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Health security in 2014: building on preparedness knowledge for emerging health threats

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Ideas, information, and microbes are shared worldwide more easily than ever before. New infections, such as the novel influenza A H7N9 or Middle East respiratory syndrome coronavirus, pay little heed to political boundaries as they spread; nature pays little heed to destruction wrought by increasingly frequent natural disasters. Hospital-acquired infections are hard to prevent and contain, because the bacteria are developing resistance to the therapeutic advances of the 20th century. Indeed, threats come in ever-complicated combinations: a combined earthquake, tsunami, and radiation disaster; blackouts in skyscrapers that require new thinking about evacuations and medically fragile populations; or bombings that require as much psychological profiling as chemical profiling. Response requires up-to-date laboratories with genetic sequencing capabilities for infectious agents and rapid detection methods for chemical and radiological threats, nimble medical and epidemiological response units, and an alert and prepared workforce.

These complex and interconnected problems have spurred innovation across government to create interconnected solutions. Increasingly, the USA is building national capabilities to improve health security, which is defined as a state in which the nation and its people are prepared for, protected from, and resilient in the face of health threats.[1] To ensure a nation's health security entails preventing, protecting, mitigating, responding to, and recovering from all hazards that adversely affect health, requiring strengthening health and response systems at the local, state, and national levels. These capabilities are being built to address a wide range of hazards so that a strong base of readiness for any threat is developed.

Public health advances that have resulted in a more resilient and prepared nation and that have led to such system strengthening at all levels of government have been described,[2] and include improvement and coordination of public health infrastructure through the National Incident Management System (NIMS), expansion of the Strategic National Stockpile (SNS), upgrading of medical care and countermeasures capabilities, and improvement of laboratory expertise and capacity. We describe continued progress in the ongoing commitment to keep people in the USA healthy and safe (panel 1).

In an emergency, capabilities from all sectors are used to mitigate the acute event. However, the public health consequences of an event are not always visible, and health expertise has historically been conspicuously absent from emergency management. Over the past decade, awareness has grown that health is part of almost every event; much progress has been made in emergency management to use public health expertise in planning, response, and recovery. This integration is core to national activities to promote health security.

NIMS was established in 2004 as a comprehensive, systematic, principle-driven approach to management of emergencies of all causes and sizes. The Department of Health and Human Services (HHS) uses, supports, and promotes NIMS with local and state health departments through both the Centers for Disease Control and Prevention's (CDC) Public Health Emergency Preparedness programme and the Office of the Assistant Secretary of Preparedness and Response's Hospital Preparedness Program to be used whether responding to daily incidents or natural disasters.[3] As seen in the Boston Marathon bomb attack on April 15, 2013, these investments and use of NIMS are very worthwhile. In Boston, the city's public health commission oversees citywide emergency response, requiring close integration of emergency response and public health. Immediately after the bombings, medical and health department personnel began treating more than 140 injured people,[4] and coordinated hospital transportation for 90 people—all within 30 min. Boston's health authorities credited their quick response to robust exercise and planning, the city's strong interagency partnerships, and support from the state and federal government.

This support included use of a capabilities-based approach to preparedness, with concrete measures of performance (panel 2). Part of the city's training also included a seminar in 2009 with doctors from India, Spain, Israel, the UK, and Pakistan—countries that had managed blast injury terror attacks. On the day of the Boston Marathon bomb attack, local hospitals were able to draw from lessons learned in those and other exercises to respond with great speed and success. Additionally, HHS used a new Mental and Behavioural Health Concept of Operations to deploy federal mental health responders. This mental health framework is an integral part of efforts throughout HHS to identify, study, and facilitate activities that promote resilience and recovery in communities across the nation.

