A Framework for Healthcare Disaster Resilience:

A View to the Future

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Executive Summary

Although the healthcare system is undoubtedly better prepared for disasters than it was before the events of 9/11, it is not well prepared for a large-scale or catastrophic disaster. Just as important, other segments of society that support or interact with the healthcare system and that are needed for creating disaster-resilient communities are not sufficiently prepared for disasters. This report is the culmination of a 2-year project funded by the Robert Wood Johnson Foundation to examine US disaster healthcare with the purpose of identifying changes, innovations, and new efforts that could strengthen the country's ability to provide medical care in major disasters. In the report, we analyze a range of disasters that could confront the United States and consider their impacts on the healthcare system, including how medical care would be delivered in those scenarios, both to victims of the disaster and everyone else. We found that many of the current programs are quite valuable and should continue to be supported, and that several new initiatives should be pursued that would improve the disaster readiness and resilience of the US health sector.

Through a sequence of literature review, key informant interviews, focus groups, and a working group meeting, we concluded that there are 4 categories of disasters that could cause significant illness and injury and for which the United States should be prepared. The importance of identifying these categories is that they pose different kinds of operational challenges, resource needs, and overall requirements. These categories are:

- **Relatively small-scale mass injury/illness events:** for example, bus crash, tornado, multiple shootings, local epidemics/small disease outbreaks
- **Large-scale natural disasters:** for example, Hurricanes Maria, Sandy, Katrina; moderate earthquake; large-scale flooding, such as Hurricane Harvey
- **Complex mass casualty events:** for example, large-scale shootings (Las Vegas, Orlando) or bombings (Boston Marathon) with many victims, mass casualty burn events (Rhode Island nightclub), chemical or radiological incidents, limited-scale bioterrorism, limited outbreaks of lethal and contagious infectious diseases, such as Ebola or SARS
- **Catastrophic health events:** for example, nuclear detonation, large-scale bioterrorism, severe pandemic, or major earthquake

We conducted a gap analysis for each type of disaster and concluded that the United States is fairly well prepared for relatively small-scale mass injury/illness events that happen more frequently, less well prepared for large-scale and complex disasters, and poorly prepared for catastrophic health events.

To address these gaps, we offer a series of recommendations, including the establishment of a network of disaster resource hospitals, an initiative to promote a culture of resilience among grassroot and community-based organizations, greater resources for the Hospital Preparedness Program, more robust development of healthcare coalitions, and a dedicated ASPR effort focused on planning for catastrophic health events. If these changes were implemented, they would help make the health sector more resilient and the country could become far stronger in its ability to manage the mass medical care needs for a range of disasters. We discuss ways in which these initiatives might be funded and promoted, including potentially through the upcoming reauthorization of the Pandemic and All-Hazards Preparedness Act, and we outline next steps needed to implement these proposals.

The Problem This Project Intends to Address

Although the healthcare system is undoubtedly better prepared for disasters than it was before the events of 9/11, it is not well prepared for a large-scale or catastrophic disaster. Just as important, other segments of society that support or interact with the healthcare system and that are needed for creating disaster-resilient communities are not sufficiently prepared for disasters. The structures and assumptions that underpin the way in which disaster healthcare in the United States is planned for and provided are decades old and may no longer be consistent with the existing healthcare landscape. The current way in which US disaster healthcare is organized is a haphazard accretion of many policies, practice patterns, and market forces that have evolved over many years. Although demonstrable progress has occurred since the implementation of the Hospital Preparedness Program (HPP)—under the Office of the Assistant Secretary for Preparedness and Response (ASPR) at the Department of Health and Human Services (HHS)—and the Public Health Emergency Preparedness (PHEP) program—at the Centers for Disease Control and Prevention (CDC)—few would argue that the current system is rationally designed or optimally effective or efficient. These programs were rapidly implemented after 9/11 in

response to a crisis and injected into a highly fragmented and competitive, fee-for-service healthcare system that had never before seen disaster preparedness as a core mission and that had weak links to public health. Public health for its part had likewise never before seen disaster preparedness as a central responsibility. Neither the healthcare sector nor public health had ever worked closely with emergency management. Over the past 16 years, these sectors have worked hard to adapt to this new disaster health mission and mandate, but progress has been difficult, in part because the healthcare system is not well structured for this purpose.

These new programs were not integrated into preexisting programs such as the National Disaster Medical System (NDMS)[1] or the Metropolitan Medical Response System (MMRS).[2] The MMRS program was subsequently defunded. Later, a new program of local volunteers, the Medical Reserve Corps (MRC),[3] was established, but it was also not well integrated into other programs. There are other federal and state programs that relate to healthcare preparedness and response, including the Emergency Medical Assistance Compact (EMAC),[4] the Cities Readiness Initiative, and the Urban Areas Security Initiative, among others.

For the most part, these programs operate within distinct silos. The NDMS consists of deployable teams of healthcare providers and support personnel who can be sent on short notice to a disaster site as well as a network of hospitals around the country that have signed up to potentially take evacuated patients in transfer in a disaster. This system operates largely in parallel with the healthcare coalitions (HCC) established as part of the HPP. The MRC consists of locally organized groups of volunteers that can provide limited assistance in a local disaster, but it too is often not integrated with local HCCs.

