EVACUATE OR SHELTER-IN-PLACE? DECISION-MAKING FOR HOSPITALS DURING HURRICANE SANDY

by
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Dissertation Abstract

When disasters are impending, public officials and hospital administrators must determine whether to evacuate or shelter-in-place hospitals. During recent hurricanes, hospitals have proven unable to sustain continuity of operations. While failure to preemptively evacuate can endanger the safety of patients and staff, evacuation is not without risk and should only be undertaken if warranted. Little is known about how evacuation and shelter-in-place decision-making for hospitals occurs in practice. This research examined evacuation and shelter-in-place decision-making for hospitals in Delaware, Maryland, New Jersey, and New York during Hurricane Sandy in 2012. State emergency preparedness laws that may have affected evacuation and shelter-in-place of hospitals were systematically identified and analyzed. Semi-structured interviews were conducted with key informants who were responsible for decision-making during Sandy. Interviews were recorded, transcribed, and thematically analyzed. At the time of Sandy, none of these states had enacted statutes or regulations explicitly granting the government the authority to order shelter-in-place of hospitals. While all four states had enacted laws explicitly enabling the government to order evacuation, the nature of this authority and the individuals empowered to execute it varied. Hospital executives reported having authority and responsibility for decision-making. In New York and Maryland, government officials stated they could order hospital evacuation whereas officials in Delaware and New Jersey said the government lacked enforcement capacity and therefore could not mandate evacuation. Key informants relied on their instincts and did not employ aids or tools to make evacuation and shelter-in-place decisions during Sandy. Risk to patient health from evacuation, prior experience, cost, and ability to maintain

continuity of operations were the most influential factors in decision-making. Flooding and utility outages were the primary determinants of evacuation. States can further improve their readiness for catastrophic disasters by ensuring explicit authority to order evacuation and shelter-in-place where it does not already exist. Governmental and hospital plans should explicitly delineate decision-making processes and include explicit thresholds that, if exceeded, would trigger evacuation. Comparative risk assessments that inform decision-making would be enhanced by improved collection, analysis, and communication of data on morbidity and mortality associated with both pre- and post-evacuation versus sheltering-in-place of hospitals.

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Introduction

Problem Statement

Recently, there has been growing recognition that global climate change is occurring and that the severity of natural disasters has and will continue to increase as a consequence. According to the United States Global Change Research Program, "Even without further coastal development, storm surge levels and hurricane damages are likely to increase because of increasing hurricane intensity coupled with sea-level rise, the latter being a virtually certain outcome of the warming global climate" (Karl, Melillo, & Peterson, 20009). As a result of the flooding of New Orleans during Hurricane Katrina in 2005, 1% of the exposed population died, a rate that is no better than average event mortalities for historic floods (Jonkman, Maaskant, Boyd, & Levitan, 2009). There is an urgent need to adapt and respond to the challenges climate change poses in order to protect public health.

When natural disasters such as hurricanes strike, public officials and hospital administrators are faced with complex decisions to ensure the public's health and safety. A common, crucial decision is whether to evacuate healthcare facilities or whether to have patients and staff "shelter-in-place" (i.e., to remain within the healthcare facility for the duration of the emergency). During recent disasters, most notably Hurricane Katrina, hospitals and other healthcare facilities have proven unable to sustain continuity of operations and patient care while sheltering-in-place (Gray & Herbert, 2006). Moreover, failure to preemptively evacuate has endangered the safety of patients and staff. However,

evacuation is not without its own risk. Although data for hospitals does not exist, research has found that evacuation, and not the hurricane itself, significantly increases rates of mortality, morbidity, and hospitalization among nursing home patients (Dosa et al., 2010). Consequently, experts advise against policies of universal evacuation of healthcare facilities when there are impending storms (Dosa et al., 2012). Thus, as a storm is approaching, public health leaders and healthcare administrators must weigh the risks of evacuation against the risks of sheltering-in-place.