Public health information sharing has improved rapidly. So-called digital epidemiology has enabled practitioners and researchers to use electronic databases and information to enhance traditional surveillance methods.[5] In 2012, HHS launched its Now Trending developer challenge to create programmes for health departments to monitor social media during an outbreak. The challenge

***Panel 1*: Examples of health security advances in the USA**

- Since the 2001 attacks, the US Congress has appropriated funding for the Department of Health and Human Services (HHS) to provide to all states to improve their public health and health-care preparedness and response capabilities. These efforts are aligned within HHS and to the national preparedness goal.
- Response activities are coordinated through state-of-the-art emergency operations centres at the US Centers for Disease Control and Prevention (CDC) and the HHS Secretary's Operations Center in Washington DC, in addition to centres at almost all state public health departments. Health departments use the National Incident Management System, allowing for structured collaboration across responding agencies.
- More than 150 laboratories in the USA now belong to CDC's Laboratory Response Network and can test for biological agents. Regional chemical laboratories are also able to measure human exposure to toxic chemicals through tests of clinical specimens.
- The Select Agent Regulations, updated in 2012, came into full effect in April, 2013. The regulations prioritised selected agents and toxins on the basis of risk to the public, established suitability standards for people with access to the most threatening (tier 1) agents and toxins, and established personal reliability measures to improve biosafety and biosecurity.
- The National Disaster Medical System has improved how it organises and deploys more than 75 of its nationally distributed disaster medical assistance teams, mortuary response teams, and veterinary response teams, in addition to other specialised units that provide medical response surge during disasters and emergencies through on-scene medical care, patient transport, and the delivery of definitive care through its participating hospitals.
- The Biomedical Advanced Research and Development Authority (BARDA) is mandated to support the advanced development of medical countermeasures, and has built a pipeline of more than 150 novel drugs or diagnostics for chemical, biological, radiological, and nuclear threats and pandemic influenza. Seven of these products have received approval from the Food and Drug Administration. BARDA has provided 12 new products under Project Bioshield that can be distributed in a public health emergency.
- The Strategic National Stockpile was authorised and expanded, ensuring the availability of key medical supplies. All states have plans to receive, distribute, and dispense these assets.

New legal authorities:

- The Pandemic and All Hazards Preparedness Reauthorization Act (2013) clarified or expanded HHS' legal authorities to support communities in preparing for, responding to, and recovering from emergencies. Established by the original Act in 2006, the HHS Assistant Secretary for Preparedness and Response continues to direct the National Health Security Strategy, which helps to coordinate the efforts of many partner agencies.
- The HHS Secretary can now temporarily reassign health personnel funded through HHS grants authorised under the Public Health Service Act, to respond to an official public health emergency.
- The HHS Secretary can declare the significant potential for a public health emergency, thereby enabling the Food and Drug Administration to issue Emergency Use Authorizations for diagnostic test distribution or distribution of other medical products.

For more on **WHO's International Health Regulations** see http://www.who.int/ihr/en/

resulted in MappyHealth, a Twitter monitoring programme now being piloted for digital health surveillance around the country, helping officials examine real-time events. Digital surveillance was used by public health workers during the influenza A H7N9 outbreak to monitor Chinese social media for events, myths, and concerns.[6]

Improvements in digital surveillance have also improved public communication. Local health departments that can monitor Twitter can give immediate feedback to correct dangerous mistruths that are contagious on social media.[7] CDC's @CDCEmergency Twitter feed, first established during the influenza A H1N1 response, now reaches more than 1·5 million people with emergency health information. During the Japan nuclear disaster response, Twitter was used to correct the dangerous myth that healthy people in the USA should take potassium iodide to prevent harm from radiation.[8]

These technological advances have been developed in parallel with diplomatic information sharing advances. WHO's International Health Regulations and multilateral collaborations, such as the Global Health Security Initiative, have provided a framework for international cooperation during public health disasters. Improved capacity and the high priority placed on rapid information sharing led to China's timely reporting in 2013 of clinical and genetic information about influenza A H7N9 and early sharing of isolates, by contrast with the response to sudden acute respiratory syndrome (SARS) a decade earlier, when information was slower to emerge.[9,10] Cloud computing allowed for distribution of validated epidemiological and analytical programmes to the global community, while allowing China to share genomic sequences, providing the opportunity for immediate actions to analyse the viral genome and develop vaccine candidates.[6]

The Public Health Emergency Medical Countermeasure Enterprise was established by HHS to coordinate federal efforts and build new ways to respond to 21st century health threats—from discovery to deployment. The programme generated a government-wide strategic plan to build all-hazards capabilities and countermeasures throughout federal public health agencies.

