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Emergency Preparedness and Public Health Systems Lessons for Developing Countries

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Abstract: Low- and middle-income countries, where emerging diseases often make their debut, are also likely to bear the harshest consequences of a potential influenza pandemic. Yet public health systems in developing countries are underfunded, understaffed, and in many cases struggling to deal with the existing burden of disease. As a result, developed countries are beginning to expand assistance for emergency preparedness to the developing world. Given developing countries' weak infrastructure and many competing public health priorities, it is not clear how to best direct these resources. Evidence from the U.S. and other developed countries suggests that some investments in bioterror and pandemic emergency preparedness, although initially implemented as vertical programs, have the potential to strengthen the general public health infrastructure. This experience may hold some lessons for how global funds for emergency preparedness could be invested in developing countries to support struggling public health systems in responding to current health priorities as well as potential future public health threats.

(*Am J Prev Med* 2008;34(6):529–534) © 2008 American Journal of Preventive Medicine

Introduction

Improving the capacity of developing countries to respond to emerging diseases and especially influenza pandemics is essential to reduce both transmission around the globe and the human toll of outbreaks in the developing world. Investing in this capacity in developing countries is thus increasingly seen as a shared concern within the global community. As a result multilateral and bilateral donors committed a total of US\$582 million in loans and grants to buttress the response capacity of developing and middle-income countries.¹ While there is broad agreement on the need for additional funding, there is less clarity on how the funds should be spent. Although the developed world has invested its bioterror- and pandemic-preparedness dollars and euros into building highly specialized emergency-response capacity, it is not clear whether this could or should be replicated in the developing world, where public health infrastructure is weak due to years of underinvestment and where there are urgent, competing public health priorities that by necessity take center stage.²

This article examines the value of a multiple-use approach to emergency preparedness in the develop-

ing world—one that aims to build capacity for both emergency preparedness and current core public health activities. Such an approach could offer developing countries an opportunity to strengthen their public health system platforms, allowing them to respond to multiple priority diseases rather than creating specialized programs that will likely be difficult to sustain in the longer term. First, it reviews evidence from developed countries on the impacts of emergency preparedness for bioterrorism and pandemic influenza—which require similar public health system responses—on public health departments and the overall public health system, focusing on investments proven to have substantial collateral impacts on other public health activities. It then explores how similar multiple-use investments could be made in the developing world.

Background

There is growing concern that the world is facing an influenza pandemic caused by a mutated avian virus. In 2003/2004, an outbreak of the H5N1 subtype of influenza A killed or caused the destruction of 150 million birds in Asia—the largest such outbreak in history. Two hundred and five people were infected with an overall case fatality rate of 56%.^{3,4} If H5N1 or a similar virus improves the efficiency of its human-to-human transmission, such an outbreak could precipitate a major global pandemic.¹ Globally, other emerging diseases, such as Ebola, Marburg; drug-resistant tuberculosis (TB); and others are also on the rise.⁵ Jungles and other ecosystems in low- and middle-income countries

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have frequently been the source of emerging diseases. The Ebola, Marburg and Lassa hemorrhagic fever viruses, as well as the virus responsible for Rift Valley Fever, are native to Africa.⁶ H5N1 influenza spread from migratory birds in Asia to birds in Africa and Europe in 1996—a path that could be followed by a more lethal human form of the virus.⁷

At the same time, the public health infrastructures in developing countries that must contain these new threats are weak and stretched thin with the current disease burden. Indeed, health systems in the lowest-income countries suffer from insufficient health system funding, large shortages of health workers, and dilapidated infrastructure, particularly in rural areas.^{8,9} In 2003, for example, 34 of the 46 countries in the WHO African region spent less than US\$34 per capita on health, the minimum amount recommended by the Commission on Macroeconomics and Health, with 29 of the countries spending US\$20 or less.^{8,10} As a result, many countries struggle to provide routine immunization and healthcare services for common disorders, much less offer routine surveillance of influenza-type illness.

Recent experience with emerging diseases suggests that weak outbreak notification and containment may lead to high mortality and morbidity.⁶ In the 2000–2001 Ebola outbreaks in Uganda, a lack of gloves, masks, and gowns, as well as inconsistent sterilization in hospitals, increased the rates of transmission of the disease to healthcare workers and other patients.¹¹ People who become infected often have higher fatality rates because supportive or curative treatment is not routinely available, and a lack of information about disease transmission may delay the seeking of treatment.⁵

