is a priority, and he suggested that the new FMT QA system could be a potential model for QA in other non-FMT public health teams even for more routine threats such as tuberculosis in low- and middle-income countries (LMICs).[3]

Norton added that the Global Health Emergency Workforce is part of the reform of WHO and the new Emergency Preparedness and Response Platform, incorporating the expansion of current partnerships such as FMTs and GOARN. He described the unified emergency response program as seeking to build energy by strengthening health systems' resilience and surveillance capacities, developing research and development "blueprints," and offering field support by delivering district teams using logistics arms.

Strengthening Countries' Ability to Receive Support

Enhancing a country's ability to receive international support teams was another topic of discussion. Sarley stated that humanitarian response is important, but if there are robust, resilient, and routine systems in place that integrate all stakeholders, then when experts come in from the outside there is a platform upon which they can work. Rubinson commented that global teams are received by countries but the teams are not always well matched. Appropriate metrics could help to match teams and guide proper responses. He suggested that clinical care, rather than an "afterthought," should reorganize to be featured more prominently in the response model. Norton suggested that domestically, countries could prepare for the arrival of international teams (e.g., by preexercising or pretraining national teams). Granting the license to practice as a team, he suggested, would make it

[3] After being approved for a new user account and submitting an expression of interest, applicants' self-declared information is peer-reviewed by a mentor. The organization is pre-registered and receives a validation site visit; registered organizations then complete a biannual cycle of validation site visits, virtual validation, and deployment validation.

easier for international teams to be welcomed and absorbed effectively. Campbell remarked that to receive an international support team requires a minimum capacity, understanding, and awareness consistent with the WHO International Health Regulations (IHR).

Strategies for Incorporating Clinicians Effectively in Outbreak Response

Rubinson offered a set of strategies for more effectively incorporating clinicians in outbreak response: "Clinical response is not just about bedside providers." He argued for the utility of attempting supportive care, remarking that many diseases are survivable with adequate supportive care, so it is crucial to give clinicians an accurate picture of what they will be doing and any information available about whether their care may be helping. Furthermore, he highlighted the need to establish a number of common scenarios that countries can experience, and plan for how to bring teams in effectively. His first recommendation was that clinicians are much less useful without a systematic clinical strategy. Clinicians need to fit into a system: case finding, community outreach, and ETUs must to work together to be functional. He stressed the need to consider data and analysis as more than merely research but as essential to a meaningful outbreak response, differentiating between data used to study diseases and data employed to become more efficient at care delivery.

He reiterated the need for clinicians to understand how the disease is transmitted in particular health care settings, very early in the disease response, and taking the necessary preventive steps (see Box 5-1). In addition to this, clinicians can often act as a frontline surveillance system and

BOX 5-1
Case Study: Clinical Response to EVD in Sierra Leone

Rubinson shared his experience as a clinician assigned by WHO in 2014 to Kenema Government Hospital, a referral facility for most of Sierra Leone. There was no national or international clinical strategy; scope of care was lacking and there was only limited dissemination of iterative clinical experience. No physicians from Sierra Leone were working in the ETU, and there was no clinical oversight or guidance. He described some of the ways they sought to re-establish goals and objectives of care in the ETU: by transferring patients who did not need to be there; by concentrating on very sick patients in a single ward; and by engaging survivors and people who were less ill in caring for others as additional staff.

SOURCE: Rubinson presentation, August 6, 2015.

become key resources in early detection and response. This incorporation of disease understanding informs a systematic clinical response strategy comprising short-, mid-, and longer-term functional objectives to ensure that care iteratively improves and appropriate metrics are employed to accurately assess status such as critical mortality, preventable deaths, and system stress. An international cohort of out-of-country experts should ideally be available to consult on clinical problems encountered. Further, he highlighted the importance of assessing the course of the disease and anticipating the resources needed (e.g., the appropriate arrangement of clinicians, support staff, and equipment, and early observations regarding predictors of mortality for triage purposes).

Rubinson's next recommendation was that responding clinicians should be practicing clinicians until the response is mature, especially given that the distributions of clinicians is heterogeneous and spread throughout the world. Determining whom to deploy can be a challenge, and decisions need to take into account the basic tools necessary to provide care. Early in the event, though, he advised that those deployed should be seasoned clinicians comfortable with acute care, specialists as needed (such as pediatricians[4]), and mentally and physically fit people who are effective team members.

Rubinson's final recommendation was that clinicians should train and deploy in teams, with organic nonclinical capabilities, rather than operate as a labor pool. Team deployment offers the advantages of coordinated command and control, logistical independence, and enhanced security and safety. It facilitates standardized functional capabilities, and training together fosters familiarity before the team enters a high-stress environment. Norton suggested the benefits of "twinning" Western clinicians so that when they are ready to deploy to the twinned country they are familiar with the available resources and setting-specific needs and can be as effective as possible.[5]

Engaging Community Health Workers in Outbreak Response

Panjabi of Last Mile Health recommended professionalizing community health care workers not only for primary care delivery but also for disease response, branding it as particularly critical in the aforementioned

[4] He advised never turning away pediatricians, because of the impact of disease outbreaks on children in affected communities.

[5] As Norton explained, "twinning" is a process by which doctors in two or more countries train in each other's country to prepare for effective foreign deployment as necessary. Training in another country allows a foreign doctor to understand a country's resources, needs, health system mechanisms, and other elements in order to practice there more effectively. For example, a German clinician may train in Turkey (and vice versa), before deployment to Turkey, allowing him or her to be more effective in practice there.

"blind spots" where zoonoses pandemics can originate and be the most difficult to manage. He described how community health care workers can provide a critical surveillance, preparedness, and response network for epidemics through active case finding, contact tracing, facilitating community trust and education, rapidly identifying and referring patients in need of medical care, and offering prehospital care (Heymann et al., 2015; Ly et al., n.d.; Perry et al., n.d.). Further, they can serve as a link between the community and outbreak response teams, by educating the communities and helping survivors to reintegrate back into their communities. By training them to identify suspected cases, community health workers can then isolate the patient, contact the relevant facility, educate the patient's caregiver, and keep the community calm. Regarding surveillance and preparedness, he suggested identifying the potential role of community health workers in reserve teams, risk stratification, and decentralizing surveillance from the facility to village level in remote areas (Kenny et al., 2015; Tanser et al., 2006). The objective is determining how to integrate these preparedness functions with everyday service delivery.

INCREASING WORKFORCE CAPACITY IN EMERGENCIES: HIGHLIGHTED OPPORTUNITIES

At the root of most of the discussion on workforce capacity was the concept of task shifting or task sharing. Norton characterized task sharing as "an answer for everything" and recommended increasing sectors of the health care workforce other than physicians, who are expensive. This would involve, for example, finding the appropriate ratio of physicians to nurses, or exploring models run by rural nurse practitioners under remote supervision by a doctor with prescribing rights. Discussion of task sharing also touched on the potential for using alternative technologies such as telemedicine or mobile health for rapid response and diagnosis. Another suggestion made by a few participants was the development of a new cadre of health care providers, such as clinical associates. South Africa employs a clinical associate workforce because the need for doctors exceeded their availability. Others suggested recruiting retired health workers to augment capacity during crisis periods, and devising "crash" training programs to be implemented quickly during times of need to bring the workforce up to basic capacity. Nasidi emphasized the importance of a workforce trained and educated in principles of public health, to both regional and global public health, describing them as "foot soldiers" who have responded to outbreaks worldwide and who are critical to building the system.

In his presentation, Norton outlined several types of individual and teams (other than clinical or FMTs) that could contribute to global surge capacity. Public health individual technical experts could be deployed

through WHO's GOARN or other mechanisms, coupled with public health teams from national public health services. Logistics teams could provide services, including operations support, health systems repairs or building, and supply chain assistance. Emergency operatives and managers could offer leadership, coordination, and emergency operations center support.

Nguku and Nasidi of the Nigerian CDC outlined some of the features that underpinned Nigeria's strong EVD response. There was government leadership from the outset through the Nigerian emergency operations center. Community outreach began on the same day as the first diagnosis. There was a comprehensive preparedness plan in place prior to the outbreak, which enabled a rapid response. Multiple sectors were involved, including public–private partnerships. Through Nigeria's Field Epidemiology Laboratory Training Program (FELTP) program, there was a highly skilled workforce immediately available to carry out a full range of surveillance and response activities. Leung remarked that another sector that is usually engaged only at the last minute is the military, suggesting that the military has useful skills and lessons to offer that should be proactively incorporated during times of peace. However, Fallah warned that military involvement can often inhibit a community's response, so caution and balance is warranted.

PLANNING EMERGENCY OPERATIONS STRATEGIES

Hanfling of UPMC's Center for Health Security called for recasting public health to include emergency preparedness and response. This integration would involve thinking about incident management systems with concrete strategies, tactics, and objectives; improvements in public health infrastructure are imperative to achieving this.

Strategic Planning of Operations Around Infectious Disease Outbreaks

Strategic planning of operations around disease outbreaks was a topic of dialogue among participants in the focus area on incorporating global reserve teams on the ground. Campbell reported that participants discussed the importance of the strategic plan being multisectoral, suggesting the integration of clinical care, public health capacity, logistics, information technology (IT), communications, transportation, leadership, traditional healers, NGOs, and civil society. In terms of coordination, he stated that the role of government is central. Operationally, Norton suggested the plan should address the four "Ss" (staff, supplies, space, and systems to coordinate) that are fundamental capacities for FMTs, but often lacking in LMIC health systems—particularly supplies and space. A time-phase resource model would clearly establish the functions that should occur at

which levels at specific times. Partners involved in constructing the plan, reported Campbell, could include (in addition to governments) WHO, United Nations (UN), relevant specialists, academia, and the private sector. Campbell noted that within a country, sufficient national operational capacity and a national emergency operations center are vital resources for constructing the planning of operations.

Campbell emphasized that reinstating national ownership and national decision making in implementing these strategic plans will make a crucial difference in the future in determining when regional or international support is required. Furthermore, understanding how countries formulate, develop, and implement an emergency operations center and coordinate leadership will require actually working through those strategies in practice and in training at the national level. This is how to build the capacities to sustain these systems on a continuing basis. López-Acuña recommended that systems strengthening should be operationalized and supported by concrete performance measurements: rather than referring to "principles, attributes, pillars, or blocks," planning strategies should distill clear definitions of the functions that are actually being performed and monitored by performance metrics.

Nasidi suggested that time to respond could be improved by repurposing existing emergency response systems or mechanisms for other diseases. Analyzing existing systems, mapping mechanisms, and geographic distributions with the view to how they could be utilized for other diseases could lead to having a set of systems based on a single agenda. Sarley noted that a preexisting, resilient eHealth patient tracking system for polio patients in Nigeria was transitioned for tracking patients with EVD. Audesmore of eHealth Africa mentioned that such systems are also in place in Liberia and Nigeria to track vaccinations, which could be suitable for repurposing.

Models of Emergency Preparedness Systems

Hanfling introduced a framework that is applicable across emerging infectious disease outbreaks, and at its foundation are ethical considerations, as well as the legal authority and environment (see Figure 5-4).