Hurricane Sandy

On October 29, 2012, Hurricane Sandy made landfall in New Jersey, devastating the Mid-Atlantic region's healthcare system, particularly hospitals. While several hospitals evacuated prior to the storm's arrival, other hospitals with seemingly similar risk profiles opted to shelter-in-place only to have to undertake urgent evacuations after critical infrastructure was damaged. Due to a 14-foot storm surge, fuel pumps supplying backup generators at New York University Langone Medical Center were damaged, necessitating the urgent evacuation of 322 patients – including 21 infants from the hospital's Neonatal Intensive Care Unit – overnight during the storm (Espiritu et al., 2014; VanDevanter, Kovner, Raveis, McCollum, & Keller, 2014). A short while later, nearby Bellevue Medical Center was evacuated for the first time in its 275-year history (Ofri, 2012; Uppal et al., 2013). In contrast, the Veterans Administration New York Harbor Healthcare System's Manhattan Campus, which neighbors these facilities, had evacuated preemptively, thus avoiding the need for any emergency evacuation during the storm.

The perilous evacuation of these two major medical institutions, in contrast to their neighbor, raised questions about how evacuation and shelter-in-place was decided upon and why government officials had not mandated hospital evacuation, as they had done one year prior in anticipation of Hurricane Irene in August 2011. U.S. hospitals are required to have all-hazards emergency plans, which may include procedures for evacuating patients (The Joint Commission, 2012; 42 CFR 482.41). Although guidance exists to facilitate evacuation and shelter-in-place decision-making, little is known about how decision-making occurs in practice.

Conceptual Model for Understanding Evacuation of Healthcare Facilities

After Hurricanes Katrina and Rita, Dobalian et al. (2010) developed a conceptual model to study future healthcare facility evacuations and specifically to understand decision-making processes of facility administrators (Figure 1). This conceptual model provided the context in which to examine decision-making and its influence on evacuation and shelter-in-place of hospitals during Hurricane Sandy in 2012.

Research Goal

The goal of this research was to enable public health, healthcare, and emergency management practitioners to respond to the near-term threats of climate change and to

protect public health by improving evacuation and shelter-in-place decision-making for hospitals.

Specific Aims and Research Questions

The study area of this research consisted of four contiguous states within the Mid-Atlantic region[*] of the United States – Delaware, Maryland, New Jersey, and New York – that were significantly impacted by Hurricane Sandy in 2012.[†]

The specific aims of this research study were to:

Specific Aim 1 – Characterize the region's public health legal preparedness at the time of Hurricane Sandy by identifying and comparing emergency authorities and responsibilities of Mid-Atlantic state governments.

Research Question 1.1: Within the Mid-Atlantic region of the United States, which organizations and individuals had authority and responsibility to issue emergency and public health emergency declarations and what did these authorities entail?

[*] Federal agencies involved in public health and emergency response include different states in their definitions of the "Mid-Atlantic" Region (Table 1). For the purpose of this research, Mid-Atlantic States are defined as states located in the middle of the Eastern Seaboard (i.e., the east coast) of the United States off of the Atlantic Ocean.

[†] Hurricane Sandy was nicknamed and popularly known as "Superstorm Sandy" because of its considerable size. Although Sandy weakened from a Category 3 hurricane (on the Saffir-Simpson Hurricane Wind Scale) in the Caribbean to an intense post-tropical cyclone before landfall in the United States, to avoid confusion, it is referred to as Hurricane Sandy throughout this dissertation.

Research Question 1.2: Within the Mid-Atlantic region of the United States, which organizations and individuals had authority and responsibility to order evacuations and what did that authority entail?

Research Question 1.3 Within the Mid-Atlantic region of the United States, which organizations and individuals had authority and responsibility to order shelter-in-place and what did that authority entail?

Specific Aim 2 – Characterize key stakeholders' perceptions of authority and responsibility for evacuation and shelter-in-place decision-making for hospitals during Hurricane Sandy.

Research Question 2.1: Who had authority to make evacuation and shelter-in-place decisions for hospitals in the Mid-Atlantic region of the United States during Hurricane Sandy?

Research Question 2.2: Who was responsible for making evacuation and shelter-in-place decisions for hospitals in the Mid-Atlantic region of the United States during Hurricane Sandy?

Specific Aim 3 – Describe the nature of hospital evacuation and shelter-in-place decision-making during natural disasters, namely hurricanes, through an examination of Hurricane Sandy.

Research Question 3.1: What legal and decision-making processes did government officials and hospital executives in the Mid-Atlantic region of the United States employ to make decisions about evacuating or sheltering-in-place hospitals during Hurricane Sandy?

Research Question 3.2: What data, resources, or aids informed these decisions?