Our understanding of the intersection of health and disasters has evolved over the past 15 years. It is now widely recognized that the resilience of communities and systems should be the goal rather than just preparedness. That is to say, communities should seek to resist the impact of disasters, recover promptly to normal operational capacity, and learn how better to withstand future events. The need for whole-of-community and whole-of-government involvement is now recognized, as is the value of health-in-all-policies. Many healthcare issues in disasters occur outside the traditional healthcare system and require a broader public health and community response; therefore, we refer in this report to the "health sector," by which we mean all entities that are involved in people's health. As we described in a previous report on health sector resilience related to Hurricane Sandy:

> "We define the health sector very broadly. This sector includes organizations that have long been at the center of preparedness efforts, such as hospitals, emergency medical services (EMS), and public health departments, as well as many entities that have not routinely been part of preparedness efforts. Among these are outpatient clinics, long-term care facilities, home health providers (both formal home health agencies and informal care provided by family and friends), behavioral health providers, correctional health services, and the healthcare providers who work in all of these settings. The health sector also includes community-based organizations that support these entities and represent the patients who receive services from them." [5(p54)]

And as we learned from many hurricanes, especially Katrina and Sandy, the most vulnerable in our society—those who have fewer resources and who must often rely on fragile support systems—have disproportionately greater need of the healthcare system during disasters.[1] As noted above, many aspects of society other than just the traditional healthcare system influence people's health. This includes access to decent housing, food, and education as well as strong families and cohesive communities. Policies and actions that address these fundamental issues comprise what the Robert Wood Johnson Foundation refers to as a Culture of Health.[6] We believe that, in the same way that cultural changes are needed to improve health, cultural changes are needed to promote disaster resilience. At the same time, preparedness programs need to be reexamined, gaps analyzed, and new solutions considered.

The resilience of a community to disaster depends on both inherent and adaptive factors.[7] Inherent factors include such things as the underlying health and wealth of the population, access to nutritious food and clean water, and education. Much good work is being done on these issues, including by the Robert Wood Johnson Foundation's Culture of Health. Adaptive factors are those actions taken before, during, or after an event that lessen its negative impact. In this project, we focus on adaptive resilience to acute events that cause substantial illness, injury, or stress on the healthcare system. We consider not only adaptive actions that can be taken by the healthcare system but also ways in which other components of civil society can complement, support, and fill gaps in resilience to acute health disasters.

Inherent and adaptive resilience are closely interrelated. Just as inherent economic and social factors greatly influence the impact of acute disasters on a community's health and are often key to the resilience of the community and its health sector, effective adaptive actions (preparedness, response, and recovery) can greatly influence the long-term health and welfare of a community. Ineffective adaptive actions can leave a community struggling for years—as in the Ninth Ward in New Orleans after Katrina. Conversely, effective actions can leave a community stronger than it was before the disaster—

for example, Cedar Rapids after the historic flooding. Furthermore, communities can glean lessons from their response to disasters that inform and enhance greater overall community resilience.

In this document, we propose a framework for building a more effective disaster health system in the United States based on an analysis of the threats and the gaps and embracing new concepts of community resilience. We propose new initiatives, make policy recommendations, and outline priority actions, including a research agenda.

Methods

We conducted a literature review covering the 5-year period ending in October 2015, searching for articles that focused on US health system preparedness or resilience. The search identified 119 articles. We followed this review with a series of interviews, 2 working group meetings, 2 conference calls, and a focus group in Cedar Rapids, Iowa. In total, the research involved 44 subject matter experts and thought leaders who provided insight into how the changes in the healthcare system were affecting preparedness and resilience and what could be done to improve the situation. There was general agreement that these changes created both problems and opportunities, but also that neither had been adequately explored. There was also general agreement that there has been real progress in building health sector resilience but that accumulated experience shows that different types of disasters require quite different responses. From these discussions and our own analysis, we developed a strawman framework for future health sector resilience, the elements of which were discussed in an expert advisory working group.

Findings

Different Disaster Categories Require Different, Overlapping Approaches

Not all disasters are alike, and, therefore, there are limits to all-hazard preparedness. We identify 4 broad types of disasters for which the US healthcare sector must prepare, each with a distinct set of characteristics. The different types of disasters produce different burdens on

the healthcare system and require a different scope of preparedness and response. These 4 types of disasters (in order of frequency/probability) are:

- **Relatively small-scale mass injury/illness events:** for example, bus crash, tornado, multiple shootings, local epidemics/small disease outbreaks

- **Large-scale natural disasters:** for example, Hurricanes Maria, Sandy, and Katrina; moderate earthquake; large-scale flooding, such as Hurricane Harvey

- **Complex mass casualty events:** for example, large-scale shootings (Las Vegas, Orlando) or bombings (Boston Marathon) with many victims, mass casualty burn events (Rhode Island nightclub), chemical or radiological incidents, limited-scale bioterrorism, limited outbreaks of lethal and contagious infectious diseases, such as Ebola or SARS

- **Catastrophic health events:** for example, nuclear detonation, large-scale bioterrorism, severe pandemic, or major earthquake

The current healthcare "system" and disaster preparedness and response programs do not equally address all of these. Each type of disaster has its own requirements and necessary approaches. Many disasters have common preparedness and response elements, and this is the logical basis for all-hazard preparedness. But it is also true that a hurricane versus a pandemic versus a mass shooting have highly distinct characteristics, and so some (or much) of what will be required will not be addressed by an all-hazards approach. Preparing for one type only partially prepares us for other types, and focusing solely on the common elements leaves gaps for specific actions or capabilities required for each type of event. Different events require different mixes of skill sets, resources, and response capabilities when the principal goal is to reduce injury and illness and to save lives.