The link between poverty and high epidemic mortality is confirmed by historic experience. Vital registry data from the influenza epidemic of 1918, which likewise may have originated in birds, showed a 30-fold difference in mortality rates between some of the most- and least-developed regions of the world; this is thought to be due in large part to the effects of poverty, including the lack of supportive care, as well as poor nutrition and high levels of comorbidity.^{12,13} While experts note that even in the U.S. a major influenza epidemic would likely overwhelm the public health capacity, epidemiologic modeling suggests that if a global influenza pandemic similar to that of 1918 were to have happened in 2004, 96% of the deaths globally would have been in developing countries, with 59% in sub-Saharan Africa and South Asia, two of the world's poorest regions.^{12,14,15} The mortality rate would be 1.6% in sub-Saharan Africa and South Asia versus 0.2% in the wealthy countries belonging to the Organization for Economic Co-operation and Development (OECD).¹²

Preparedness and Public Health Systems in the Developed World

The 2001 terrorist attacks on the World Trade Center and the subsequent release of anthrax shocked the U.S. into taking stock of the emergency response capacity of its public health systems. Significant additional funding to strengthen this capacity followed. In the U.S., the biodefense preparedness budget increased from \$294 million in 2001 to \$3 billion in the next year and to \$5.2 billion in 2004. Of the funds committed since 2001, \$3.6 billion was spent on state, local, and hospital preparedness, representing a substantial infusion of new money into public health systems that had seen little new funding in the preceding decade.¹⁶ At the same time, the European Union (EU) established the Health Security Committee to develop a health information system, EU-wide surveillance, a database of the medicines stock, a facility to disseminate medicines and specialists, and health-specific protocols for a coordinated EU response to an attack.¹⁷

By 2006 a growing concern about the possibility of pandemic influenza of avian origin in the U.S. led to an infusion of another \$3.8 billion into preparedness activities.¹⁸ The bulk of preparedness budgets in the U.S. was allocated to a range of related health activities intended to respond to acts of bioterror, emerging infectious diseases, and later pandemic influenza. Bioterror and pandemic preparedness investments included the upgrading of disease surveillance, hospital capacity to handle mass casualties, patient isolation systems, laboratory diagnostics for new biologic agents, and the enhancement of command and control structures as well as communication among health and emergency services agencies.¹⁹

Public health officials became concerned that the singular focus on new threats might overshadow the traditional activities of public health departments and hospitals and weaken their ability to tackle existing challenges.^{20–23} Among the negative effects observed was the diversion of staff in hospitals and public health departments from routine activities to meetings and training sessions on preparedness, and reduced attention to nonbioterror-related concerns. Implementing new preparedness activities while maintaining ongoing activities proved to be a challenge.^{20,24} For example, the program to vaccinate health workers against smallpox—one of the most prominent bioterror-preparedness activities—caused many health departments to defer or cancel other core public health activities, because of the burden of program work and the required monitoring for adverse effects.^{17,25} While infectious disease response may have received a boost from preparedness funding, chronic disease programs lost ground because of the diversion of managers' attention.^{20–22}

However, not all preparedness funding was earmarked restrictively, and health managers were able

Table 1. Selected multiple-use preparedness investments and activities in developing countries

| Area | Sample investments and activities |
|----------------------------|---|
| Laboratories | National research laboratories (e.g., Pasteur Institutes) Diagnostic technology transfer between developed and developing countries Multifunctional district-level laboratories National laboratory policies and action plans |
| Health information systems | Vital registries Cause-of-death training and reporting Health information system strategic plans |
| Human resources | Demographic surveillance systems Training of epidemiologists, health economists, biostatisticians Training of health managers and planners Salary support for public health workers Paid community health workers connected to health systems |
| Communication | Improved community health education materials Websites for public health messages Spokespeople for public health information Development of locally-relevant information channels (e.g., radio, plays) |

to direct some of the preparedness funding to investments such as infrastructure—human resources and communication—which proved to have multiple uses.^{19,21} As described below, these investments were found to improve both the general functioning of public health departments and hospitals and their ability to handle traditional health threats (Table 1).

Infrastructure (Laboratories and Health Information Systems)

Investments in communications, lab capacity, and epidemiologic tools had application to bioterror and pandemic influenza as well as to the broader health system. Examples of such multiple-use investments included radio systems, new computer equipment, improved hospital isolation facilities, and online alert networks.^{20,21,24} There were also improvements in laboratory capacity to handle a variety of biological agents, both bioterror-related and other.²⁴ Web-based health information networks that were put in place in response to the 2001 terror attacks, such as New York's health emergency response data system, have been used since to monitor infectious disease outbreaks, track health facility assets, and run simulation exercises.^{20,26} Syndromic surveillance, a computerized notification system for patterns of symptoms suggestive of an infectious disease outbreak, was successfully used for nonbioterror diseases in New York City (influenza,

rotavirus).²⁷ Telephone-based syndromic surveillance, using existing telephone health information lines, is being developed in Canada and the United Kingdom (UK).^{28,29} In Europe, France's Institut de Veille Sanitaire (Institute for Public Health Surveillance), whose mandate was expanded in 2004 in the wake of the European terrorist attacks, collects health information on infectious and other diseases from regional networks and communicates it to the National Ministry of Health and European partners, such as the European Early Warning and Response System (EWRS).³⁰ This infrastructure has had synergies for pandemic influenza preparedness, as the EWRS in turn has been used to focus the EU's response to severe acute respiratory syndrome (SARS) and avian influenza cases in Europe.³¹