Hanfling stressed the importance of situational awareness—"how do we know what we don't know"—in response to an emergency event, which requires implementing a process for identifying those unknowns. While Mexico and the United States had a pandemic influenza plan in place from 2004 to 2006, it was developed for an epidemic coming from a distant location, never assuming it may emerge nearby. Further, there need to be cogent processes in place for identifying the appropriate time to move on to the next level of response; implementing clinical processes and operations; and making mid-course decisions. Many emergency plans can be narrative and

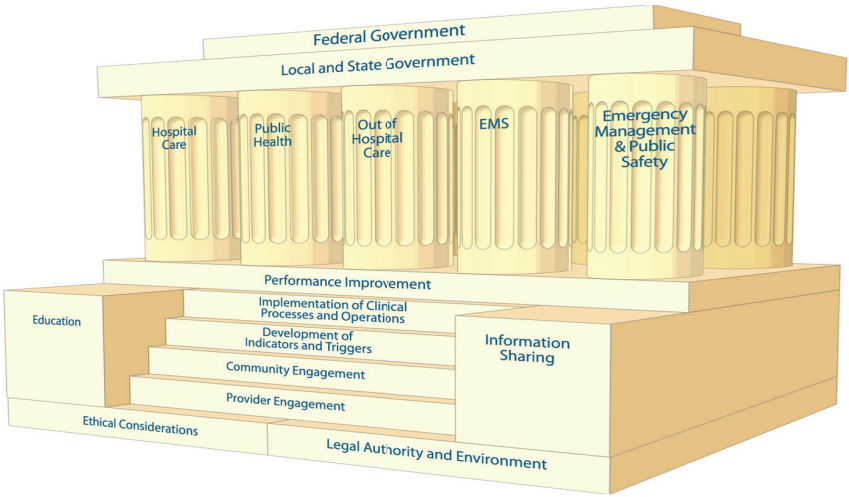

FIGURE 5-4 Conceptualizing a systems framework for catastrophic disaster response.
SOURCE: Hanfling presentation, August 6, 2015.

administratively focused, but adding flexibility and adaptability in terms of operational models can assist in implementing the plan's actions to the specific needs.

Indicators and Triggers

Hanfling explained that determining indicators and triggers for action are what guide decisions about moving on to the next level of response (IOM, 2013). Indicators are measurements, or predictors, of change in demand for health care service delivery or in the availability of resources. "Indicators" should go through a process of analysis or vetting to develop into scripted triggers and tactics that produce outcomes. "Triggers" are decision points that are based on changes in the availability of resources; they need to be adapted to health care services delivery all along the care continuum.[6] According to Hanfling, this requires considering what information about demand and resources is available across the health system, understanding how this information is shared and integrated across stakeholders, determining how this information drives actions, and ultimately

[6] Perl suggested that when dealing with certain pathogens, there can be an element of security that necessitates developing triggers when the good of the people outweighs sovereignty.

deciding what actions might be taken to provide the best health care possible in the particular situation. Many of these indicator measurements could be taken from the various surveillance and information sharing systems described in Chapter 4. The command and control component of the system is tasked with monitoring of indicators and triggers. Hanfling cited and concurred with the recommendation that to facilitate leadership and coordination, "deliberate efforts should be made to identify one agency with the charge to prepare, oversee, coordinate and be accountable for health security actions during a public health emergency" (Salinsky and Gursky, 2006).

Ali Ardalan, Associate Professor and Chair, Disaster and Emergency Health Academy, Tehran University of Medical Sciences, Iran, described the Incident Command System (ICS), a standardized approach to command, control, and coordination that provides a common hierarchy within which responders from multiple agencies can be effective. Its fundamental concepts are unity of command, common terminology, management by objective, span of control, and flexible and modular organization. Structurally, the ICS comprises four subsections: operations, planning, logistics, and finance and administration. Public information officers, safety offers, and liaison officers serve supportive and coordinating functions. He referred to the Infectious Disease Emergency Response Plan in San Francisco[7] and CDC's modified Liberia model (Pillai et al., 2014) as examples of models that are based on the ICS structure; however, he noted as of now, there is no high-level evidence to support or to compare effectiveness and efficiency of different management models for pandemics.

Martineau identified a challenge with respect to the utility of a hierarchical model of control, i.e., the difficulty of communicating certain kinds of insights and information "to the top" in order for effective decisions to be made. He suggested the use of scripted triggers and tactics as well as unscripted ones. Hanfling responded that some "flatter" models do exist, but that they require technology and processes for bringing in information at all levels, synthesizing and analyzing the information, and then using that to influence decisions.

Crisis Management Models in Africa

Hanfling provided an overview of several crisis management models in Africa (Rohwerder, 2015). In 1999, Nigeria created a framework for response at the local, district, and national levels. The framework incorporates an Incident Command System and Emergency Operations Center. He mentioned that in Ethiopia, Kenya, and Niger, the models have a food security focus. Generally, those models involve multiple ministries with different

[7] See http://www.sfcdcp.org/iderplan.html (accessed October 2, 2015).

responsibilities, but limited resources to actually execute their powers. However, he noted that their famine early warning systems serve as good examples of "indicators." Aceng explained that Uganda has created a national response system, with district and subdistrict levels, that promotes an integrated and multisectoral approach aimed toward continually strengthening the system's framework and its institutional capacities.

REGIONAL COOPERATION AND CAPACITY SHARING

To maximize resource and capacity management in the long term, all countries do not need to develop full capacities for every service or function if their neighboring countries in the region have existing systems capable of supplementing and supporting them, both during and between outbreaks. Tomori of the Nigerian Academy of Science called for more sharing through regional bodies and international support to ensure that countries build capacity without duplication. Dovlo of WHO also characterized sharing capacities between countries as critically important. For instance, training capacity in some countries could help to close the gap in training for less developed countries. Norton noted that neighboring countries can make a huge difference in terms of timely response and providing the appropriate context and skills; Myers noted similarly that if medical teams are available and on standby, and if a government can trust that the neighboring assistance will actually arrive, then perhaps countries would not need to build up that capacity themselves, and can focus on endemic issues. Another participant remarked that countries with existing services, such as an established training system, could provide a place for countries without existing services to train. Campbell remarked that every country does not necessarily need to have specialist capacity, for example, if its neighbor has a better resource system and has an existing 10-year capacity that is established. He further called for integrating regional capacity and the global international specialized capacity, rather than treating the latter as an international firefighting brigade or a Special Weapons and Tactics (SWAT) team.

Several participants called for regional and national initiatives for capacity sharing of clinical and public health teams and, more broadly, regionally preparing for response and surge-capacity sharing. Leung spoke to the issue of harmonization in supranational efforts, citing as an example the convergence of a new leadership team in the WHO Regional Office for Africa (WHO-AFRO), the U.S. Secretary of State meeting with the African Union commissioner for an agreement about the African CDC, and the subcontinental regional organizations in Africa. He wondered how those groups will effectively work together, if they do at all, and how any overlaps or gaps will be addressed unless there is proper harmonization among them. In that vein, Kimball recognized the West African Health Organization and the African Union as promoting sharing capabilities.

6

Closing Remarks

In the 21st century alone, outbreaks of infectious disease have cost untold lives, inflicted severe damage on already inadequate health systems and infrastructures, and triggered economic, social, and humanitarian crises on a global scale. This is despite the fact that with adequate resources, our modern-day capacity for care is such that most people with severe infections can be treated and survive—as Fowler and Rubinson both remarked—and healers should not become ill as is so common in low- and middle-income countries (LMICs) during infectious disease outbreaks. This chapter discusses the crucial, moral imperative to take immediate, practical action in implementing solutions to imbue health systems with the strength, resilience, and sustainability to successfully manage, quell, and endure such emergencies.

CROSSCUTTING PRINCIPLES

Various participants highlighted several crosscutting principles that have the potential to meaningfully impact the success of solutions and strategies implemented going forward. Myers of The Rockefeller Foundation summarized principles as applicable to efforts across the board to strengthen health systems and emergency response capacities:

- Strengthen countries' everyday health systems
- Build on existing infrastructures, systems, and capacities
- Capitalize on interoutbreak periods
- Communicate effectively and equitably
- Engage multiple sectors

Integrating International Goals and Capacities

With various global challenges and international agendas occurring, there is a concern that the bandwidth of countries might be stretched too thin, or that some goals or capacities could be diluted in the face of so many. While the core competencies of the International Health Regulations (IHR) were the main focus of this meeting, the new 2015 Sustainable Development Goals (SDGs) have areas of crossover, as well as the new Sendai Framework for Disaster Risk Reduction 2015-2030. Omaswa of the African Centre for Global Health and Social Transformation (ACHEST) acutely pointed out the importance of identifying and highlighting the overlap and intersection of related areas so that players at the country level can synergize to achieve progress instead of worrying about an endless list of goals. While not all in each of the lists may explicitly reference health, López-Acuña commented that an effort is needed to integrate the message of resilient health systems, universal health coverage, SDGs, and even unmet Millennium Development Goals to be able to communicate a single, holistic package to policy makers and ministers of health and finance. In order to do this well, as Myers noted, capitalizing on crosscutting principles such as engaging multiple sectors and building upon existing infrastructures would be tremendous first steps.

STRENGTHENING EVERYDAY HEALTH SYSTEMS IN A COUNTRY

Multiple participants emphasized the importance of bolstering countries' everyday, primary health systems (including essential public health capacities) to strive for universal care delivery. While disease outbreaks and corresponding donor funding often draw focus to the surge capacity needs directly related to that specific disease outbreak, having diverse elements of public health embedded throughout a system during and between outbreaks can often be more effective than simply focusing only on surge elements in times of crisis. Strong day-to-day health systems also have the resilience and flexibility to respond quickly and effectively in situations of disease outbreak or other health emergencies, without compromising their abilities to continue delivering essential primary care and other functions not directly related to the emergency. A key topic of discussion among many participants in the workshop was the need to assist countries in building the core heath capacities that form the foundation of an everyday system that is both resilient and sustainable enough to respond to emergencies.

As described throughout this summary, a resilient health system capable of delivering quality care to its population will need basic infrastructure on which to build—including clean water and sanitation for hospitals and facilities as well as well-designed supply chains where laboratory samples

and supplies can be moved throughout a country, discussed by Rasanathan and Matowe. As Panjabi of Last Mile Health presented, including immunizations and maternal and child health services can be a key part of a primary care platform, and can also be achieved through frontline community health workers. Having these and other workers trained not only in their own disciplines for routine care delivery, but also in basic infection control and prevention practices could also assist in halting outbreaks before they progress too far—as Perl demonstrated with the Middle East respiratory syndrome experience in Saudi Arabia. While building all of these capabilities will not happen overnight, several participants saw ongoing investment in sustainable financing mechanisms as a possible way to achieve that goal. Dovlo of the World Health Organization's Regional Office for Africa (WHO-AFRO) commented that their regional office has been prioritizing the development of coherent and comprehensive national policies encompassing all of these elements for countries. As they get partners to buy in and can complete more analyses, they can work toward a broader approach to universal health coverage, but it will be over the long term. As Anywangwe pointed out, ensuring country autonomy in decision making regarding donor funds will also be essential in ensuring a country's goals are reached and not just the donor's goals. See Box 6-1 for a more detailed list of strong health system components.