Characteristics of the 4 Types of Health Disasters

In this section we analyze the 4 disaster types and their defining characteristics. From this analysis we can infer their effect on the health sector and the scope of the required response, which will in turn highlight gaps in the current healthcare preparedness and response system. (See page 12 for a table summarizing this.)

Small-scale mass injury/illness events

In these events, typically, the civil infrastructure (eg, electricity, communications, water) is mostly intact, most of the normal healthcare system is intact (although isolated damage is possible, such as occurred in the tornado in Joplin, Missouri), most of the required response resources exist in the local area, and vulnerable populations are at somewhat greater risk. (Note: Non-English speakers and disabled people are at greater risk for all events, and individuals in inadequate housing may be more vulnerable to severe weather events and epidemics.)

Example: Seattle Bus Crash

On September 24, 2015, a "Ride the Duck" amphibious vehicle collided with a charter bus carrying 45 international college students and staff on the Aurora Bridge in Seattle. Four people died at the scene, and 7 were transported to hospitals and 1 to an urgent care center. The most critical patients were transported to Harborview Medical Center, the area's Level I trauma center. The healthcare aspects of the event were judged to have been well planned, coordinated, and implemented. [8]

Large-scale natural disasters

In these events the civil infrastructure is often damaged across a wide area, healthcare facilities are damaged or degraded, vulnerable populations are at greatest risk, much of the population is displaced from normal sites and sources of health care, and, in many cases, most individuals seeking health care are not direct casualties of the event but rather patients displaced from their normal sources of health care.

Example: Hurricane Sandy in New York and New Jersey

In total, across the region, 9 hospitals were evacuated. In New York alone, hospital and nursing home evacuations involved approximately 6,300 patients. Of the evacuated hospitals in both states, 7 had provided emergency department services that were lost for days, weeks, months, or, in one case, forever. The decision making about healthcare facility evacuation was inconsistent and at times confused.

In addition to the hospitals, more than 30 nursing homes were evacuated, and many more outpatient facilities, including offices, clinics, dialysis centers, and behavioral health clinics, were forced to close. Healthcare workers and patients had difficulty getting to healthcare facilities because of closed roads and lack of fuel. In many cases these healthcare facilities were closed for weeks or in some cases months. Home health care, both formal care provided by professionals and informal care provided by families and friends, was also disrupted. Given the population of 20 million in the New York metropolitan statistical area at the time of the storm, most of which was significantly affected by the storm, it is reasonable to estimate that several million people, especially the most vulnerable members of society, were displaced from their normal sources of care for a period of time, and many of these had to attempt to seek care elsewhere. For example, elderly, homeless, and chronically ill people used emergency departments significantly more than did the general population after the storm, and 95% of primary care sites in the Rockaways temporarily closed or relocated. The healthcare facilities that remained open, or that were able to quickly reopen, experienced high patient volumes—primarily treating people for minor or routine health problems.[5(p55)]

Example: Hurricane Maria in Puerto Rico

Following this devastating Category 4 storm, 64 people were reported to have died as a direct result of the storm. However, over the subsequent 2 months, there were an additional approximately 1,000 excess deaths compared to prior years. Most of these deaths were attributed to chronic health conditions or sepsis. This is likely due to the sustained loss of access to basic medical care and infrastructure (water, power, and communications).[9]

Example: Hurricane Harvey in Houston

Patients on chronic hemodialysis must be dialyzed at least every 3 to 4 days or risk life-threatening complications. For this reason, many dialysis centers, especially those that are part of large chains, have engaged in emergency planning for their own facilities for years. Following Hurricane Sandy in New York, dialysis centers that were part of chains seemed to have fared better than those that were not; still, in the wake of Sandy approximately one-quarter of patients missed at least 1 dialysis session, and 66% received dialysis in a location other than their usual facility—most often in an affiliated center. But 7.6% received dialysis in an emergency department. Of those who were dialyzed in a location other than their usual facility, 29% experienced shortened treatment times, leading to overt symptoms in 11 cases (5%).[10] According to CNN, dialysis centers in Houston learned from the Sandy experience and dialyzed some patients early and instructed patients about what they should do to be prepared. Additionally, some centers opened their doors to all dialysis patients in need.[11]

Complex mass casualty events

In these events the infrastructure and normal healthcare system are mostly intact, specialty care and/or special training is needed to treat a large portion of the victims, and all populations are at high risk, but, as always, some vulnerable populations (non-English speakers, indigent, disabled) may have additional barriers to care.

Example: Las Vegas Shooting

On October 1, 2017, a lone gunman opened fire on a crowd of concertgoers in Las Vegas, Nevada, killing 56 and injuring 546—making it the deadliest mass shooting in US history to date. One hundred eighty of the injured, including 124 with gunshot wounds, were treated at the closest hospital, Sunrise Hospital and Medical Center—located 6 miles from the shooting—the state's largest hospital and a Level II trauma center. Sixteen of the patients died, at least 30 required surgery, and 23 were in critical condition 2 days later. One hundred four victims were treated at the next closest hospital, University Medical Center of Southern Nevada, located 15 miles away and the state's only Level I trauma center.[14] University also received transfers from some of the other community hospitals. Valley Health System's 6 hospitals treated 229 patients, 8 of whom died and 19 of whom were in critical condition.[15] Dignity Health-St. Rose Dominican received 61 patients across its 3 hospitals, of which 32 were treated at their Siena Level III trauma center.[16]

Example: Rhode Island Station Nightclub Fire

In 2003, a fire in a Warwick, Rhode Island, nightclub during a rock concert caused a mass casualty disaster. Of the 439 people in the building, 96 died at the scene and 215 were treated across 16 hospitals throughout Rhode Island and neighboring Massachusetts. Over the first hour, Kent County Hospital, a 350-bed community hospital located 2 miles away, received 40 patients. Over the subsequent few hours, they received 42 more. Of these 82 patients, half were treated and released from the emergency department, and 18 were stabilized and transferred to 5 different burn units up to 60 miles away.