One cornerstone of the programme is the development of new medical countermeasures. Since July, 2012, seven products for anthrax, botulism, and influenza have received approval from the Food and Drug Administration. The SNS contains substantial formulary to provide prophylaxis or treatment to address the deliberate dissemination of anthrax, plague, botulism, or tularaemia, and enough smallpox vaccine to immunise every person in the USA. Botulism antitoxin, anthrax immune globulin, and vaccinia immune globulin are also routinely made available for distribution for routine public health indications as needed. SNS materials can be delivered anywhere within the USA within 12 h. Furthermore, the HHS medical care and countermeasures strategy—which includes a focus on development of the next generation of influenza vaccines, diagnostics, and novel antivirals—has also led to advances in vaccines for seasonal influenza, and better prepared the nation for the next pandemic. For example, the US Government now has licensed cell-based and recombinant seasonal influenza vaccines and have stockpiled pre-pandemic cell-based vaccine.

Increasingly, the USA seeks to develop products that can address countermeasure requirements and also day-to-day needs. As a result, these government investments in products such as next-generation antimicrobials for biological threats can be supported by the market to address routine public health problems, such as antimicrobial resistance.

In addition to storing these medical countermeasures, the SNS has established a nationwide readiness programme with 72 metropolitan areas in its Cities Readiness Initiative. Cities receive technical assistance in developing plans to receive, distribute, and dispense medical assets, and must plan to respond to a large-scale bioterrorist event within 48 h. This initiative reflects the value of having all the components of the system work together: research scientists work alongside logistics experts to ensure that as they build new life-saving products, others are making sure that they can get them to the right place, under the right conditions, in the right amount of time.

The NDMS is made up of more than 5000 citizen responders, including physicians, mid-level providers, nurses, emergency medical service personnel, and leadership staff; and 1600 civilian hospitals across the country that can support the definitive care for patients who are evacuated from an affected area of all kinds of hazards.

Federal Medical Stations, components of which are also stored in the SNS, can be deployed and staffed by the US Public Health Service and NDMS medical personnel. After Hurricane Sandy, these stations were deployed along with more than 20 mobile field care sites to provide both human and animal care. These resources provided relief for overworked local medical responders and facilities, and helped community members maintain access to critical services. Multidisciplinary medical teams were able to assess and treat both acute and chronic medical needs, and either discharge or transfer patients for further care as necessary, helping to relieve the medical surge that the local hospitals were experiencing. The teams also assisted responders who got sick or injured in going back to work quickly, strengthening community resilience.

CDC and HHS have supported public health laboratories around the country since the mid-1990s, through epidemiology and laboratory capacity-building cooperative agreements and the Laboratory Response Network (LRN). The 150-member LRN, founded in 1999, assures standardised equipment, reagents, and protocols for testing, quality assurance and quality control, and result messaging. Funding has gone towards renovation of old state and local public health laboratory facilities, purchasing of state-of-the-art testing equipment, and paying for more than 400 laboratory worker positions each year. Nowadays, LRN laboratories can undertake rapid tests for high-priority biological agents such as those that cause anthrax, smallpox, and plague. Receipt of test results within hours, not days, is crucial in the event of a biological or chemical attack. State laboratories showed their response capacity and the benefits of these investments during the 2012 multistate fungal meningitis outbreak, during which around 750 people were infected and more than 60 killed by contaminated spinal and paraspinal steroid injections.[11] The Tennessee Department of Health identified and raised the alarm on the initial cluster of cases. The Virginia Department of Health and state public health laboratory identified a rare fungal pathogen, *Exserohilum rostratum*, which contaminated the steroid injections—a critical discovery. The Michigan Department of Community Health identified the first case of a joint infection from the injections.

These findings aided the response in several ways. Tennessee's actions to identify the cluster led to a nationwide patient notification effort so that cases were quickly discovered and treated. By identification of the fungus involved, time was saved in developing specific diagnostic, patient management, and treatment guidelines. The Michigan discovery of the joint infection led to instructions for doctors to look for medical complications that were related to the injections.[12]

***Panel 2:* Public health and health-care preparedness capabilities**

The Department of Health and Human Services (HHS) identified the following 15 public health and health-care preparedness capabilities (shown in their corresponding domains) as the basis for state and local public health and health-care preparedness.