Research Questions 3.3: How can evacuation and shelter-in-place decision-making for hospitals be improved to better protect public health?

Background and Literature Review

Hurricanes

A tropical cyclone is an organized system of clouds and thunderstorms with a closed circulation around a low atmospheric pressure center that originates over tropical or subtropical waters (Rosential, n.d.). Hurricanes[‡] are defined as tropical cyclones with maximum sustained 1-minute surface winds of 74 miles per hour (mph) or greater (Table 2) (Goldenberg, n.d.). Atlantic Hurricanes are a subset of hurricanes that form in the North Atlantic Basin, which includes the North Atlantic Ocean, Caribbean Sea, and the Gulf of Mexico (Table 3) (NWS, n.d.c). Ninety-seven percent of tropical activity in the Atlantic Basin occurs in "Atlantic Hurricane Season," which runs between 1 June and 30 November (AOML, n.d.). On average between 1970 and 2010, there were 11 annual tropical storms originating in the Atlantic Basin, 6 of which became Atlantic Hurricanes (DOC, 2013).

The National Hurricane Center uses the Saffir-Simpson Hurricane Wind Scale, a scale of hurricane intensity ranging from 1 (least severe) to 5 (most severe), to warn the public of potential property damage from a hurricane, as well as to inform emergency management decisions such as evacuation (Table 4) (The Associated Press, 2007). Over a typical 2-year period, the U.S. coastlines are collectively struck by an average of 3 hurricanes, 1 of

[‡] Tropical cyclones are referred to by different names depending on where they occur in the world. Storms that occur in the Indian Ocean are referred to simply as cyclones. Tropical cyclones that occur north of the Equator and west of the International Dateline (i.e., in the Western Pacific Ocean) are referred to as typhoons, while Northern Hemisphere tropical cyclones that occur east of the International Dateline to the Greenwich Meridian (i.e., Atlantic and Eastern Pacific Oceans) are termed hurricanes (Table 3).

which is classified as a Category 3, 4 or 5 hurricane (DOC, 2013).[§] Between 1900 and 2010, the costliest tropical cyclone on record to strike the U.S. mainland was Category 3 Hurricane Katrina (2005), which was responsible for $105.8 million US Dollars (USD) of property damage, followed by Category 5 Hurricane Andrew (1992), which resulted in $45.6 million USD in damage, and Category 2 Hurricane Ike (2008), which resulted in $27.8 million USD in damage. Even after accounting for inflation, eleven of the thirty costliest hurricanes on record have occurred between 2000 and 2010. After normalizing for societal vulnerability today (e.g., population and property development), eight of the top costliest tropical cyclones still occurred between 2000 and 2010 (Blake, Landsea, & Gibney, 2011).[**] [††] Between 1851 and 2010, the three deadliest tropical cyclones in the U.S. were the Galveston Hurricane of 1900 (Category 4), Florida/Lake Okeechobee Hurricane of 1928 (Category 4), and Hurricane Katrina (Category 3), which resulted in 8000,[‡‡] 2500,[§§] and 1200 deaths respectively (Blake et al., 2011).

Hazards associated with tropical cyclones include high winds, heavy rainfall, storm surge, inland flooding, tornadoes, and rip currents (NWS, n.d.a). Hurricanes and these environmental hazards can result in public health harms such as drowning, electrocution, carbon monoxide poisoning, heat-related illness, food and water-borne illness, musculoskeletal injuries, insect and animal bites, and mold exposure.

[§] A Category 3, 4, or 5 on the Saffir-Simpson Scale is also referred to as a "major" hurricane.
[**] Beginning in 1995, these costs include adjusted National Flood Insurance Program flood damage amounts. These costs have been adjusted for 2010 Dollars on the basis of the U.S. Department of Commerce Implicit Price Deflator for Construction.
[††] This only includes data from 1900-2010. No estimates of the financial burden of hurricanes are available prior to 1900. Data after 2010 have not yet been analyzed and/or published.
[‡‡] Could be as high at 12,000 deaths.
[§§] Could be as high as 3,000 deaths.