AUGMENTING EXISTING CAPABILITIES TO INSTILL RESILIENCE

As Rasanathan of the United Nations Children's Fund stated in Chapter 1, resilience is not useful for its own sake; rather, it is useful because it allows for more effective health care delivery to patients, and it makes the system flexible enough to respond to unexpected health threats. Resilience and sustainability go hand in hand, Myers of Rockefeller explained, and health systems strive for this sustainable capability because that can allow them to function at a high level for everyday needs, as well as address emergencies and events that strain the system. However, as many participants pointed out, while this discussion is logical in an academic sense, it is not a realistic scenario for many health care systems in LMICs. Not having basic equipment such as gloves and other personal protective equipment (PPE), like they lacked at Marie Claire Tchecola's hospital in Guinea, or not having access to clean water as Saran Kaba Jones discussed, can make it extremely difficult to surge capabilities in an emergency. Existing capabilities can be adapted or surged in an emergency, but only if they are adequately funded, operational, and tested in the interepidemic periods. Campbell of WHO summarized the importance of first building a country's basic health capacities, followed by basic public health capacity, and then looking to increase resilient capabilities for outbreak management and

BOX 6-1
Components of a Strong Day-to-Day Health System[a]

During the workshop, several participants cited a range of components that a strong day-to-day health system should feature and that countries seeking to strengthen their health systems should address. These include, but are not limited to:

- Universal access to care, including extremely remote areas or "blindspots" where outbreaks often occur. (Campbell, Panjabi)
- Strong infrastructure to support health, including access to clean water, sanitation, and hygiene (WASH) funding and programs. (Greenough, Jones, Rasanathan)
- Robust primary care platform, including services geared toward maternal and child health, vaccines and immunizations, and integrated mental health care. (Panjabi, Petersen)
- Availability of essential medical supplies and technology, including access to pharmaceuticals. (Matowe)
- Effective infection control and prevention practices that extend to all health care providers, including community health workers and traditional healers. (Anyangwe, Greenough, Fowler, Perl)
- Sufficient laboratory and diagnostic services at local, district, and national levels with capacity for quick response time.
- Health literacy and advocacy. (Lamptey, Petersen)
- Country ownership and autonomy—"home-grown, home-owned" approaches tailored to the country's specific needs and structure. (Fitter, Jones, Myers, Omaswa)
- Compliance with IHR core capacities. (Dovlo, Kimball, Leung, López-Acuña)

[a] This list is the rapporteurs' summary of main topics and recurring components from the presentations, discussions, and summary remarks by the meeting and session chairs. Items on this list should not be construed as reflecting any consensus of the workshop participants or any endorsement by the National Academies of Sciences, Engineering, and Medicine.

emergency response—but the order cannot be altered for the system to function in a sustainable manner.

International Health Regulations Compliance

While having countries achieve the core competencies outlined within IHR would be a progressive step toward realizing stronger global health security, it will require continued dedication, said López-Acuña. One of his 10 elements to build resilient and sustainable health systems was to meet

the core commitments of IHR. He suggested that IHR compliance be more prominently mainstreamed into health systems development frameworks and that currently, Official Development Aid has not sufficiently supported this stream of work. He also called for matching up already existing systems where possible. As an example, any emergency preparedness and response system that is created should be dovetailed with the national structures responsible for IHR (such as the national focal points so strong communication is ensured).

Related to this suggestion and perhaps inherently included were two other elements: Discharge the essential public health functions (EPHFs) and strengthen public health infrastructure. The EPHFs can be helpful in understanding the conditions in each country, and standard performance measures and tools that can be built on and adapted are already in place in some areas. For instance, López-Acuña said, in the Region of the Americas, Pan American Health Organization/WHO and the U.S. Centers for Disease Control and Prevention developed performance standards and indicators for 11 EPHFs that they have used to assess and measure EPHFs in all countries and territories of the Western Hemisphere. However, as stated earlier and throughout this summary, many functions within a health systems are interrelated. López-Acuña noted that the strength of the underlying public health infrastructure will dictate a system's ability to effectively execute the EPHFs. Dedicating resources to a strong infrastructure, especially during the interepidemic period will help to organize the delivery of services during emergencies, he said.

Lessons Learned from Other Countries

Similar to the previous example of performance standards in the Americas, many promising examples were highlighted in this workshop that countries looking to build their health systems could adapt and implement in their own national context. Tomori and Dovlo called for resource sharing regionally and through international support by countries who could not realistically build their own capacity, and would want to avoid duplication when resources are limited. As many have called attention to the lack of resources in many of these countries with fragile health systems, creating redundant systems and capacities in a region would not be efficient. Instead, noted Leung, harmonization should be a goal of international and regional bodies related to response and training needs for specific skillsets related to emergency response.

Integrating donor compliance into country-specific planning was another positive example of creating opportunities for countries to create more sustainable systems. Guhathakurta and Fitter commented on the potential dangers of not enabling long-term and flexible funding mecha-

nisms for countries, creating accidental dependencies and making it difficult to self-regulate at the national level and maintain accountability to all stakeholders, not just donors but citizens as well.

Norton from Australia also suggested the benefits of "twinning" which he noted is a process by which doctors in two or more countries train in each other's country to better prepare for foreign deployment. This method allows foreign doctors to more clearly understand the uniqueness and specifics of a country's health system and available resources before being thrown into the environment during a crisis. Rubinson of the University of Maryland added that these deployments would be of even more benefit when done in a team-based environment. Having the advantages of coordinated command and control and logistical independence can facilitate standardized functional capabilities for each team member, and again should allow them to be more productive when entering a high-stress environment.

Lamptey summarized many of these examples, saying that while this effort in building resilient and sustainable health systems needs to be country-led and country-owned, we cannot forget about the lessons that have been learned already. He referenced Uganda's Ebola experience, Nigeria's CDC, polio eradication efforts, and the response to the HIV epidemic, and commented that pulling the relevant lessons from these case studies and using those as examples for countries to adopt in a full sector-wide response would be a great step in the right direction. Finally, he and López-Acuña synergized their call for accountability to stakeholders. Lamptey explained that in too many instances, recommendations are geared toward the donor community and other members, but in reality these efforts must be led by the countries with governments taking ownership and responsibility. One participant added that the populations of the country in need of problem solving need to be present and have their voices heard when developing solutions, otherwise, who will truly benefit? López-Acuña agreed, saying community engagement in monitoring and evaluation of health system performance is critical. He called for developing more independent accountability and engagement with civil society and academia. In closing, Omaswa of ACHEST cautioned that though ensuring accountability of donors and governments is warranted and needed, without continued drive, interest, and pressure from the people within each country—the health care workers, the patients, the scientists—things may not change. This continued dialogue and invested interest by all sectors needs to continue to truly solve the problems of fragile health systems.

A

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B

Statement of Task

Global Health Risk Framework: Resilient and Sustainable Health Systems to Respond to Global Infectious Disease Outbreaks: A Workshop

An ad hoc committee will plan and conduct a 3-day public workshop that will identify and explore the core capabilities and capacities required across key sectors to build effective, resilient, and sustainable systems that support improved health outcomes in countries across the globe. While all countries are susceptible to new or emerging infectious diseases, especially in focus will be those lacking a strong health infrastructure. The committee will define the specific workshop topics to be addressed, develop the agenda, select and invite speakers, and moderate workshop discussions.

The workshop will examine and define core components and capacity and capability requirements for effective, resilient, adaptive and sustainable health systems. Core capabilities will be explored in the context of ongoing concurrent efforts, including the International Health Regulations, the Post-2015 Hyogo Framework, Global Health Security Agenda, Health in All Policies, and the Sustainable Development Goals. Key measures and indicators for each core component will also be identified. Areas for consideration will include

- **Surveillance and Health Information Systems:** information technology, multifunctional platforms, networks, and related processes to detect, assess, and report potential disease outbreaks and other human and environmental hazards, threats, and risks; risk communication; information and communication portals (both tradi-

tional and nontraditional such as population surveys, community outreach activities and social media).

- **Workforce Capacity:** education and training of a competent workforce of health care and other professionals; strengthening of systems for identification, mobilization, coordination and management of local and regional providers (e.g., health care workers, traditional and faith-based healers), and foreign medical teams (World Health Organization Global Reserve Corps, International Medical Corps, Médecins Sans Frontiéres); workforce care and protection.
- **Health Systems Infrastructure:** physical infrastructure, point of care access (pre-hospital, ambulatory, inpatient); clinical care and other workforce capabilities; outbreak response capacities; public health, laboratory, behavioral health, and social services capacities (including those associated with the International Health Regulations); surge capacity; learning health care system models; infection control practices; fatality management and burial practices.
- **Community, Regional and Global Partner Engagement:** establishing and building community trust and social capital, engagement, and accountability; policies and processes (International Health Partnership principles) for identification, coordination, and management of partners (governmental, nongovernmental, private-sector, faith-based organizations, health sector, and nonhealth sector).
- **Supply Chain Coordination and Management:** medical countermeasure monitoring, distribution, dispensing, and tracking of medical and pharmaceutical products and supplies; monitoring and tracking adverse events, policies and processes for scarce resource allocation; assessment of surge capacity.

A summary of the presentations and discussions at the workshop will be prepared by a designated rapporteur in accordance with institutional guidelines.

C

Agenda

August 5-7, 2015 | La Palm Royal Beach Hotel | Accra, Ghana

WEDNESDAY, AUGUST 5, 2015 (DAY 1)

8:30am-8:50 am Workshop Co-Chairs Welcome

Michael Myers, Managing Director, The Rockefeller Foundation, *Co-Chair, Workshop Planning Committee*

Francis Omaswa, Executive Director of the African Centre for Global Health and Social Transformation (ACHEST), *Co-Chair, Workshop Planning Committee*

Opening Remarks

Aba Bentil Andam, Vice President, Ghana Academy of Arts and Sciences Representative

8:50am-9:10 am Overview of the National Academy of Medicine Global Health Risk Framework Initiative

Patrick Kelley, Director, Board on Global Health, Institute of Medicine, USA

Session I: Opening Plenary: Lessons from a Historical Perspective

Session Moderator: Gabriel Leung, Dean, Li Ka Shing Faculty of Medicine, The University of Hong Kong, *Workshop Planning Committee*

9:10am-10:30am Case Study Panel Presentation

Severe Acute Respiratory Syndrome (SARS)
Rob Fowler, Physician, University of Toronto, Canada

Ebola
Jane Ruth Aceng, Director General of Health Services, Ministry of Health, Kampala, Uganda

Middle East Respiratory Syndrome Coronavirus (MERS-CoV)
Trish M. Perl, Division of Infectious Diseases, Department of Medicine, Johns Hopkins University, USA

10:30am-11:00am BREAK

Session II: Building Health Systems Resilience

Session Moderator: Francis Omaswa, Executive Director of the African Centre for Global Health and Social Transformation (ACHEST), *Co-Chair, Workshop Planning Committee*