Biosurveillance
- Public health surveillance and epidemiological investigation
- Public health laboratory testing

Community resilience
- Community preparedness
- Community recovery

Incident management
- Emergency operations coordination

Information management
- Emergency public information and warning

Information sharing

Countermeasures and mitigation
- Medical countermeasure dispensing
- Medical materiel management and distribution
- Non-pharmaceutical interventions
- Responder safety and health

Surge management
- Fatality management
- Mass care
- Medical surge
- Volunteer management

Health-care coalitions supported by HHS helped states to assist hospitals in managing the surge of patients.

These enhancements in our national public health laboratory system capabilities have helped to support the development of laboratories worldwide. In this interconnected world, fostering this and the other public health preparedness capabilities overseas is crucial to US health security. HHS has worked to build infrastructure and provide technical assistance with partner countries in Asia, Africa, and Latin America. As a result, US partners are building the scientific capacity to detect, contain, and respond to novel threats before they become global threats.

Bioterrorism, pandemics, and other global threats to the nation's health security remain major concerns. We must ensure that lessons learned locally, such as those of the Boston Marathon bombing or response to Hurricane Sandy, are shared and implemented widely in US states and cities with adequate funding and support. Much work remains to make the efforts and improvements of the past few years integral components of routine health systems, addressing existing gaps in preparedness, and to duplicate these efforts globally as part of the new international Global Health Security Agenda in support of the International Health Regulations. All this work has to be accomplished in the midst of substantial decreases in federal and state funding for public health and health-care preparedness. In view of the challenging fiscal environment, additional progress will need increased emphasis on a risk-based approach and focus on a very limited number of priorities.

One of the most pressing priorities is meeting the needs of vulnerable populations who tend to have poor health outcomes during and after disasters. Although some innovative efforts have been launched at HHS to increase access to federal data to address the needs of vulnerable populations, this population is often not included in emergency planning processes despite their disproportionate vulnerability and numbers. They include a large part of society, not limited to children; elderly, poor, and disabled people; and those not fluent in English. Although the public health community is aware of this need and many important efforts are being made across the country,[13–15] we need more strategies to locate, engage, and communicate with vulnerable populations and make them the focus of our preparedness planning—not the annex. Addressing the needs of these populations and other related efforts to foster better personal and community preparedness are concrete measures to create resilient communities. This shared responsibility for resiliency is implicit in the all-community approach to ensure US health security.

Previous major disasters and mass casualty events drew attention to continued stress points for health-care services including insufficient back-up emergency power and decision points for evacuating patients versus sheltering in place; shortages of emergency medical services and medical supplies and insufficiently trained staff; and the inability to refill prescription medications. The cornerstone of efforts to improve the health-care delivery system's ability to surge and be resilient has been to establish and sustain health-care coalitions. Establishment of broad-based health-care coalitions are a solid beginning, but this approach will be successful only if we learn from and not just record lessons from previous disasters. Efforts should incorporate changes on the basis of these lessons, and include robust integrated planning and exercising of the health-care and public health systems that are coordinated with emergency management. We need to foster improved and expanded stakeholder engagement in health-care coalitions with increased inclusion of emergency medical services, public safety officials, and other crucial infrastructure partners such as the power and water sectors. Information systems will be critical in helping these coalitions to work together, share information and resources, and coordinate a system-wide response. Additionally, alternative models are needed for financing both preparedness and response activities.

Other priorities include embracing new technology for disease monitoring and real-time information sharing; improving the evidence base; expanding preparedness principles to include climate disruption; and encouraging even more cross-sector integration between public health, health care, emergency management, and, especially, the private sector. These are just a few necessary efforts across public health agencies that seek to make Americans more resilient and prepared. Building on this integrated and systematic approach to health security will strengthen US health security for decades to come.

Contributors

Both authors contributed equally to the writing and editing of this Viewpoint, and approved the final draft.

Declaration of interests

We declare no competing interests.

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