Sheltering and Evacuation Hazards

When hurricanes are impending, state and local public officials are faced with the difficult decision of whether to order evacuation. Even more complicated than evacuating the general public is the decision of whether to evacuate the vulnerable population of hospitalized patients or whether to have those patients and the providers who care for them "shelter-in-place" (i.e., remain in the hospital for the duration of the emergency). Hospitalized patients, unlike the general public, cannot self-evacuate. Moreover, they rely on public officials and hospital administrators not only to ensure their safety but also to ensure continuation of their medical care regardless of whether they shelter-in-place or evacuate.

When a decision to shelter-in-place is made, failure to ensure continuity of essential services can put both patients and workers at risk. Anecdotal reports from Hurricane Katrina revealed that some hospitals which sheltered-in-place lost electricity and, in turn, functions that required power including: lights, elevators, air conditioning, running water (and the sanitation of lavatories), and communications, as well as clinical functions (Kline, 2007). At the Medical Center on Keesler Air Force Base in Biloxi, Mississippi, facility emergency generators were destroyed by storm surge, forcing staff to perform a cesarean delivery using battery-operated flashlights to illuminate the operative field and a small generator, which was borrowed from a critically ill patient who had to be manually ventilated during the entire cesarean delivery (Allen, Flinn, & Moore, 2007). Similarly, loss of power at Charity Hospital in New Orleans resulted in the application of altered

standards of care for critically ill patients. This included the inability to obtain head scans of a patient who had a serious brain injury, no laboratory services, and the need to cool patients with Styrofoam cafeteria trays due to lack of air conditioning and a shortage of fans. In addition to resulting in altered – and potentially unacceptable – levels of care, lack of power also placed workers at risk of injury. The inability to use elevators forced staff to carry patients and equipment up and down stairs. One patient was carried down seven flights of stairs on an exterior fire escape to be evacuated. A generator was "hauled up seven floors by a large group of men…since the generator was large and quite heavy, this required a herculean effort on the part of all involved [and] of course the effort had to be repeated with other generators" (Kline, 2007). At Tulane Hospital, staff had to move bedbound patients down unlit stairways; two patients were on left ventricular assist devices, which could not be moved more than 2 feet from the patient and weighed 500 pounds. Tulane staff not only had to perform tasks with which they were unfamiliar but also had to lift and move significant weight in an unfavorable environment (e.g., temperatures significantly above 79 Fahrenheit and minimal lighting) (McSwain, 2010).

In light of the conditions that emerged in facilities that did not evacuate in anticipation of Hurricane Katrina, healthcare facility administrators have since reported feeling pressure to evacuate all at-risk facilities prior to hurricane landfall (Dosa et al., 2012). Although evacuation may be necessary to ensure adequate standards of care for patients, as well as to protect patients and workers, evacuation is not without risk. It can disrupt delicate social conditions, separating fragile patients from familiar settings, usual care-providers, and regular medication administration. While unwarranted evacuation can be a nuisance

for ordinary citizens, it can be harmful – and even life threatening – to vulnerable populations such as the elderly, disabled, and mentally ill. Although limited evidence exists for hospital populations, a study of nursing home residents with dementia discovered that patients who were evacuated were at increased risk of death even 30 and 90 days after relocation (Brown, 2012).

In 2011, in anticipation of Hurricane Irene, many healthcare facilities in the Mid-Atlantic region evacuated. In New York City alone, at least 7,000 patients were evacuated from hospitals and chronic care facilities in low-lying areas (Farley, 2013). Ultimately, Irene did not impact the Mid-Atlantic region as anticipated. According to the testimony of New York City Health Commissioner Thomas Farley, "in retrospect these evacuations were unnecessary" (Farley 2013). Moreover, many healthcare facility administrators reported that they believed evacuation adversely impacted their patients (Farley, 2013). Given the risk evacuation poses, universal evacuations of healthcare facilities are not advised (Dosa, 2012). Thus, the likelihood of the storm and the risks associated with evacuation must be carefully weighed against the risk of sheltering in-place in the hospital for the duration of the emergency.

Emergency Planning Requirements

As a condition of participation in Medicare, the Centers for Medicare & Medicaid Services (CMS) require that hospitals are "constructed, arranged, and maintained to ensure the safety of the patient, and to provide facilities for diagnosis and treatment" (42

CFR 482.21, 2011). Hospitals that seek to be compensated under Medicare must have "emergency power and lighting in at least the operating, recovery, intensive care, and emergency rooms, and stairwells. In all other areas not serviced by the emergency supply source, battery lamps and flashlights must be available" (42 CFR 482.21, 2011). State survey agencies routinely visit hospitals to determine compliance with these and other Medicare conditions of participation. Participating hospitals must also comply with the Life Safety Code of the National Fire Protection Association (2000), which requires written emergency plans for fire and evacuation.