11:00am-11:45am Building Sustainable Health Resilience: A Systems Approach

Michael Myers, Managing Director, The Rockefeller Foundation, *Co-Chair, Workshop Planning Committee*

11:45am-12:30pm Discussion with Attendees and Case Study Panelists

12:30pm-1:30pm Lunch (on-site)

Session III: Focus Area Discussions

1:30pm-3:30pm Breakout Discussions by Focus Area

Focus Area 1: Disease Surveillance Systems **Room: Plenary**

Facilitators: David Fitter, Epidemiologist, Emergency Response and Recovery Branch, U.S. Centers for Disease Control and Prevention

Oyewale Tomori, President, Nigerian Academy of Science, *Workshop Planning Committee*

Speaker:

- David Fitter, Epidemiologist, Emergency Response and Recovery Branch, U.S. Centers for Disease Control and Prevention

Focus Area 2: Local and Regional Workforce Capacity **Room: Bugum-2**

Facilitator: Stella Anyangwe, Honorary Professor in Epidemiology at the School of Health Systems and Public Health at the University of Pretoria

Speakers:

- Jim Campbell, Director, Health Workforce, WHO Executive Director, Global Health Workforce Alliance
- Abdulsalami Nasidi, Director General, Nigeria Centre for Disease Control
- Patrick M. Nguku, African Field Epidemiology Network, Nigeria Field Epidemiology and Laboratory Training Program

Focus Area 3: Health Care and Public Health Integration **Room: Odwira**

Facilitator: P. Gregg Greenough, Research Director, Harvard Humanitarian Initiative, Harvard School of Public Health

Speaker:

- Koku Awoonor-Williams, Regional Director of Health Service for the Upper East Region of Ghana

Focus Area 4: Community Engagement **Room: Bugum-1**

Facilitator: Ben Adeiza Adinoyi, Africa Zone Health and Care Coordinator, International Federation of Red Cross and Red Crescent Societies, *Workshop Planning Committee*

Speakers:

- Mosoka Fallah, Co–Principal Investigator: Ebola Natural History Study; U.S.–Liberian Research Partnership/National Institute of Allergy and Infectious Diseases, Liberia
- Janet Nakuti, Senior Program Officer, Monitoring and Documentation, Raising Voices, Kampala, Uganda

3:30pm-4:00pm Break

Session IV: Plenary: Report Out

Session Moderator: Michael Myers, Managing Director, The Rockefeller Foundation, *Co-Chair, Workshop Planning Committee*

4:00pm-4:45pm Report Out by Facilitators

4:45pm-5:30pm Large Group Discussion

5:30pm Adjourn

5:30pm-7:00pm Reception

THURSDAY, AUGUST 6, 2015 (DAY 2)

8:30am-8:45am Welcome

Michael Myers, Managing Director, The Rockefeller Foundation, *Co-Chair, Workshop Planning Committee*

Francis Omaswa, Executive Director of the African Centre for Global Health and Social Transformation (ACHEST), *Co-Chair, Workshop Planning Committee*

Opening Remarks

Delanyo Dovlo, Director, Health Systems and Services Cluster, WHO Africa Regional Office

Session V: Cross-Sector Engagement in Building Systems to Support Health

Session Moderator: Ann Marie Kimball, Associate Fellow, Royal Institute of Foreign Affairs, Chatham House, *Workshop Planning Committee*

8:45am-10:15am Panel Discussion: Cross-Sector Engagement

Panelists:

Public Health:
- Peter Lamptey, Distinguished Scientist and President Emeritus, FHI 360

Mental Health:
- Inge Petersen, Professor of Psychology, University of KwaZulu-Natal, South Africa

Health Care:
- Kumanan Rasanathan, Senior Health Specialist, United Nations Children's Fund

Business/Private Sector:
- Graham Davidson, Managing Director, Simandou Project, Guinea, Rio Tinto
- Nana Yaa Afriyie Ofori-Koree, Foundation and Sustainability Manager, Vodafone Ghana Foundation

Nongovernmental Organization/Civil Society:
- Saran Kaba Jones, Founder and Executive Director, FACEAfrica, Liberia

10:15am-10:45am Break

10:45am-11:45am Discussion with Attendees: Reaction to Panel Discussion

11:45am-12:45pm Lunch (on-site)

Session VI: Focus Area Discussions

12:45pm-3:15pm Breakout Discussions by Focus Area

Focus Area 1: Health Information Systems **Room: Bugum-2**

Facilitator: Paul Biondich, Research Scientist, Regenstrief Institute, Inc.

Speakers:
- Kate Wilson, Director of Digital Health Solutions, PATH, USA

Focus Area 2: Incorporating Global Reserve Teams on the Ground **Room: Bugum-1**

Facilitator: Jim Campbell, Director, Health Workforce, WHO Executive Director, Global Health Workforce Alliance

Speakers:
- Ian Norton, Foreign Medical Teams Working Group, WHO, Australia
- Lewis Rubinson, Director, Critical Care Resuscitation Unit, University of Maryland, USA

Focus Area 3: Health Care Delivery and Supply Chain **Room: Odwira**

Facilitator: David Sarley, Senior Program Officer, The Bill & Melinda Gates Foundation

Speakers:
- Lloyd Matowe, Director, Pharmaceutical Systems Africa
- Raj Panjabi, CEO, Last Mile Health, Liberia

Focus Area 4: Leadership and Management **Room: Plenary**

Facilitator: Dan Hanfling, Contributing Scholar, University of Pittsburgh Medical Center, USA

Speaker:
- Ali Ardalan, Associate Professor and Chair, Disaster and Emergency Health Academy, Tehran University of Medical Sciences, Iran

3:15pm-3:30pm Break

Session VII: Plenary: Report Out

Session Moderator: Francis Omaswa, Executive Director of the African Centre for Global Health and Social Transformation (ACHEST), *Co-Chair, Workshop Planning Committee*

3:30pm-4:30pm Report Out by Facilitators

4:30pm-5:15pm Large Group Discussion

5:15pm Adjourn

FRIDAY, AUGUST 7, 2015 (DAY 3)

9:00am-9:15am Welcome

Michael Myers, Managing Director, The Rockefeller Foundation, *Co-Chair, Workshop Planning Committee*

Francis Omaswa, Executive Director of the African Centre for Global Health and Social Transformation (ACHEST), *Co-Chair, Workshop Planning Committee*

Session VIII: Synthesizing Components to Build Resilient Health Systems
Session Moderators: Michael Myers, Managing Director, The Rockefeller Foundation, *Co-Chair, Workshop Planning Committee*; Francis Omaswa, Executive Director of the African Centre for Global Health and Social Transformation (ACHEST), *Co-Chair, Workshop Planning Committee*

9:15am-9:45am Building Integrated, Sustainable, and Resilient Health Systems-Reflections from the Workshop Planning Committee

Planning Committee Panelists

- Ben Adeiza Adinoyi
- Aba Bentil Andam
- David Fitter
- Ann-Marie Kimball

9:45am-10:15am Discussion with Attendees

10:15am-10:30am Break

10:30am-11:30am Building Integrated, Sustainable, and Resilient Health Systems—A Reaction Panel

Panelists:

- Peter Lamptey, President Emeritus/Distinguished Scientist, FHI 360
- Raphael Frankfurter, Executive Director, Wellbody Alliance
- Delanyo Dovlo, Director, Health Systems and Services Cluster, WHO Regional Office for Africa
- Daniel López-Acuña, Former Director for Recovery and Transition, Cluster of Health Action in Crisis, World Health Organization
- Marie Claire Tchecola, Nurse, Donka Hospital, Conakry, Guinea (Translation by Pascale Krumm, Health Communications Office, U.S. Centers for Disease Control and Prevention)

11:30am-12:00pm Wrap Up and Discussion with Attendees

12:00pm Closing Remarks

Patrick Kelley, Director, Board on Global Health, Institute of Medicine, USA

Michael Myers, Managing Director, The Rockefeller Foundation, *Co-Chair, Workshop Planning Committee*

Francis Omaswa, Executive Director of the African Centre for Global Health and Social Transformation (ACHEST), *Co-Chair, Workshop Planning Committee*

12:15pm Workshop Adjourned

D

Speaker Biographies

Jane Ruth Aceng, MBCHB, MMed, MPH, is the Director General Health Services at the Ministry of Health in Uganda. Dr. Aceng holds a bachelor's degree in Medicine (MBChB), MMed (Pediatrics), and a Master's of Public Health. She is a pediatrics expert at the level of a senior consultant. Dr. Aceng has vast experience both as a manager and a practicing medical consultant, which she accumulated while serving in various capacities as Senior Medical Officer, Medical Officer Special Grade, Medical Superintendent, Consultant Pediatrician, Senior Consultant Pediatrician, Hospital Director, and currently as the Director General Health Services. As the Director General Health Services, she is responsible for coordinating technical functions for the delivery of health services, a role she fulfills through the directorates of clinical and community services and planning and development.

Ben Adeiza Adinoyi, MCCB, MA, MSc, is currently the Health and Care Coordinator Africa for the International Federation of Red Cross and Red Crescent Societies (IFRC) in Nairobi, Kenya, a position he has held since 2012. In this capacity he facilitates the development of an Africa-wide health strategy and ensures health-related operations and programs are implemented in strict compliance with technical guidelines, procedures, and methods. He promotes the development of cross-country cooperation and represents the Africa zone in the health management forum on an international level. His previous roles in IFRC included working as the Emergency Health Delegate for Africa, and the Regional Health and Care Manager for the West Coast IFRC office, and serving as the Regional HIV/AIDS officer for the West Coast Office. Prior to joining the IFRC, he had roles as the

Head of the Department of Pediatrics at Centre Hospitalier Departmental in Benin, Resident Doctor of the Kogi State Diagnostic and Reference Hospital in Anyigba, Resident Doctor of the Ahmadu Bello University Teaching Hospital in Kaduna, and as an Intern Medical Officer at the Kaduna Armed Forces Reference Hospital.

Aba Bentil Andam, PhD, MS, is a Ghanaian particle physicist and current Vice President of Sciences at the Ghana Academy of Arts and Sciences. She earned a degree at the University of Cape Coast in Ghana. She sought further education in Britain where she earned a master's degree from the University of Birmingham and a PhD from Durham University. In 1986 and 1987 she studied charmed mesons at the German research station DESY (Deutsches Elektronen-Synchrotron). Her research centered on radon and she surveyed human exposure levels of the radioactive gas in Ghana. Beginning in 1987, she participated in educational clinics at secondary schools promoting women in the sciences. Dr. Andam has been a professor at the Kwame Nkrumah University of Science and Technology since 1981. She has headed the physics department since the mid-2000s. She conducts research in applied nuclear physics at Kumasi's Nuclear Research Laboratory. She has served as chair of the Women in Science and Technology in Africa's West African region.

Stella Anyangwe, MD, PhD, is an Honorary Professor of Epidemiology at the School of Health Systems and Public Health (SHSPH), University of Pretoria, South Africa, and is trained as a physician (MD) and Epidemiologist (PhD). Dr. Anyangwe retired from the World Health Organization in 2013 after 17 years of service, during which she was WHO Country Representative (WR) in Mali, the Seychelles, South Africa, and Zambia between 1998 and 2011. Her last assignment for WHO was as Programme Area Coordinator for Disaster Preparedness and Response in the African Region. Since joining the University of Pretoria's SHSPH in September 2014, Dr. Anyangwe's focus has been on disaster risk management (DRM) and how it relates to global health, and especially on the training of all health workers in DRM for health.