Rhode Island Hospital, a 700-bed academic medical center affiliated with Brown University with a Level I trauma center and burn unit located 12 miles away, received 64 patients over the course of 2 hours—45 of whom were in critical condition—plus 8 patients transferred in from Kent County Hospital. Eight pattients were subsequently transferred from Rhode Island Hospital to another burn unit.

In total, of the 215 patients treated in hospitals, 79 were admitted—most in critical condition—but only 4 died. Clinicians and administrators at these hospitals attributed this remarkable outcome to the planning and drills that they had conducted since 9/11. Yet, after-action reviews indicated many areas for improvement, particularly in communications and area-wide coordination.[12,13]

Catastrophic health events

In such an event, the infrastructure may be damaged =, the normal healthcare system may be degraded and therefore would be enhanced risk, many complex casualties can be anticapted, and the geographic extent of casualties would likely cover a large area.

Example: National Planning Scenarios

The 2005 Department of Homeland Security National Planning Scenarios outlined 15 catastrophic health events.[17] The following are 3 examples:

- A detonation of a 10-kiloton nuclear device in Washington, DC, would produce:

    o   9,000 instantaneous deaths due to intense heat and supra-lethal levels of prompt radiation
    o   19,000 injured from the blast, burns, trama, and prompt radiation
    (6,000 die within <24 hours)
    o   130,000 people who would receive sufficient fallout radiation to cause acute radiation sickness (ARS) (30,000 die within 24 hours)

    This leaves on the order of 100,000 people who might be saved if they can receive medical care within several days.

- A wide-area biological attack with *Bacillus anthracis* would expose 328,000 people to the spores. This would produce 13,000 deaths if the exposed population could not be adequately prophylaxed and treated in time.

- A magnitude 7.5 earthquake in a major city would be expected to produce 1,400 deaths and 18,000 hospitalizations.

In each of these scenarios, there are huge challenges with regard to healthcare surge capacity, delivery of healthcare resources, crisis standards of care, and transport of patients to and between healthcare facilities.

Disaster Types, Characteristic Burdens, and Scopes

Disaster Type	Characteristics	Burden on the Healthcare System	Scope of Response	Examples
Relatively small mass injury/illness event	Infrastructure remains intact -Most response resources exist in the local area -Most normal healthcare capacity remains intact (isolated damage possible: eg, Joplin tornado) -Vulnerable populations at somewhat greater risk for some events (eg, infectious disease outbreaks, shootings, tornados) but not all	Transient surge, typically limited to hospitals	Local healthcare coalition/s (HCCs): -Local hospitals -Public health -EMS -Emergency management agency	-Bus crash -Tornado -Multiple shooting or smaller mass shooting -Local infectious disease outbreak/epidemic
Large-scale natural disasters	-Infrastructure is damaged to some extent -Healthcare facilities are degraded -Affected population is displaced from normal site of health care -Vulnerable populations are at the greatest risk -Most patients are not direct casualties, but, rather, patients displaced from their normal sources of health care	-Many parts of the system degraded, some for a prolonged period of time -Transient surge in emergency department patient volume, could be large -Prolonged surge in many parts of the healthcare system that do remain functioning	One or more HCCs with outside mutual aid, federal support, and strong community and health sector resilience	-Hurricanes (eg, Sandy, Katrina) -Moderate earthquakes (eg, Napa 2014) -Large-scale flooding (1993 Mississippi/Missouri River flood)
Complex mass casualty events	-Infrastructure wholly or largely intact—bombings or fires could affect some infrastructure -Normal healthcare capacity is intact -Specialty care and/or specialized training required to treat a large number of patients -Vulnerable populations are not at substantially greater risk	-High burden of trauma, critical care, specialty care on multiple healthcare facilities -Transient and prolonged surge could overwhelm surge capacity at individual facilities, but the broader local or regional healthcare system capacity is largely sufficient—some specialty care capacity may be placed under higher burden for some events (eg, large-scale burn events)	Multiple large specialty hospitals with robust capabilities, plus one or more HCCs	-Large-scale shooting (eg, Las Vegas 2017) -Bombing with many victims (eg, Oklahoma City 1995) -Mass casualty burn event -Large-scale decontamination of patients (eg, radiological accident, chemical spill, white powder incident) -Chemical, radiological, or limited scale biological terrorism (eg, 2001 anthrax attacks)
Catastrophic health event	-Infrastructure may be damaged, severely so in some events -Normal healthcare system may be degraded, severely so in some events -Many complex casualties occurring simultaneously -Affected area and population will vary by event, but they likely cover a large geographic area -Vulnerable populations are at elevated risk	-Severely increased burden on local and regional health sectors may overwhelm surge capacity, even if the healthcare infrastructure remains intact -National coordination and augmentation will likely be required for the response	National-level response, requiring coordination and resources from outside the affected area	-Nuclear weapon detonation -Large-scale bioterrorism -Severe pandemic -Massive earthquake (eg, Northridge, CA, 1994)

Where the Gaps Are

Given the preceding analysis, how well prepared is the United States for each type of disaster?