Alternatively, hospitals can be exempt from these state surveys and can be deemed in compliance with Medicare conditions of participation if they achieve accreditation through one of the national accrediting organizations (CMS, 2015). At the time of Hurricane Sandy, there were three CMS-approved national accrediting organizations: Joint Commission, Det Norske Veritas Healthcare, Inc., and Healthcare Facilities Accreditation Program (CMS, n.d.).[***] The Joint Commission[†††], the largest healthcare accrediting organization, requires hospitals to develop and maintain an Emergency Operations Plan (EOP) that describes response procedures, which could include evacuation (The Joint Commission, 2012). As a result of these conditions of participation and accreditation requirements, hospital emergency plans often focus on internal emergencies such as fires. Additionally, such plans typically address the logistics of

[***] Since Hurricane Sandy, the Center for Improvement in Healthcare Quality (CIHQ) was also approved as a national accrediting organization (CMS, 2013).
[†††] Formerly known as the Joint Commission on Accreditation of Healthcare Organizations.

evacuation (i.e., evacuation procedures) and not how decision-makers can or should determine whether evacuation is appropriate (Hassol, Biddinger, & Zane, 2013).

Hurricane Sandy

On October 29, 2012, Hurricane Sandy made landfall in Brigantine, New Jersey, ravaging the Mid-Atlantic region of the United States. Hurricane Sandy was the second costliest cyclone in U.S. record-keeping history and the largest named storm on record in the Atlantic Ocean. Of the 147 deaths directly attributed to Hurricane Sandy, nearly half occurred in the Mid-Atlantic and Northeastern U.S. (Blake, Kimberlain, Cangialosi, & Beven, 2013). In addition to resulting in direct mortality, Hurricane Sandy had devastating impacts on the Mid-Atlantic region's healthcare systems, particularly hospitals (The City of New York, 2013; OIG, 2014).

In New York City alone, to ensure safety and continuity of medical care, approximately 6,300 patients were evacuated from 37 healthcare facilities (Farley, 2013). There were a total of 8 full-scale acute care hospital evacuations related to Hurricane Sandy.[‡‡‡] Two acute care hospitals evacuated in New Jersey – one prior to Sandy's landfall in Hudson County and one during the storm in Bergen County (Washburn, 2014). In New York State, one evacuation took place in Long Beach, Long Island while the remaining 5 evacuations took place in New York City (4 in Manhattan and 1 in Brooklyn) (The City

[‡‡‡] In Staten Island, New York there was also a psychiatric hospital, South Beach Psychiatric Center, which evacuated prior to Hurricane Sandy (NYS OMH & NYS DOH, 2013).

of Long Beach, n.d.). Three of the New York acute care hospital evacuations were preemptive. The remainder occurred during or in the immediate aftermath of (up to 2 days after) Sandy's landfall (Adalja et al., 2014).

Evacuation Decision Making

In Hurricane Sandy's aftermath, researchers and news media questioned why hospitals that were in close proximity to one another and had ostensibly similar risk profiles made differing decisions about evacuation and shelter-in-place (Hartocollis & Bernstein, 2012). There was also lingering uncertainty about why New York government officials had not ordered evacuation of hospitals in low-lying areas as they had in anticipation of Hurricane Irene in 2011 (Fink, 2012). Commentators called for "clear and consistent criteria to guide evacuation decisions," as well as integrated local and regional decision-making for sentinel events" (Hanfling, Powell, & Gostin, 2013; Powell, Hanfling & Gostin, 2012).

In response to similar calls after Hurricane Katrina in 2005, the U.S. Department of Health and Human Services funded the development of tools and aids[§§§] to support hospital evacuation and shelter-in-place decision-making (Zane et al., 2010). In addition to the Agency for Healthcare Research and Quality Hospital Evacuation Decision Guide, numerous state resources were also developed post-Katrina (California Hospital

[§§§] Aids refer to devices used to assist in the deliberative process of decision-making. Aids facilitate decision-making by helping decision-makers think about the situation, their options – including the option to do nothing – as well as the risks and benefits of each option. Examples of decision aids include checklists and decision trees.