Human Resources

Funding for public health human resource development has risen dramatically in the U.S., from under \$1 million in 1997 to \$100 million in 2003, in large part buoyed by bioterrorism grants.³² New staff hired with bioterror funds include preparedness coordinators who have helped to bring a new organizational skill-set to public health departments.²⁰ Newly hired epidemiologists and statisticians have helped to bolster overall public health surveillance and planning.²⁴ New training requirements for emergency preparedness have also provided opportunities to re-examine and update preservice and inservice training curricula for public health workers.³³ One important concern raised by public health managers is the sustainability of the funding.²¹

Communication

New technologies have strengthened the communication links between facilities (hospitals, laboratories) and public health agencies that were leveraged for broader data-sharing.²⁰ Similarly, communication among levels of government improved through the systems developed for emergency preparedness.²¹ Such partnerships have improved coordination among the various actors in responding, for example, to a mass blackout in Cleveland, a TB outbreak in Virginia, and a series of hurricanes in Miami.^{24,34} Public communication also benefited, both through the efforts of the newly hired risk-communication personnel and as a result of heightened public attention to the work of public health agencies.

Implications for Public Health Systems in Developing Countries

This experience with health system preparedness in the U.S. and Europe may offer insight into which investments may be particularly useful in improving the capacity of

developing countries to respond to emergencies while strengthening their basic public health systems.

Infrastructure

Laboratories. Functional laboratories—well-equipped, -supplied, and -staffed—are essential to delivering quality routine health services and to responding to public health emergencies. Yet in the developing world, even basic laboratory facilities that, according to the WHO, should be able to perform malaria microscopic evaluation and hemoglobin, HIV, and glucose testing are scarce. This is compounded by a lack of diagnostic equipment and trained technicians, weak monitoring, and inconsistent or absent standards for laboratory testing.^{35–37} Ministries of Health are often unaware of the actual (as opposed to “on paper”) functionality of a given laboratory or hospital, making response planning difficult.^{38,39} Laboratory-medicine experts have called for major investment in African laboratories, exhorting donors to build within, rather than circumvent the existing laboratory infrastructure to avoid the creation of redundant parallel systems.³⁵ While governments recognize the need for investments in laboratories in principle—74% of African countries have a national laboratory policy—these plans have not materialized in many countries, due in part to shortages of financial and human resources.⁴⁰

A promising example of the development of laboratory infrastructure is the Pasteur Institutes, a network of research laboratories in 30 developing countries, including some of the poorest countries in Africa: Central African Republic, Senegal, Côte d’Ivoire, Niger, Cameroon, and Madagascar. The Institutes conduct research on locally prevalent infectious diseases, train local scientists, and facilitate technology transfer in laboratory medicine.^{41–45} The international community’s focus on AIDS has brought substantial new resources to developing countries, particularly in Africa, and this has also translated into better laboratory capacity. Thus, 90% of African countries responding to a WHO survey reported that they now have the capacity to screen for HIV antibodies at the district level.⁴⁰ New investments could expand these laboratories’ capacity to diagnose other infectious diseases.

Health information systems. Effective surveillance systems are essential to identifying potential outbreaks. While establishing real-time virologic or syndromic surveillance should not be a priority in developing countries, investing in well-functioning health information systems that can be used to communicate epidemiologic as well as administrative data in a timely manner—from the lowest level of the health system to the central ministry of health—is a shared priority area for health system development and emergency preparedness. The need for better health data is great: The

WHO estimates that it receives accurate cause-of-death statistics from only 31 of its 193 member states.⁴⁶

As a result, the WHO has launched a global partnership for improved health information systems, the Health Metrics Network. This network supports developing countries in assessing their health information systems and improving their coverage of vital registration, as well as providing training on international health information standards (e.g., ICD classification). Cambodia, for example, is working with the Health Metrics Network and the Japanese International Cooperation Agency to scan and analyze 11 million birth and death records and to conduct a national census that will, for the first time, include information about mortality and causes of death.⁴⁷ Countries such as Sierra Leone are undertaking the assessment of health information systems and making 10-year strategic plans for improvement.⁴⁸ Health information systems could also be used to gather information on the actual (rather than planned) functionality of health posts, centers, and hospitals that would be valuable for a wide range of health planning activities.