Ali Ardalan, MD, PhD, is a pioneer in disaster risk management in Iran and the Middle East and the North Africa region who was the driving force behind the creation of MPH and PhD training programs in disaster health studies. He is an Associate Professor and Director of Disaster and Emergency Health Academy at Tehran University of Medical Sciences, an Adviser to the Deputy Minister of Health, and Director of the Disaster Risk Management Office at I.R. Iran Ministry of Health and Medical Education. He is also a non-United Nations member of the UN's Disaster Management

Team in Iran. Dr. Ardalan serves WHO-Eastern Mediterranean Region as a temporary advisor, and collaborates with WHO/Geneva on advocacy of "disaster risk reduction for health" and "hospitals safe from disasters" in line with post-2015 framework for disaster risk reduction (DRR). Since 2012, he is a Visiting Scientist at the Department of Global Health and Population at Harvard School of Public Health, and a Senior Fellow at the Harvard Humanitarian Initiative. Dr. Ardalan is an International Board of Global Network of Disaster Reduction (GNDR) member where he represents the Central Asia region. He was a nominee for the 2015 United Nations Sasakawa Award. Dr. Ardalan is author and co-author of more than 70 articles in English and Persian peer-reviewed journals and has contributed in the 2009 United Nations Office for Disaster Risk Reduction Global Assessment Report and the 2013 International Federation of Red Cross and Red Crescent Societies World Disasters Report. He was a guest researcher at the Karolinska Institute, and remains an active contributor to the Disaster Supercourse based at the University of Pittsburgh.

Koku Awoonor-Williams, MD, MPP, MPH, is a clinician and public health consultant. He is the Regional Director of Health Service for the Upper East Region of Ghana. For decades, Dr. Awoonor-Williams worked at several levels of Ghana's health system and for decades was District Director of Health Services in the Nkwanta District of Ghana where he implemented several health systems innovations aim to bring health services closer to the doorsteps of communities. He has also served as the National Coordinator of the Ghana Community-based Health Planning and Services (CHPS) Programme. He is currently Chair of the Navrongo Health Research Centre Ethics Review Board, Co–Principal Investigator of Ghana Mobile Technology for Community Health (MoTeCH) Project and a contributor to several other local and international health programs and initiatives and a member of Governing Board of Global Doctors for Choice (GDC). He is Co-PI of the Ghana Essential Health Intervention Program (GEHIP), a collaborating scientist of Averting Maternal Death and Disability (AMDD) Project of Columbia University Mailman School of Public Health and a founding faculty of Advancing Reproductive and Community Health Systems (ARCHeS), a program of the Heilbrunn Department of Population and Family Health (HDPFH), Mailman School of Public Health, Columbia University.

Paul Biondich, MD, is a senior medical informatics researcher and pediatrician whose research interests include informatics interventions in resource-constrained environments, decision support systems and open communities of practice. He is the co-founder and leader of OpenMRS, an open source medical record system platform to support underserved populations, which

is currently deployed in more than 80 countries throughout the world. He is also very active in international health information architecture development efforts, both through his leadership of a World Health Organization (WHO) Collaborating Centre in Medical Informatics, and in the formation of a new adaptive technical assistance community that supports national planning and implementation of health information sharing architectures (OpenHIE). In his leadership role of the Global Health Informatics program at the Regenstrief Institute, he participates in a wide variety of strategically important research and development health informatics initiatives for the President's Emergency Plan for AIDS Relief (PEPFAR), The Bill & Melinda Gates Foundation, U.S. Centers for Disease Control and Prevention (CDC), U.S. Agency for International Development (USAID), WHO, and Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ).

Jim Campbell, PhD, MPH, MSc, is the Director of the Health Workforce Department at the World Health Organization (WHO) and the Executive Director of the Global Health Workforce Alliance (GHWA). Prior to taking on this role in July 2014, Dr. Campbell was the Director of the Instituto de Cooperación Social Integrare (ICS Integrare), a not-for-profit research institute in Barcelona, Spain, where he worked for 8 years. He has worked as a specialist researcher/advisor on Human Resources for Health for governments, United Nations agencies, and philanthropic foundations, including WHO, GHWA, United Nations Population Fund (UNFPA), World Bank, UK Department for International Development (DFID), North American Aerospace Defense Command (NORAD), and The Bill & Melinda Gates Foundation. Examples of this work include the Global Code of Practice on the International Recruitment of Health Personnel (2010), WHO policy recommendations on "Increasing access to health workers in remote and rural areas through improved retention" (2010), "A Universal Truth: No Health Without a Workforce" published at the Third Global Forum on Human Resources for Health in Recife, Brazil (2013), and the State of the World's Midwifery 2014 report.

Graham Davidson, PGD, is currently the Managing Director for the Simandou project of Rio Tinto located in Guinea, West Africa. He was appointed to this role on September 12, 2011, and is based in Conakry. Mr. Davidson joined the mining industry in 1986 and has continued his involvement in mining through to today. He has been with Rio Tinto for 25 years and was previously Chief Executive Officer of Port Waratah Coal Services based in Newcastle, Australia.

Delanyo Dovlo, MBCHB, MPH, MWACP, is Director of the Health Systems and Services Cluster at the World Health Organization (WHO) Regional

Office for Africa (AFRO). He was previously WHO Representative to Rwanda and before that, a Health Systems Adviser at WHO headquarters. He is a public health physician from Ghana with more than 30 years of clinical practice and public health experience. A former director of Human Resources Development in Ghana's Ministry of Health during the country's health sector reforms in the 1990s, he has been a consultant in the area of human resources for health (HRH), on health systems, and on health sector reforms. Dr. Dovlo has an MBCHB from the University of Ghana, an MPH from University of Leeds, United Kingdom, and a Membership of the West Africa College of Physicians (MWACP). He is a Fellow of the Ghana College of Physicians & Surgeons. Dr. Dovlo was a member of the *Joint Learning Initiative*, a global HRH review in 2004 and was lead author of its Africa report, contributing to its global report, *Human Resources for Health: Overcoming the Crisis* (2004). He has served on the External Advisory Group on HRH for WHO-HQ in 2004, and chaired the WHO AFRO Multi-Disciplinary Advisory Group on Human Resources for Health 2004-2005. He was also on the Health Advisory Group of the Untied Nations Global Commission on International Migration and has published on the migration of health workers, medical education, and management systems in health.

Mosoka P. Fallah, PhD, MPH, MA, is a public health consultant and was recently made a Visiting Scientist in the Department of Global Health and Population at the Harvard T.H. Chan School of Public Health. He has recently been made the Principal Investigator for the largest cohort study on Ebola survivors in Liberia. During the Ebola crisis in Liberia he served as the Head of Case Detection in the Montseraddo Incident Management System administering critical aspects of Liberia's Ebola response. In this capacity he has been providing technical support to the Montserrado County Health Team since the inception of the Ebola epidemic. Dr. Fallah provides training for surveillance, contact tracing, case management, and community mobilization. He was instrumental in developing training workshops for health workers across the national response. In particular, Dr. Fallah recently led contact-tracing efforts to contain the St. Paul Bridge Cluster, a 22-case Ebola viral disease (EVD) cluster between December 2014 and February 2015 that may be one of the last active lines of transmission in Liberia. He is a member of the Harvard–London School of Hygiene & Tropical Medicine Independent Panel on the Global Response to Ebola, which includes Peter Piot, the co-discoverer of Ebola, Chelsea Clinton, and Julio Frenk, Dean of the Harvard T.H. Chan School of Public Health. Previously, Dr. Fallah provided extensive consultancies in the areas of social science, public health, biomedical and translational research at top-tier universities in the United States and in Liberia. He has experience

in international development work including serving as a consultant on a U.S. Agency for International Development (USAID)-funded project with Indiana University and the Liberia Ministry of Health and Social Welfare to develop a program for the training of mid-level public health staff. Many of the students from his program are currently leading major Ebola response efforts throughout Liberia in surveillance and contact tracing. He has worked extensively with the Ministry of Health and Social Welfare of Liberia, medical centers, and other nonprofit organizations to initiate this flagship program in Liberia. Dr. Fallah received his Doctor of Philosophy in Microbiology, Immunology, and Molecular Genetics from the University of Kentucky College of Medicine (2011); a Master of Public Health from the Harvard T.H. Chan School of Public Health (2012); a Master of Arts in Evaluation and Measurement from Kent State University (2006); and a Bachelor of Science in Chemistry/Biology from the University of Liberia (2001). Dr. Fallah was a highlighted recipient of *Time Magazine*'s Person of the Year in 2014 as an Ebola fighter.

David Fitter, MD, is a medical epidemiologist with the U.S. Centers for Disease Control and Prevention (CDC). He is currently with the Emergency Response and Recovery Branch, where he works on health systems. He has worked in multiple settings, including Haiti, Kenya, and Turkey. Most recently he worked on the Ebola response in Guinea. Dr. Fitter earned his medical degree from the University of Chicago.

Rob Fowler, MD, MDCM, MSc, is critical care physician and Associate Professor of Medicine at the University of Toronto and Director of Research for the Department Medicine at Sunnybrook Health Sciences Centre, Canada's busiest trauma-critical care hospital. He received his medical degree at McGill University, his residency training at the University of Toronto, and completed a critical care fellowship and clinical epidemiology training at Stanford University. He is also an Adjunct Scientist at the Ontario Institute for Clinical Evaluative Sciences and the Associate Program Director for the Dalla Lana School of Public Health's Institute of Health Policy, Management and Evaluation. He is a past Clinician-Scientist of the Ontario Ministry of Health and Long-Term Care and a current Clinician-Scientist of the Heart and Stroke Foundation. Dr. Fowler's clinical and academic interests include the access and outcomes of care for critically ill patients in the global context. He has investigated differential use of critical care resources according to gender, age, insurance status, and where people live in the world. His work has also highlighted how selective patient exclusion in clinical research leads to deceased generalizability of all our findings. He has studied international differences in end-of-life care as a Commonwealth Fund Harkness Fellow. During the 2003 severe acute respiratory

syndrome (SARS) epidemic, he helped to provide the first descriptions of critically ill patients and modes of disease transmission. Working with colleagues throughout North America, Asia, Europe, and Australia during the 2009-2010 influenza pandemic, he facilitated international research programs to study clinical characteristics, treatments, and outcomes of patients with H1N1-related critical illness. In 2013-2015, working with the World Health Organization (WHO), he assisted in establishing a clinical research program for Middle East respiratory syndrome (MERS) with colleagues in the Kingdom of Saudi Arabia and is a clinical lead for WHO in the West Africa Ebola virus disease outbreak.