Association, 2010; HSPH-EPREP, 2012). After Hurricane Sandy, Hassol et al. (2013) noted, "The most senior administrators of each hospital should be familiar with the data and plans upon which an evacuation decision would be based and use the best available guides for decision making, before and after an evacuation." Given the existence of these decision-making resources, as well as CMS and national accrediting organization emergency planning requirements, questions arise about whether decision-makers during Sandy were familiar with and employed these tools, as well as whether these resources are effective. It is also unknown whether and if so, how hospital administrators are considering the health and safety of their employees in their decision processes. Guidance for considering employee health and safety is limited; an Occupational Safety and Health Administration toolkit, the Hurricane eMatrix, focuses only on hazard exposure and risk assessment for response and recovery workers – not healthcare facility employees (OSHA, n.d.).

Existing peer-reviewed literature on hospital evacuations is limited (Bagaria, Heggie, Abrahams & Murray, 2009). Many publications are anecdotal and relay the experiences of practitioners and patients in healthcare facilities that evacuated (Kline, 2007; Ofri, 2012). With a few exceptions (McSwain, 2010; Verni, 2012), the majority of studies have considered the experience of single healthcare facilities (Blaser & Ellison, 1985; Uppal et al., 2013), units within hospitals (Espiritu et al., 2014; King et al., 2015), or even individual patients (Ramme, Vira & McLaurin, 2015). Other research has focused on the experiences of receiving hospital facilities or of staff who were evacuated and then re-assigned to these receiving hospitals (Adalja et al., 2014; VanDevanter et al., 2014).

Although this body of literature contains many lessons regarding preparedness and logistics of evacuation, it contains little information about how evacuation and shelter-in-place decisions for hospitals are made in practice (Bagaria et al., 2009).

McGlown (2001) identified variables health care executives considered critical in the decision to evacuate a healthcare facility. Though this research provided important insight, it did not include public health practitioners who play a key role in evacuation decision-making for healthcare facilities. Additionally, McGlown's research did not pertain to a specific emergency or decision that had taken place (i.e., it did not examine what factors were considered in practice during a specific disaster).

After Hurricanes Katrina and Rita in 2005, Dobalian, Claver and Fickel (2010) developed a conceptual model to study future healthcare facility evacuations and specifically to understand decision-making processes of facility administrators (Figure 1). A few studies have examined evacuation decision-making for hospitals during recent Hurricanes. Downey, Andress and Schultz (2013b) examined decision-making for 7 acute care hospitals within a single healthcare system that evacuated during Hurricane Rita in 2005. They identified the issuance of mandatory evacuation orders, storm characteristics (wind speed, storm surge, and projected path) and loss of regional communications as the most influential factors prompting evacuation (Downey, Andress & Shultz, 2013a). Ricci, Griffin, Heslin, Kranke, and Dobalian (2015) examined hospital evacuation and shelter-in-place decision-making processes during Hurricane Sandy, but the generalizability of this research is limited as it considers a single federal hospital facility. There remains a

lack of information on decision-making processes (i.e., how information is gathered, weighed, and acted upon), particularly when evacuation must be decided upon for multiple healthcare institutions in close proximity to one another.

Methods

Aim 1

To assess the public health legal preparedness of the Mid-Atlantic region, state emergency preparedness laws that may have affected evacuation and shelter-in-place of hospitals during Hurricane Sandy in 2012 were systematically identified and analyzed. Within the Mid-Atlantic region of the U.S., organizations or individuals who had legal authority to declare an emergency, declare a public health emergency, and order evacuation or shelter-in-place during Hurricane Sandy were identified. The nature of these authorities was subsequently described and analyzed.