Small-scale mass injury/illness events

The burden on the healthcare system produced by events of this type is typically a transient surge in patients, lasting a few hours to a few days, that is mostly limited to hospitals and EMS. Public health may or may not be directly involved, depending on the event. Well-prepared hospitals, health departments, and EMS providers, as part of highly functioning healthcare coalitions (HCCs),[18] provide the structure and function required for small-scale events. Improvements in hospital preparedness over the past 15+ years, nurtured by funding from the HPP and guided by HPP[19] and the Joint Commission,[20] along with public health preparedness funding and guidance under the PHEP Cooperative Agreement,[21] have created a capability for managing the health impacts of small-scale disasters that did not previously exist. This capacity has been tested countless times in recent years, and in most cases the hospitals and their respective HCCs have performed admirably. HCCs vary widely in terms of their capabilities. Some are quite mature and highly functional, but many are much less well developed. Continued stable funding of HPP and PHEP is needed to maintain and improve this capability. Over the past several years, HPP funding has been cut by almost half, which has hampered coalitions' ability to grow and mature.[22]

HCCs also face the challenges of a rapidly changing healthcare landscape, especially the consolidation of individual hospitals, clinics, and providers into integrated healthcare networks and accountable care organizations (ACOs).[23] These new structures do not align well with the simple notion of geographic coalitions of independent hospitals, as HCCs were first envisioned years ago. HCCs will need to continue to evolve along with the changing healthcare landscape. As more and more services move from inpatient to outpatient, hospital-based surge capacity naturally shrinks as the number of hospital beds decreases. This makes it ever more important for HCCs to engage with outpatient providers. And as most hospitals and many outpatient facilities merge into integrated networks that cover multiple communities, there will be increasing business pressure to keep patients "in network" rather than sharing a sudden patient surge across competing hospitals within a community. HCCs will need to work with these networks to reconcile this tension.

Large-scale natural disasters

These events typically place a great burden on a healthcare system and consequently on the population served by the system. Many parts of the system may be damaged or degraded—some for prolonged periods. This includes hospitals and healthcare facilities but also services like home care. There is typically a transient surge in hospital emergency department volume that could be quite large. There may also be a prolonged surge on many other parts of the healthcare system that remain functioning. The duration and magnitude of the burden may be affected by policy decisions and actions taken (or not), such as preemptive evacuations of healthcare facilities or transportation shutdowns. Effective response requires the involvement of one or more coalitions with outside mutual aid, federal support, strong community resilience, and strong resilience of all parts of the health sector.

Ample evidence from natural disasters (especially hurricanes) indicates that greater resilience of all aspects of the health sector as well as many other parts of civil society is needed. The vast majority of patients seeking health care after such an event are people displaced from their normal sources of care, especially young, old, chronically ill, and poor people. If all parts of the health sector (not just hospitals) were better prepared and more resilient, and if other critical parts of government and civil society—such as transportation, power and water utilities, and communications—prioritized supporting the health sector more highly during disasters, there would likely be less stress on the healthcare system and better health for the most vulnerable members of society during disasters.

Complex mass casualty events

These events can be expected to create a heavy but transient burden of trauma, critical care, and specialty care patients. Surge capacity at individual facilities may be temporarily overwhelmed, but overall local/regional healthcare system capacity is typically sufficient to meet the increased demand. The growth of HCCs, trauma networks, and sophisticated EMS dispatching systems have enabled an impressive response to several recent events of this kind of event--for example, the Boston marathon bombing and the Las Vegas shooting. It is not clear, however, that larger events than these could be handled well or that all communities would have responded as effectively as those communities did. The magnitude of the burden may be affected by policy decisions and actions taken (or not), such as effective distribution of patients or effective public and healthcare notification.

Complex mass casualty events require highly specialized care that is typically found only in large academic medical centers. For the most part, community hospitals do not have the resources, depth of staff, or expertise needed for these types of events. Even with vastly increased preparedness funding, it is doubtful that most community hospitals would be able to achieve and maintain the level of expertise and preparedness needed for this kind of patient care. Therefore, preparedness policy should focus on promoting a network of disaster centers of excellence among large medical centers or large integrated healthcare systems. Beyond providing the comprehensive clinical services that now exist, these hospitals must also have active disaster programs to do the education, training, and research the country needs. This includes educating and training their own personnel as well as being an expert resource for other facilities and researching best practices and innovative approaches to be shared nationally. The current HPP approach does not provide enough funding to the hospitals to enable this kind of development. The way in which the nation responded to domestic cases of Ebolavirus disease by creating a network of a limited number of strategically located, directly funded, designated specialty centers is a good model to follow.

An organized network of such centers of excellence with robust capabilities, each connected to one or more local HCCs, would provide a national capability for dealing with these very challenging events.

Catastrophic health events

In a catastrophic health event, a markedly increased burden on local and regional health sectors can be expected that may overwhelm surge capacity, even if the infrastructure is fully intact (which it may not be, depending on the scenario). Many parts of the system may be damaged or degraded for prolonged periods. This includes hospitals and healthcare facilities, but also services like home care. Patients would include victims of the event as well as patients with chronic conditions who are displaced from their normal sources of care. The magnitude of the healthcare system burden may be affected by policy decisions or actions taken (or not), such as effective public messaging about sheltering.