Raphael Frankfurter, BA, is the Executive Director of Wellbody Alliance, a health care organization in Kono District, Sierra Leone. Wellbody advances the right to health and saves lives by operating a comprehensive medical center for the poorest Sierra Leoneans and community health worker systems in partnership with the public health care system. Wellbody has worked in collaboration with Partners in Health through the Ebola outbreak, and Mr. Frankfurter has served as Partners In Health (PIH)–Sierra Leone's Strategic Advisor for Community Health to develop community health worker programs linked to the network of Ebola Care Centers that PIH/Wellbody has been running across the country. Mr. Frankfurter studied anthropology and global health at Princeton University, and prior to assuming his position conducted extensive ethnographic research in Kono District.

P. Gregg Greenough, MD, MPH, has worked extensively in applying epidemiologic methods to public health problems within conflict- and disaster-affected populations. After graduating from the Case Western Reserve University School of Medicine (1989), he completed a residency and fellowship in Emergency Medicine at the University of California, Los Angeles (UCLA) (1997) and earned an MPH at Johns Hopkins University (1998). Dr. Greenough has worked in relief operations in the Balkans, Central America, Africa, the United States, the Palestinian Territories, and Haiti. While on faculty at Johns Hopkins University Center for Refugee and Disaster Response, he directed two national nutrition and food security studies of the West Bank and Gaza Strip and evaluated refugee health programs in Colombia, Kenya, and Tanzania and disaster preparedness in Tanzania. Since 2005, he has been the Research Director of the Harvard Humanitarian Initiative (HHI) at Harvard University, providing senior leadership in establishing the Initiative's research agenda, designing and implementing field studies, supervising the analysis of data, interpreting analyses to relevant humanitarian stakeholders, and teaching field research methods. His field studies have included the burden of disease in the Hur-

ricane Katrina displaced population; the effects of landmines on human security in Angola and Lebanon; evaluating the use of open platforms and mapping in Colombia; public health surveillance in Ethiopia, India, and Zimbabwe; and gender-based health outcomes from recent conflicts in Central African Republic, Darfur, and Syria. He holds faculty appointments at Harvard Medical School and the Harvard School of Public Health, is a fellow at the François-Xavier Bagnoud Center for Health & Human Rights, and attends in the Department of Emergency Medicine at Brigham & Women's Hospital.

Margaret Gyapong, PhD, MSc, is currently Deputy Director for Research and Development in charge of the Dodowa Health Research Centre. In the past 22 years, she has contributed to the setup of the Lymphatic Filariasis Control Program in Ghana, building research capacity for district and regional health management teams, started and continues to maintain a Health and Demographic Surveillance System in the Dodowa Health Research Centre. The center collaborates with multiple organizations on various projects. In addition she has served on a number of task forces and committees of the World Health Organization (WHO) and the Task Force for Global Health in Atlanta, Georgia and is the lead author and facilitator of the recently launched WHO's Special Programme for Research and Training in Tropical Diseases (TDR) toolkit on Implementation Research. She joined the School of Public Health of the University of Ghana as an adjunct faculty member in 2000 and set up the Master's Program in Applied Health Social Science. In addition she has held adjunct professorial appointments with Brunel University and is currently an adjunct professor at the Georgetown University where she is also a preceptor of their international health program.

Dan Hanfling, MD, is a consultant on emergency preparedness, response, and crisis management. He is a Contributing Scholar at the UPMC Center for Health Security, Clinical Professor of Emergency Medicine at George Washington University and adjunct faculty at the George Mason University School of Public Policy. He currently serves as the co-chair of the National Academies of Sciences, Engineering, and Medicine Forum on Medical and Public Health Preparedness for Catastrophic Events. His areas of expertise include biodefense and mass casualty management, catastrophic disaster response planning with particular emphasis on scarce resource allocation, and the nexus between health care system planning and emergency management. In addition to his hospital and emergency medical services (EMS) clinical responsibilities, he serves as a Medical Team Manager for the Fairfax County–based Federal Emergency Management Agency (FEMA) and U.S. Agency for International Development (USAID) sanctioned inter-

national urban search and rescue team (VATF-1, USA-1), and has responded to catastrophic disaster events across the globe.

Saran Kaba Jones, BA, is the Founder and CEO of FACEAfrica, a community development organization working to strengthen water, sanitation, and hygiene (WASH) infrastructure and services in rural communities across sub-Saharan Africa. Ms. Jones was born in Liberia but left in 1989 at the young age of 8, shortly before the country's civil war began. The daughter of a career diplomat, Saran spent her formative years living in Cote d'Ivoire, Cyprus, Egypt, and France before moving to the United States in 1999. She returned to Liberia almost 20 years later to find a country in desperate need and made it her mission to help, specifically focused on access to safe drinking water and sanitation and empowering women and girls through education and skills training. Since launching FACEAfrica in January 2009, the organization has raised more than $600,000 from JP Morgan Chase, Coca Cola, the Voss Foundation, Procter & Gamble, Chevron, and the Robert Bosch Foundation, among others; built more than 50 WASH projects and reached 25,000 people in rural Liberia. More recently, FACEAfrica was at the forefront of Ebola response efforts in Rivercess County, Liberia, where they conducted social mobilization, prevention and awareness and community engagement programs. Ms. Jones is a board member of the United Nations Women Civil Society Advisory Group West/Central Africa and a 2013 World Economic Forum Young Global Leader. She was listed by the *Guardian United Kingdom* as one of Africa's 25 Top Women Achievers alongside President Joyce Banda of Malawi and Nobel Laureate Leymah Gbowee. In 2012, she received the Longines/*Town&Country* Women Who Make A Difference Award for her work with FACEAfrica, and earlier that year she was listed by *Black Enterprise* as one of 10 International Women of Power to Watch and by *Daily Muse* as one of 12 Women to Watch. In 2011, Ms. Jones received the Applause Africa Person of the Year Award and was the Voss Foundation's Women Helping Women Honoree. She was also a *Huffington Post* Greatest Person of the Day, and listed as one of *Forbes* Magazine's 20 Youngest Power Women in Africa. Ms. Jones is a frequent speaker on topics including water and sanitation, entrepreneurship, and gender equality and has served on panels at the World Economic Forum, Harvard University, Massachusetts Institute of Technology (MIT), the London School of Economics, the African Union, and the U.S. Department of State. Her work with FACEAfrica has been profiled extensively by *Forbes*, *The Boston Globe*, BBC *Focus on Africa*, *Town&Country*, and CNN. Prior to launching FACEAfrica, Ms. Jones worked as an Investment Project Manager for the Singapore Economic Development Board.

Patrick W. Kelley, MD, DrPH, joined the National Academies of Sciences, Engineering, and Medicine in July 2003 as the Director of the Board on Global Health. He has subsequently also been appointed the Director of the Board on African Science Academy Development. Dr. Kelley has overseen a portfolio of expert consensus studies and convening activities on subjects as wide ranging as: the evaluation of the U.S. President's Emergency Plan for AIDS Relief (PEPFAR), the U.S. commitment to global health, sustainable surveillance for zoonotic infections, cardiovascular disease prevention in low- and middle-income countries, interpersonal violence prevention in low- and middle-income countries, and microbial threats to health. He also directs a unique capacity-building effort, the African Science Academy Development Initiative, which over 10 years aims to strengthen the capacity of eight African academies to provide independent, evidence-based advice their governments on scientific matters. Prior to joining the Academies, Dr. Kelley served in the U.S. Army for more than 23 years as a physician, residency director, epidemiologist, and program manager. In his last U.S. Department of Defense (DoD) position, Dr. Kelley founded and directed the DoD Global Emerging Infections Surveillance and Response System (DoD-GEIS). This responsibility entailed managing surveillance and capacity-building partnerships with numerous elements of the federal government and with health ministries in more than 45 developing countries. He also founded the DoD Accession Medical Standards Analysis and Research Activity. Dr. Kelley is an experienced communicator having lectured in English or Spanish in more than 20 countries. He has published more than 70 scholarly papers, book chapters, and monographs. Dr. Kelley obtained his MD from the University of Virginia and his DrPH in epidemiology from the Johns Hopkins School of Hygiene and Public Health. He is also board certified in Preventive Medicine and Public Health.

Ann Marie Kimball, MD, MPH, FACPM, is a physician and epidemiologist. Currently she is serving as Associate Fellow with Chatham House where she is leading a Rockefeller investment on resilience in post-Ebola surveillance and health systems. Prior to joining Chatham, she served as Technical and Strategic Lead for The Bill & Melinda Gates Foundation Surveillance Strategy Formation. This 3-year process resulted in the first approved surveillance strategy in the history of that Foundation. Prior to her recruitment as Senior Program Officer, Surveillance and Epidemiology for the Foundation she served as Professor of Epidemiology for the University of Washington (UW) School of Public Health with adjunct appointments in Medicine (Bioinformatics and Infectious Diseases) and the Jackson School of Foreign Affairs. She attended clinically at Harborview Medical Center. She is emerita at this time. During her tenure at UW, Dr. Kimball founded

and directed the Asia-Pacific Economic Cooperation (APEC) Emerging Infections Network, and led research and training programs in surveillance and informatics in Peru and Thailand. Her research focus on global trade and emerging infections earned her a Fulbright New Century Scholars award and a Guggenheim Scholars award. She is the author of *Risky Trade: Infectious Diseases in an Era of Global Trade* (Ashgate 2006), which was highly reviewed by the *New England Journal of Medicine*, *Emerging Infections,* and *Lancet*. She has authored numerous scientific publications, and served on numerous National Academies of Sciences, Engineering, and Medicine panels. Most recently she led The Rockefeller Foundation evaluation of their global Disease Surveillance Network portfolio. She is a fellow in the American College of Preventive Medicine and member of the National Biosurveillance Advisory Committee (NBAS) from the U.S. Centers for Disease Control and Prevention (CDC). A former Epidemic Intelligence Service (EIS) Officer for the CDC in Atlanta, prior to joining UW she worked and lived in Ivory Coast, Senegal, and the Yemen Arab Republic. She served as Director of National Program Support for the Pan American Health Organization, directing the elaboration and implementation of medium-term AIDS plans in member countries throughout Latin America and the Caribbean. She has served as Director of HIV/AIDS for Washington State, and the founding Chair of the National Alliance of State and Territorial AIDS Directors (NASTAD) in the United States.

Pascale Krumm, PhD, MA, is a health communications specialist and the speechwriter for the director of the U.S. Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia. She has been with CDC for 15 years. Before joining CDC, she was a college professor for 10 years. Dr. Krumm has extensive experience in global public health. Her areas of expertise are risk communication and scientific communication, and she has taught courses in scientific communication in CDC's programs around the world. Since 2014, Dr. Krumm has been deployed to Guinea, Mali, and Sierra Leone to serve as CDC team lead for health communication in the Ebola response. Dr. Krumm is originally from Strasbourg, France.