Linking community-level clinics with the health information system would dramatically expand the usefulness of the system for both routine and outbreak epidemiology. As experience has shown with the Demographic Surveillance Systems (DSS) in Bangladesh and in several African countries, with adequate investment it is possible to obtain near real-time information on a community’s burden of disease and causes of death in low-income settings.^{49–51} Such systems can provide important information on the prevalence and seasonality of diarrheal illness and on the routine causes of death.^{52,53} Finally, basic information systems need not be expensive. Experience from Tanzania suggests that collecting data on 38 sociodemographic and health indicators (via the census and DSS) costs approximately \$0.53 per capita, per year.⁵⁴

Human Resources

Human resource shortages have been called one of the most pressing problems in the health systems of the developing world today.^{9,55,56} While shortages of clinical staff have received the most attention, there are similar or worse shortfalls in public health personnel.^{9,57,58} The shortages are exacerbated by low health worker motivation and high attrition, due in part to low wages and poor working conditions.^{59,60} All of these areas are targets for investment. An example of a successful approach is the Malawi emergency human resources program, a 6-year training and salary-improvement program financed by the UK’s Department for International Development (DFID). The program aims not only to increase the number of front-line health workers (Malawi has one doctor per 62,000 people) but also to build capacity within the Ministry of Health for

better health system management and planning as well as analysis of health data.⁶¹ Trained and paid community health workers who are linked to and supported by the health system can also play a vital role in surveillance, communication, and outbreak-control activities.^{62,63}

Training higher-level public health personnel is also important. Pandemic planning requires mathematical modeling of disease and mortality projections and their corresponding impacts on health service utilization, health costs, and other health system process indicators. Such modeling requires epidemiologists and biostatisticians as well as health planners, economists, and administrators. The same people can also perform a wide variety of essential public health tasks, such as monitoring the incidence of priority infectious diseases (e.g., HIV/AIDS) and estimating the impact of seasonal epidemics (e.g., malaria). Health economists can assist countries in estimating the resources required to respond to an emergency and to expand the health system to tackle existing morbidity.

Health policymakers need training and support to undertake comprehensive human-resource planning, which is critical to both targets. Health human resource planning relies on the sound assessment of current health worker numbers by category as well as the assessment of future inflows, attrition, and geographic distribution.^{59,64} Gaps in different health worker categories can be identified and strategies for closing these elaborated.

Communication

Communicating with the public is a core part of emergency response, and enhanced communication channels can also be used to convey routine health information.⁶⁵ The WHO influenza pandemic planning checklist suggests developing websites, leaflets, and fact sheets on topics related to pandemics.⁶⁵ The same communication tools could be used for a broad range of health priorities. For example, nearly 40% of urban Ugandan teenagers who attend high school reported looking for health information on the Internet, suggesting that it is emerging as a powerful tool for health education.⁶⁶ In many developing countries, health education materials for existing diseases, whether for the public or for health workers, are often of low quality, may not be in local languages, and are often outdated.⁶⁷ Investing in health communication would thus benefit broader health goals.

Nominating spokespeople to address potential threats, as recommended by the WHO, has been an effective strategy to energize national efforts on HIV, and could be expanded to other diseases.^{65,68} Prominent people, whether politicians like Uganda's President Museveni or actors and other celebrities, can be an important catalyst to inform and motivate the public. Investing in improved mass-media campaigns may also be of benefit to both aims. For example, evidence is emerging that focused and locally specific media campaigns can result

in the increased use of modern contraceptives.^{69,70} Other promising avenues to communicate health information include the use of soap operas, radio broadcasts, plays, and village informal communication networks, particularly in countries where literacy and access to technology are low.^{71,72} Table 1 is a summary of possible multiple-use investments in developing countries.

Conclusion

Concerns about bioterrorism and pandemic influenza have put a spotlight on public health systems across the globe. Experience in the U.S. and other developed countries suggests that preparedness funding, when directed toward multiple-use investments, has strengthened core public health system functions. An exclusive focus on bioterror and pandemic preparedness is inappropriate in developing countries, where underfunded ministries of health often strain to perform routine public health functions. Instead, donor funds for emergency preparedness should be leveraged to strengthen health system fundamentals, such as health information systems, laboratories, human resources, and communication systems, to enable developing countries to better respond both to the current burden of disease and to future pandemics.

The author would like to thank Christine A. Aguiar for her capable assistance in the preparation of this manuscript.

No financial disclosures were reported by the author of this paper.

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