All of the efforts discussed above—from building community resilience, to HCCs, to disaster resource hospitals—would make the country much more prepared for a catastrophic health event. But to be most useful, there needs to be a detailed concept of how the many pieces would work together to get the right resources to the right patients at the right time. This would include how patients and resources are allocated, moved, and tracked. All national resources, public and private, would be needed as well as a well-developed system for crisis standards of care.

Conclusion

Progress to date in hospital preparedness and especially the creation of HCCs has prepared the nation fairly well for common, smaller-scale disasters. On the other hand, there are 2 substantial and distinct needs that are not currently being met:

- Much of civil society and many parts of the health sector are not resilient and are not participating in preparedness activities, as was demonstrated in Hurricanes Katrina and Sandy. When disaster strikes and these entities fail, people suffer and the hospitals become overwhelmed, leading to cascading hardship and suffering. To address this, many more components of the health sector and civil society need to be more resilient and connected to formal preparedness and resilience activities in their communities. To address this, we call for an initiative to build a **Culture of Resilience,** by which we mean a program designed to encourage and incentivize local grassroots and community-based organizations to become more involved in efforts that enhance the disaster resilience of the local health sector.

- Complex disasters require expertise and resources that are not found in most hospitals. Major medical centers have many of the elements needed for such events, but many lack a dedicated focus on disaster preparedness and response. A series of interconnected, well-resourced specialty hospitals are needed to provide optimal care for complex disasters. To address this, we call for an initiative to create a network of **Disaster Resource Hospitals.**

Vision of Success

To strengthen the nation's resilience for the health consequences of all kinds of disasters, we offer the following 5 recommendations:

1. Continue robust support for the HPP, focused on growing and maturing HCCs;
2. Integrate local MRC and NDMS units with their respective HCCs;
3. Initiate a new program designed to promote a **Culture of Resilience** at the local level;
4. Create a network of **Disaster Resource Hospitals;** and
5. Launch a new program at ASPR focused on preparedness for catastrophic health events.

Together these new proposals would build on the success of HCCs and hospital and public health preparedness to create a national capability for effectively responding to disaster health events of all sizes and types. We recommend that these proposals be kept in mind as the Pandemic and All-Hazards Preparedness Act is reauthorized in the coming months as well as in consideration of future preparedness legislation.

Healthcare coalitions are the bridge between the new initiatives

The creation and promotion of HCCs for emergency preparedness, largely as a result of the HPP program, is creating a foundation for further progress in healthcare resilience. Well-functioning HCCs provide the structure and capabilities required for small-scale events. Furthermore, because they now exist in most communities and they are intended to be inherently collaborative, HCCs are a natural hub for further engagement of other essential partners (see below) in building a community-wide culture of resilience to natural disasters. In some communities, other entities are active in activities that promote community health resilience, but for the most part they are focused on chronic health and societal issues

rather than acute disasters. Furthermore, these entities are not typically connected to professionals working on preparedness. Likewise, there are entities that focus on the nonmedical aspects of community disaster resilience.

HCCs may be a point of connection or integration for both kinds of entities to the healthcare disaster resilience efforts in their community. As HCCs continue to mature, they are attempting to reach out to new members of the health sector beyond just hospitals, public health, EMS, and emergency management—such as nursing homes, home care, and outpatient services. But many HCCs are struggling with this, in part due to limited funding and personnel as well as a lack of incentive on the part of these other entities to join HCCs. Therefore, additional approaches are needed to promote the integration of many more components of civil society into health sector preparedness and resilience efforts, particularly ones that incentivize community health resilience and disaster resilience organizations to join with HCCs. These new approaches could be financial incentives or regulatory requirements. We will say more about this in the section on policy recommendations. The integration may be fostered to some extent by the Emergency Preparedness Rule issued from the Centers for Medicare and Medicaid Services (CMS) on November 16, 2016. This rule requires all CMS providers and suppliers to meet specific preparedness criteria, including working in collaboration with other community partners. [24]

Likewise, HCCs connected to newly developed nearby disaster resource hospitals would provide the capabilities and capacities needed for a complex mass casualty event. For each type of event, HCCs are essential. They are the bridge that connects community resilience efforts to disaster resource hospitals and creates the infrastructure for a response to a catastrophic health event. They are also the bridge to the future—the foundation on which to build the new pieces.

A conceptual model of a future disaster healthcare system

We envision a resilient, tiered, regionalized, and adaptive system of preparedness and response that can deal as effectively as possible with all 4 types of disasters. The system incorporates all existing elements (with enhancements to all) and proposes 2 new long-term initiatives: fostering a culture of community-based resilience and forging a network of disaster resource hospitals. As illustrated in the infographic of 1 region (p.18) (perhaps a state or part of a state), we imagine a web of interconnected parts with 3 tiers: resilient communities; broad, effective healthcare coalitions; and specialized disaster resource hospitals.

Resilient communities and health sectors

At the ground level are communities and community-based organizations that focus on health, welfare, and resilience. This includes faith-based organizations, other nonprofit civic entities, community clinics that focus on the health of vulnerable populations, those organizations that focus on community development, and those that focus on other aspects of disaster resilience. Also at the ground level are community partners that provide essential services needed to support the health sector, such as public utilities, internet service suppliers, and grocery stores. Each of these, whether they realize it or not, play a role in the resilience of the health sector in a disaster. Through a new federal initiative to build a Culture of Resilience, all of these community-based organizations should be encouraged and incentivized to (1) enhance their own resilience to disasters, (2) support and encourage their community's resilience efforts, and (3) engage with local HCCs around preparedness and resilience. See the policy recommendation section for some thoughts on ways this might be accomplished.