Peter Lamptey, MD, DrPH, MPH, is a Distinguished Scientist/President, Emeritus at FHI 360 and Co-Chair of the FHI 360 Advisory Board. He is based in Accra, Ghana, but provides technical and strategic leadership to FHI 360's public and development programs, including communicable and noncommunicable diseases (NCDs), and in integrated multisectoral development interventions in more than 65 countries in Africa, Asia, Latin America, and the Caribbean. Dr. Lamptey also holds a part-time position as Professor of Global Non-Communicable Diseases at the London School of Hygiene & Tropical Medicine with joint appointments in the Faculty

of Epidemiology and Population Health and the Faculty of Public Health and Policy. Dr. Lamptey is an internationally recognized public health physician and expert in developing countries, with particular emphasis on communicable and noncommunicable diseases. With a career at FHI 360 spanning more than 30 years, Dr. Lamptey has been instrumental in establishing FHI 360 as one of the world's leading international nongovernmental organizations in implementing HIV/AIDS prevention, care, treatment, and support programs. His experience in HIV/AIDS efforts internationally includes collaboration with the World Bank to design and monitor the China Health IX HIV/AIDS Project. From 1987 to 2007, he directed three major USAID-funded HIV/AIDS Projects: The 5-year AIDS Technical Project (AIDSTECH), the 5-year AIDS Care and Prevention Project (AIDSCAP) and the 10-year Implementing AIDS Prevention and Care (IMPACT) project that encompassed HIV/AIDS programs in Africa, Asia, Latin America, the Caribbean, Eastern Europe, and the Middle East. He received his medical degree from the University of Ghana, and advanced public health education in the United States, including an MPH from UCLA, a DrPH from the Harvard School of Public Health, and a nutrition fellowship at the Massachusetts Institute of Technology. Dr. Lamptey serves on the Lancet Commission on the Future Health of Africa, the Africa Tobacco Control Committee, Global Advisory Group for the new London School of Hygiene & Tropical Medicine (LSHTM) Centre for Global NCDs, and a member of the CSIS Commission on Smart Global Health Policy.

Gabriel Leung, MD, MPH, became the 40th Dean of the Li Ka Shing Faculty of Medicine at The University of Hong Kong in 2013. Dr. Leung, a clinician and a respected public health authority, concurrently holds the Chair of Public Health Medicine. Previously he was Professor and Head of Community Medicine at the University and served as Hong Kong's first Under Secretary for Food and Health and fifth Director of the Chief Executive's Office in government. Leung is one of Asia's leading epidemiologists, having authored more than 350 scholarly papers and edited numerous journals. His research defined the epidemiology of two novel viral epidemics, namely severe acute respiratory syndrome (SARS) in 2003 and influenza A (H7N9) in 2013. While in government, he led Hong Kong's policy response against the 2009 influenza A (H1N1) pandemic. Dr. Leung currently directs the World Health Organization (WHO) Collaborating Centre for Infectious Disease Epidemiology and Control. He was inaugural Chair of the Asia Pacific Observatory on Health Systems and Policies during 2010-2014. He regularly advises national and international agencies, including WHO, World Bank, Asian Development Bank, and the Chinese Center for Disease Control and Prevention.

Daniel López-Acuña, MD, MPH, is a Spanish and Mexican national. He graduated as Medical Doctor (MD) at the National Autonomous University of Mexico in 1978 and specialized in Public Health and Health Systems at Johns Hopkins University between 1979 and 1983, where he obtained his MPH degree. Dr. López-Acuña worked over a period of 30 years for the Pan American Health Organization and the World Health Organization (WHO) in Washington, DC, and Geneva, respectively. He served there as Director of Health Systems, Director of Program Management, Director of Recovery and Transition in the Cluster of Health Action in Crisis, Advisor to the Director General for the WHO Reform, and Director of Country Cooperation and Collaboration with the United Nations System. He retired from WHO in December 2014 and he is now an independent health systems, public health, and development cooperation consultant based in Gijon, Spain. He is the author of many books and articles in the fields of health policy, health systems, humanitarian health response, public health, and development cooperation.

Lloyd Matowe, PhD, MSc, is the Director of Pharmaceutical Systems Africa (PSA). PSA is an international health organization providing consulting services to developing countries to strengthen pharmaceutical supply chains and to address systems and management challenges. PSA has presence in the United States, Liberia, Nigeria, Uganda, Tanzania, and Zambia. Dr. Matowe has vast experience strengthening the pharmaceutical value chain systems in Africa, having worked in more than 23 countries in Africa on the matter. Previously he has worked with the Global Fund in Geneva and Management Sciences for Health, and as a consultant on pharmacy systems for organizations such as Supply Chain Management System (SCMS), World Health Organization (WHO), the East African Community, the Southern African Development Community, PATH, and USAID, among other organizations. Dr. Matowe is active in academia being on staff at the University of Iowa School of Pharmacy, at Kwame Nkrumah University of Science and Technology School of Pharmacy in Ghana, at Makerere University in Uganda, and at the University of Liberia. Dr. Matowe has published widely in the field of public health pharmaceutical systems and has given in excess of 100 talks in more than 30 countries on pharmacy and supply systems strengthening. Dr. Matowe holds a PhD in Health Systems Implementation from the University of Aberdeen in the United Kingdom, a Master's degree in Clinical Pharmacology from the same institution, and a Bachelor of Pharmacy Degree from the University of Zimbabwe. He has received several awards for services to the pharmacy profession, including recognition by the government of Liberia for resuscitating the training of pharmacists in the country after the war. He is currently leading training

efforts in Liberia aimed at pharmacy and supply chain management after the Ebola epidemic.

Michael Myers, MA, performs a number of leadership roles at The Rockefeller Foundation. He leads the Foundation's global health work including its Transforming Health Systems initiative and the campaign for universal health coverage. He also coordinates strategies for the Foundation's work in the United States with a focus on building inclusive economies in cities. Mr. Myers joined The Rockefeller Foundation in 2010 and led the organization's successful centennial program, which included an array of global activities to build on past successes and to help shape the Foundation's future direction. Prior to coming to The Rockefeller Foundation, Mr. Myers served in leadership capacities in the U.S. Senate for much of his career, including chief counsel and staff director to the late Senator Edward M. Kennedy. He worked on a range of issues, including health care, employment, economic development, refugees, immigration, and education. Before his career in government, Mr. Myers worked on refugee and international humanitarian matters for nongovernmental organizations and the United Nations High Commissioner for Refugees. Mr. Myers holds both a bachelor's and a master's degree in political science from Columbia University.

Janet Nakuti, MA, PGD, is a Senior Program Officer responsible for Monitoring and Learning at Raising Voices in Kampala, Uganda since 2007. Over the years, she has developed substantial experience working to promote the rights of children and women in communities and specifically engaging communities to create social norm change to prevent violence against women and children. Ms. Nakuti coordinated large randomized controlled trials (RCTs) with SASA! and the Good Schools Methodologies in Uganda and engaged in rigorous and intensive operations research for the RCTs. She has assembled and managed several teams, and provided guidance to various partners using SASA! in Botswana, Burundi, Ethiopia, Kenya, Malawi, South Sudan, Tanzania, and Uganda. She has co-authored several publications around violence prevention. Before Raising Voices, Ms. Nakuti worked with Save the Children Norway in Uganda, UPHOLD, a USAID-funded project, WHO, Creative Research and Evaluation Centre, Ministry of Health, and Makerere University in Kampala. She is currently serving as a member of the Board on Community Health Alliance Uganda and Amber House, and also serves on the Advisory Board of Friends of Canon Gideon Foundation (FOCAGIFO).

Abdul Nasidi, PhD, MSc, is a doctor with 40 years of experience. He obtained a Master's in epidemiology in 1979 and a PhD in virology in 1983,

and worked as surgeon and subsequently transferred into public health in 1983. Dr. Nasidi worked as a scientific officer from 1980 to 1986, when he was appointed as Nigeria's Chief Epidemiologist. He became Director Public Health in 1991 at the Federal Ministry of Health from where he retired in 2008. He was appointed to serve as Special Technical Adviser to the Minister of Health and in 2010 was recalled by the government to establish the Nigeria Centre for Disease Control. He received a national honor of the Officer of the Order of the Niger (OON) in 2002. In 2014 he was appointed the Director, Chief Executive Officer by the President of Nigeria.

Patrick Mboya Nguku, MD, PGD, a medical epidemiologist by training, currently serves as the Resident Advisor of Nigeria Field Epidemiology and Laboratory Training Program (FELTP) (www.nigeria-feltp.net) and has been since October 2008. He received his medical degree and postgraduate diploma in HIV management from University of Nairobi in 2000 and 2003, respectively. He received his FELTP training from the Kenya FELTP between 2004 and 2006. He served as National Coordinator of Surveillance and Response in Kenya in 2006-2008 and was instrumental to the Integrated Disease Surveillance and Response (IDSR) scale up and response to a multi-country Rift Valley fever outbreak, among others. He also served in the multi-agency response to the Ebola outbreak in Uganda in 2007 and Nigeria in 2014. He has conducted trainings and supported public health workforce development and surveillance system strengthening activities in multiple countries.

Ian Norton, MD, is an emergency physician with post graduate qualifications in Surgery, International Health, and Tropical Medicine. Dr. Norton works for the World Health Organization headquarters in Geneva heading the new Foreign Medical Team Unit. Previously the Director of Disaster Preparedness and Response at the National Critical Care and Trauma Response Centre, Darwin, Australia, he led key developments in the Australian Medical Assistance Team (AUSMAT) initiative, in particular an innovative training program for disaster response teams, and a fully self-sufficient capability for international field hospital deployment for the Australian government. He has led the Australian government medical team deployments to the Ashmore reef boat explosion, Pakistan floods, Solomon Islands Dengue outbreak and Typhoon Haiyan in the Philippines, including a 50-bedded surgical field hospital and tertiary referral trauma center for Tacloban city within days of the storm. He is the lead author of the new World Health Organization (WHO) global classification and standards for Foreign Medical Team (FMT) deployment to sudden onset disasters which led to his appointment to WHO. In that role he leads the development of a global registry of FMTs and the increasing role of WHO in their quality

assurance and coordination. He was deployed for more than 5 months to the 2014 West African Ebola outbreak and led the coordination of more than 60 FMTs in 3 countries and the design and construction of 5 large Ebola treatment centers in Monrovia, along with plans for building by the United Kingdom, United States, and World Food Program (WFP) in the 3 worst-affected countries. He led the coordination of 132 FMTs in Nepal during the earthquakes of April and May 2015. Lessons learned during these recent responses for a rapid and predictable international health response to all-hazards will reshape the FMT initiative along with the mechanisms of emergency health response within WHO, and is integral to the future of Dr. Norton's portfolio at WHO.

Afriyie Ofori-Koree, MSc, is an astute transformational leader with an educational background in natural resources management and public health. She has more than 10 years of experience in developing and delivering international and local programs across various development sectors both in the public and private sector. She has experience in the oil and gas, local government, international development, and telecommunications sectors. She is currently working as the Foundation and Sustainability Manager for Vodafone Foundation Ghana to improve general public health by leveraging on the resources in the telecommunication sector.