Broad, effective healthcare coalitions

Most HCCs now include acute care hospitals, public health departments, EMS, and emergency management agencies. All other healthcare facilities and providers should be encouraged and incentivized to participate as well. HCCs and their constituent members (eg, hospitals and public health agencies) are the natural conduit through which community entities can connect to traditional preparedness efforts. HCCs are the bridge between the community resilience efforts and disaster resource hospitals.

Specialized disaster resource hospitals

Large academic medical centers with comprehensive services are the referral hubs for most highly specialized medical care—in particular, for services that might be relevant for disasters. Typically, they provide the most advanced pediatric and adult critical care, are the hubs of the trauma system (Level I trauma centers), and often have burn units. They have the capabilities needed for providing care to the most complicated disaster-related injuries and illnesses, including all kinds of surgery as well as expertise in radiation injuries and infectious diseases. In many cases they are also a major player in their local HCC. In addition, because of their size, they often have one or more full-time emergency managers on staff, a resource that is not available in many smaller hospitals. By setting rigorous standards, providing direct funding, and requiring accountability, a network of geographically distributed disaster centers of excellence (Disaster Resource Hospitals) could be created. They would be closely connected to the local HCCs and other local disaster resources, such as Medical Reserve Corps and National Disaster Medical System units. Through telemedicine and other evolving technologies, they could be a source of real-time, remote, clinical expertise. In addition, they could provide education and training to their local partners and coordinate exercises. They could also provide a research test bed for best practices and innovation and serve as a brain trust of expertise for each other and state and national governments. By advanced practice innovation, they would become models for other hospitals. As part of their innovation research they could promote a Culture of Resilience by exploring ways for the formal healthcare system to interact more closely with civil society and community-based organizations around disasters.

This infographic illustrates 3 disaster resource hospitals linked to each other; each is linked to 3 HCCs, and each of those resides in a culture of community-based resilience.
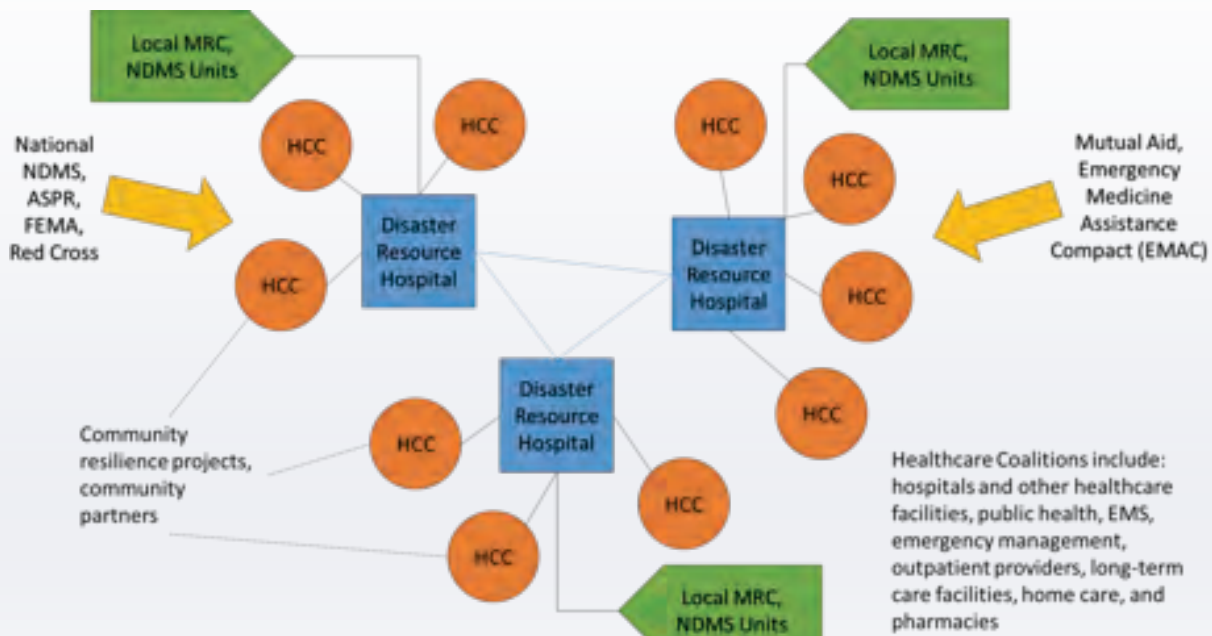
A national coordinator for catastrophic health events

There should be group in ASPR that is responsible only for preparing the nation for a catastrophic health event. There are many individuals and offices in ASPR working on various aspects of healthcare preparedness, but by necessity they focus primarily on events that are mostcommon. Catastrophic health events are different from other disasters in many ways. With the programs that now exist (with refinements) and the new initiatives described above, many of the pieces would exist for an effective national response to a catastrophic health event, but coordinating the various pieces requires an explicitly dedicated focus on catastrophic threats. Some group should be responsible for maintaining sustained focus on catastrophic health events and integrating the work of the various initiatives without the distraction of needing to prepare for and respond to other types of common events.

Policy Requirements to Foster This Vision

For each of the tiers in our conceptual model, there are distinct policy and funding/incentive requirements, as well as different sources of guidance. Below we outline the various policy requirements, funding sources, and guidance for each of the tiers. There is the possibility that these goals and policies could be incorporated into PAHPA efforts this year.