Francis Omaswa, MBBCh, MMed, FRCS, FCS (ECSA), is the Executive Director of the African Center for Global Health and Social Transformation (ACHEST), Chancellor of Busitema University in Uganda, Chair of the African Platform for Human Resources for Health, and Co-Chair of the Global Policy Council on Health Worker Migration. He was the founding Executive Director of the Global Health Workforce Alliance, Director General of Health Services in the Ministry of Health in Uganda, founding Director of the Uganda Heart Institute, founding Chair of the Global Stop TB Partnership Board, Chair of the Portfolio and Procurement Committee of the Global Fund, and Chair of the Independent Review Committee of GAVI. He has a keen interest in leadership and governance of health and in access of the poor to health care and spent 5 years testing models for this at the rural Ngora Mission Hospital in Uganda. Dr. Omaswa is a graduate of Makerere Medical School, founding President of the College of Surgeons of East Central and Southern Africa, Fellow of the Royal College of Surgeons of Edinburgh and the New York Academy of Medicine, Senior Associate at the Johns Hopkins Bloomberg School of Public Health, and Foreign Associate of the Institute of Medicine of the National Academies of Sciences, Engineering, and Medicine. He has recently published two books: *African Health Leaders: Making Change and Claiming the Future* and *Handbook for Health Ministers*.

Raj Panjabi, MD, MPH, is Co-Founder and CEO of Last Mile Health, Instructor in Medicine at Harvard Medical School, and Associate Physician in the Division of Global Health Equity at Brigham and Women's Hospital. At age 9, Dr. Panjabi escaped a civil war in his home country of Liberia. He returned as a 24-year-old medical student to serve the people he had left behind, co-founding Last Mile Health, a Liberia- and Boston-based nonprofit organization working to save lives in the world's most remote villages. Described by *Forbes* as "a healthcare model for 1 billion people," Last Mile Health employs village health workers—giving them the training, equipment, and support they need to perform as community health professionals. Their work has been published in the *Lancet*, the *Journal of the American Medical Association*, and *PLoS Medicine,* and has been featured by the *Wall Street Journal, NPR,* and the *New York Times*. In 2015, *Fortune Magazine* named Dr. Panjabi 1 of the World's 50 Greatest Leaders. Dr. Panjabi is a Forbes 400 Philanthropy Fellow, a Draper Richards Kaplan Foundation Social Entrepreneur, an Echoing Green Fellow, and a Clinton Global Initiative Advisor. He is a recipient of the Outstanding Recent Alumni Award from Johns Hopkins, the Distinguished Young Alumni Award from the University of North Carolina, and the Global Citizen Movement Award. Dr. Panjabi received his medical and public health training at the University of North Carolina School of Medicine, Johns Hopkins Bloomberg School of Public Health, Massachusetts General Hospital, and Harvard Medical School.

Trish M. Perl, MD, MSc, is a Professor of Medicine in the Infectious Diseases Division at Johns Hopkins University and the Senior Epidemiologist for Johns Hopkins Medicine and has an interest in the epidemiology of risk factors for the development and transmission of *Staphylococcus aureus*, influenza, Middle East respiratory syndrome (MERS) and other emerging infections and their prevention and control. Her expertise and research interests predominately involve reducing the risk of transmission of organisms to patients and health care workers, and surveillance for organisms that cause harm to humans.

Inge Petersen, PhD, MSc, is a Professor of Psychology at the University of KwaZulu-Natal, South Africa. She has played a leading role in three multinational research consortiums concerned with strengthening mental health services in low- and middle-income countries (LMICs), namely the Mental Health and Poverty Project, the Programme for Improving Mental Health Care (PRIME), and Emerging Mental Health Systems in Low- and Middle-Income Countries (EMERALD). She has developed a body of work over the past decade focused on strengthening the evidence for the integration of mental health into primary health care as well as using implementation

science to understand how to strengthen health systems to enable scaled up integrated mental health care. Dr. Petersen is currently a Principal Investigator for PRIME in South Africa, a work package lead for EMERALD and a Principal Investigator of the COBALT (Comorbid Affective Disorders, AIDS/HIV, and Long Term Health) trial investigating the health impact of integrated mental health care on HIV-infected patients on anti-retroviral treatment. Further, she is also well-known for her work in the field of mental health promotion and has specifically been involved in trials focused on family strengthening to promote resilience in vulnerable youth.

Kumanan Rasanathan, MD, is a public health physician currently working as a Senior Health Specialist for the United Nations Children's Fund (UNICEF) in New York. He leads or has led work at UNICEF on health in the post-2015 development agenda, social determinants of child health, district health system strengthening, integrated community case management policy, universal health coverage, and implementation research on maternal and child health service delivery. Before arriving at UNICEF, Dr. Rasanathan worked at the World Health Organization in Geneva on social determinants of health and primary health care. Prior to this, Dr. Rasanathan worked in a number of different countries as a clinician, researcher, policymaker, and program manager in clinical practice, vaccine clinical trials, primary health care, national health policy, and reducing inequities in maternal and child health.

Lewis Rubinson, MD, PhD, FCCP, is Associate Professor of Medicine at University of Maryland School of Medicine and Director of the Critical Care Resuscitation Unit at the R. Adams Cowley Shock Trauma Center. Prior to joining the University of Maryland, Dr. Rubinson was the Acting Chief Medical Officer of the National Disaster Medical System (NDMS) in the Office of Emergency Management within the Office of the Assistant Secretary for Preparedness and Response in the U.S. Department of Health and Human Services (HHS). He served as the federal Chief Marketing Officer in the HHS Secretary's Operation Center for recent major events such as Superstorm Sandy, the 2013 Presidential Inauguration, and the Democratic and Republican National Conventions. Dr. Rubinson has deployed on numerous occasions for NDMS as a front-line clinician and as the medical lead for the Incident Response Coordination Team. Dr. Rubinson is also a leader in mass critical care preparedness and has published and lectured extensively on mass casualty mechanical ventilation. In addition, Dr. Rubinson has been an international proponent and leader for establishing systems and processes to ensure clinical learning during public health emergencies. Dr. Rubinson was the U.S. Department of Health and Human Services lead for the largest critical care registry established during the 2009 influenza

pandemic. He is currently the co-chairperson of the Steering Committee for the United States Critical Illness and Injury Trials Group Program for Emergency Preparedness. Dr. Rubinson was a clinician-consultant for the World Health Organization and the clinical lead at Kenema Government Hospital in Sierra Leone in September 2014.

David Sarley, PGD, BSc, has worked for 13 years in public health supply chain management, 10 years with John Snow, Inc. (JSI), and 3 at The Bill & Melinda Gates Foundation. He currently manages several vaccine delivery supply chain investments in Nigeria, Ethiopia, and Benin as well several global integrated delivery and family planning supply chain investments. Mr. Sarley is also leading the Integrated Delivery Supply Chain strategy definition. At JSI he held several positions in the USAID DELIVER PROJECT, including Director of Public Health Supply Chain work. He also led work on supply chain costing. Prior to JSI Mr. Sarley worked in economics consultancy for 16 years in trade, transport, finance, and health economics. He was a volunteer with Voluntary Service Overseas and started his career for Ford in inventory management. He has a degree in Econometrics from Hull University and a Post Graduate Diploma from Southampton University. He has worked in more than 80 countries doing short-term economics and public health consulting and management assignments.

Marie Claire Tchecola, BSN, is an emergency room nurse from Guinea. During the Ebola epidemic in West Africa, countless health care workers put themselves in harm's way to help control the disease and provide care and comfort for those sick with Ebola. She was recognized by the U.S. Department of State in March as a 2015 International Women of Courage awardee, along with nine other women from around the world. The award honors women who have shown exceptional courage and leadership in advocating for human rights, women's equality, and social progress—often at personal risk. Ms. Tchecola grew up in a small Guinean village. She is the first woman in her family to receive an education. She could have been a doctor but chose nursing, "because you can affect more people." Because only the doctors at Donka Hospital–Conakry, Guinea's largest hospital, were supplied with gloves, Ms. Tchecola was exposed to the Ebola virus while treating a patient in July 2014. Once she identified her own symptoms, she quickly checked herself into an Ebola treatment unit to avoid spreading the disease to other patients and to protect her colleagues. In addition to fighting the disease itself, Ms. Tchecola continues to battle the stigma she experienced during and after her illness. She and her two daughters—one who is deaf from a childhood seizure—were evicted by her landlord and thrown out on the street. She has since returned to Donka Hospital to continue her work as an emergency room

nurse, which includes triaging and testing patients who may have Ebola. Ms. Tchecola continues to raise awareness and foster hope about surviving Ebola. She also advocates for other public health priorities, like vaccines for childhood diseases, and urges potential patients to visit hospitals for medical care.

Oyewale Tomori, DVM, PhD, FASTMH, is currently President, Nigerian Academy of Science. He was pioneer Vice-Chancellor at the Redeemer's University, Nigeria. He is a recipient of the Nigerian National Order of Merit (NNOM), Nigeria's highest award for academic and intellectual attainment. At the University of Ibadan, Nigeria, where he was Professor of Virology, he led research into the study of viral infections, and elucidated the properties of Orungo virus, registered with the International Committee on Taxonomy of Viruses (ICTV). In 1981, he received the U.S. Public Health Service Certificate for contribution to Lassa Fever research. At the World Health Organization (WHO) Regional Office for Africa as Regional Virologist from 1994-2004, he set up the African Regional Polio Laboratory Network, which provided laboratory diagnostic support for polio eradication, and became the forerunner of other regional diagnostic laboratory networks for other diseases. He has been involved in the investigations of outbreaks of viral hemorrhagic fevers (yellow fever, Ebola virus disease, etc.) and infections in many African countries. Dr. Tomori serves on several national and international advisory bodies, including the Nigeria Expert Review Committee (ERC) on Poliomyelitis Eradication and Routine Immunization; Nigeria National Task Force on Epidemic Diseases; Expert Working Group (EWG) for the Development of National Laboratory Services Policy; Judging Panel Bill Gates Nigeria Governors' Immunization Leadership Challenge; WHO Advisory Committee on Variola Virus Research; Co-Chairman, African Science Academy Development Initiative (ASADI)/National Academy of Sciences (USNAS)/Network of African Science Academies (NASAC) African Tobacco Control Committee (ATCC); Co-Chairman, African Science Academies' Study Team on Country Ownership of Africa's Development Post 2015 plan on millennium development goals (MDGs). He is a senior editor of *African Journal of Laboratory Medicine*. He has served as member of the U.S. Institute of Medicine (IOM) Committee on Sustainable Global Surveillance of Zoonotic Diseases; IOM Committee on Identifying and Prioritizing New Preventive Vaccines for Development; WHO Strategic Advisory Group of Experts (SAGE); and Co-Chairman, ASADI/USNAS/NASAC African Tobacco Control Committee (ATCC).

Kate Wilson, MA, MBA, is Director, Digital Health Solutions, PATH. Ms. Wilson has been advising companies on market entry strategies for digital

solutions in emerging markets for more than 25 years with experience in international commercial and nongovernmental organizations. Ms. Wilson co-founded PATH's Digital Health Solutions group in 2009 based on a belief that information and communication technology were the next essential health tool that could change decades long paradigms of poor health services delivery in the developing world. Ms. Wilson leads a global team supporting PATH's work in health information systems analysis, design and delivery. She has led PATH programs and initiatives in Asia and Africa covering areas as diverse as delivery of improved data systems and use for immunization services to the design of appropriate health information systems for universal health coverage.