Resilient communities and health sectors

To build a Culture of Resilience in the greater health sector and civil society, community-based organizations must be incentivized to engage in preparedness activities and encouraged to become more resilient themselves to disasters. Those organizations that serve vulnerable populations should prioritize their own resilience and that of their clients. Personal resilience among vulnerable populations must be promoted and supported. Organizations involved in community resilience work and non–disaster-related health coalitions should be encouraged to connect to HCCs.

Incentives and funding for these activities could come from some existing sources, including PHEP cooperative agreements to state and local health departments, or from hospitals as part of the Internal Revenue Service's (IRS) requirement for nonprofit hospitals to conduct community needs assessment and provide community benefit.[25] Other funding opportunities should be explored as well, possibly including:

- block grants (eg, grants to jurisdictions in which a certain percentage of nonhospital healthcare facilities have their own disaster/continuity of operations (COOP) plans, participate in exercises and are linked to coalitions);
- grants to jurisdictions to encourage community-based organizations to embrace resilience;
- preferred bond rates to communities that achieve certain benchmarks;
- innovation grants to community-based organizations; or
- if there were funding associated with the new CMS preparedness rule that requires community engagement by participating healthcare providers, mechanisms could be explored that share the incentive with the community, or the CMS conditions of participation for healthcare entities could be used to incentivize more active outreach to community partners.

Guidance could come from PHEP capabilities guidance and the CMS preparedness rule requirements. NACCHO's Mobilizing Action through Planning and Partnerships (MAPP),[26] a community-driven strategic planning process for improving community health, may be a useful facilitator.

Broad, effective healthcare coalitions

Continued growth and maturation of HCCs is needed, including even greater outreach to "ancillary" healthcare entities. This is the current strategy of the HPP. Beyond this, there needs to be continued meshing of HCCs with integrated healthcare networks and accountable care organizations and identification of best practices in this regard. HCCs should connect to and collaborate with local MRC and NDMS units. There needs to be ongoing study of the effects of healthcare reform on coalition functioning as well as study of the impact of the CMS preparedness rule on coalitions.

An adequate and stable HPP funding level is required to maintain HCC functioning. The current HPP funding level is half of what it was 10 years ago, and, according to many key informants in this project, this level is barely sufficient to maintain the progress that that been made to date. Additional funds will be needed as coalitions expand their memberships as required by the HPP guidelines. In our judgment, HPP funding should be significantly increased and perhaps returned to its previous maximum level of $500 million per year in order to support the expansion of coalitions. The CMS conditions of participation under the new preparedness rule may provide further incentive for coalition activities. Under the preparedness rule, providers are required to work in coordination with other local and state entities. Failure to do so could threaten a provider's participation in the Medicare and Medicaid programs. Actively participating in an HHC would be one way to meet this requirement.

More specific Joint Commission accreditation standards regarding coalition involvement would be another incentive. The Joint Commission is the nongovernmental organization that accredits most US hospitals. The Joint Commission emergency management standards require cooperation with other hospital and preparedness and response agencies. A more explicit requirement to participate in an HCC would be a strong inducement for many hospitals.

Another potential source of financial incentive is the IRS requirement for nonprofit hospitals to conduct community needs assessments and provide community benefit in order to maintain their tax exempt status. In the past, many hospitals met this requirement by documenting unreimbursed care to indigent patients. With fewer uninsured patients under the Affordable Care Act (ACA), hospitals have realized decreased credit for indigent care. Actively participating in an HCC along with other preparedness activities may help meet this requirement.

Guidance for HCCs comes primarily from the HPP capabilities requirements and indirectly from the CMS preparedness rule and the Joint Commission Emergency Management Standards.

Specialized disaster resource hospitals

ASPR, in collaboration with professional organizations, other NGOs, and the Joint Commission, should lead the creation of a regionalized network of geographically and demographically distributed disaster resource hospitals. Participating hospitals should be enrolled through a competitive process and guided by stringent capability and accountability standards. These disaster resource hospitals should be required to integrate with nearby HCCs and local NDMS and MRC units as well as local VA hospitals and local NDMS federal coordination centers. The disaster resource hospitals should be part of an

active network with the other disaster resource hospitals that includes collaboration over practice, education, and research. The network of disaster resource hospitals should be integrated with NDMS at a national level.

Initially, ASPR should directly fund the disaster resource hospitals to enable the building of the programs. This will likely require new federal legislation and appropriation. We do not support funding this initiative out of the existing HPP budget. Other funding means should be sought to make the program sustainable for the long term and not subject to volatility in the annual federal budget. Possible federal funding avenues to explore include the IRS community benefit requirement, other IRS credits, and the possibility of supplemental CMS reimbursement. In our judgment, adding a modest amount of additional reimbursement for each Medicare and Medicaid admission to disaster resource hospitals that meet specified criteria might be the best means to support this initiative in the long term.

Guidance for this initiative could come from standards for specialty designation created by a newly established board as well as ASPR capability and reporting requirements.

A program dedicated to catastrophic health events

ASPR should designate a program exclusively dedicated to catastrophic health event planning and response. The role of the office should be to create a strategy and concept of operations for how all national assets would work together to most effectively respond to a catastrophic health event and then to coordinate efforts to implement them. This office should also be charged with the implementation of a well-developed strategy for crisis standards of care. The office would work hand-in-hand with HPP, NDMS, MRC, and other offices in ASPR. In addition, it would work with relevant parts of CDC (eg, the Office of Public Health Preparedness and Response and the Strategic National Stockpile), the Department of Homeland Security, the Veterans Administration health system, and the Department of Defense health system.

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