Aim 1 Data Collection

Consistent with established public health legal research methods, emergency preparedness laws in four contiguous Mid-Atlantic states were systematically analyzed (Wagenaar & Burris, 2013). These state-level laws concerned each government's authority to: (1) declare an emergency, (2) declare a *health* emergency, and (3) order evacuation or shelter-in-place. Utilizing an electronic legal database, LexisNexis® State Capital (Bethesda, MD, USA), Delaware, Maryland, New Jersey, and New York statutory and administrative codes were searched to identify emergency preparedness laws in place on October 22, 2012, the date on which Sandy became a named storm (Blake, 2013). Initial keywords, which were based on *a priori* knowledge, included: "emergency," "disaster," "public health emergency," "health emergency," "evacuation,"

"shelter," and "sheltering-in-place." These keywords were piloted and refined through an iterative process including review of preliminary findings by myself and members of my thesis advisor committee. After piloting and finalizing search terms, three distinct queries were then conducted of the Delaware, Maryland, New Jersey, and New York statutory and administrative codes for each of the authorities of interest. The final search strings were:

(1) Authority to declare an emergency: "disaster" OR "emergency" AND "governor"
(2) Authority to declare a *health* emergency: "health emergency" OR "health disaster"
(3) Authority to order evacuation or shelter-in-place: "shelter" OR "evacuate"

The full text of every state statute and regulation returned by each query was subsequently reviewed and duplicates were removed (Table 5). The following exclusion criteria were applied to the identified laws:

(1) Executive orders, which are codified in some states, were excluded because they themselves do not confer authority but rather are examples of the exercise of authority granted by statute or regulation;
(2) Laws in which the keyword had a meaning unrelated to health emergency preparedness were excluded (e.g., bus shelters);
(3) Laws pertaining to the evacuation of vehicles (e.g., trains) or rides (e.g., fun houses) were excluded;
(4) Laws addressing only fire-related evacuation were excluded;

(5) Laws addressing only casino emergencies were excluded.

As a quality control measure, the identified laws were compared to existing, publically available lists of emergency health laws from the Network for Public Health Law and the Johns Hopkins Center for Law and the Public's Health (NPHL, 2012) (Center for Law and the Public's Health, 2013). When a discrepancy arose between search findings and existing compilations of emergency health laws, I consulted the law's text to determine whether it should be included in the data set.

Aim 1 Data Analysis

Three electronic data extraction forms (one for each of the three searches) were created in Qualtrics (Provo, UT, U.S.), an online survey and data collection program. These forms were then used to abstract information from the full text of the statutes and regulations previously determined to be relevant for each of the authorities of interest. The Association of State and Territorial Health Officers (ASTHO) Emergency Declarations & Authorities–State Analysis Guide (2011), as well as the study's aims and research questions, informed the development of the fields in each data extraction form. Abstracted data allowed for a comparison of the four states' laws with respect to the three types of emergency authorities and an understanding of the legal context that existed in Delaware, Maryland, New Jersey, and New York at the time of Hurricane Sandy in October 2012.

The final materials included: a study protocol, which documents each step in the identification of laws and subsequent data abstraction; a list of all query results; the full text of all relevant laws; three data extraction forms; and an abstracted legal data set. To foster reliability of findings, the study protocol and data extraction forms are provided in Appendices 1-4 (Wood, 2012).

Aims 2 and 3

From March 2014 to February 2015, semi-structured interviews were conducted with key informants in Delaware, Maryland, New Jersey, and New York to examine acute care hospital evacuation and shelter-in-place decision-making during Hurricane Sandy.

Selection and Recruitment of Participants

News media stories, press releases, and governmental reports were reviewed to identify organizations for inclusion. Interviewees, who were selected based on their functional role, were purposively sampled to include at least one hospital representative per state and a public health and emergency management official from the hospital's jurisdiction. Hospital interviewees were executives (e.g., chief executive officer (CEO)) or senior managers (e.g., director of emergency management). Governmental interviewees held senior leadership roles (e.g., commissioner/secretary of health, director of emergency

management) during Hurricane Sandy. Additional interviewees were added through snowball sampling.

To be eligible for inclusion, during Hurricane Sandy, an interviewee must have been employed in Delaware, Maryland, New Jersey, or New York, by either a(n): 1) hospital, 2) health department, 3) office of emergency management, or 4) other organization, which was responsible for or significantly involved in the decision to shelter-in-place or evacuate hospitals during Hurricane Sandy. Hospitals were excluded if they never considered whether to evacuate, which was determined by asking the hospital itself. Potential interviewees were excluded if they lacked direct knowledge of decision-making. Each state's hospital association – except for New York, where the trade association for the metropolitan New York area was contacted – validated hospitals for inclusion. Additionally, each state health department and the New York City Department of Health and Mental Hygiene were consulted to ensure relevant hospitals were not omitted (Appendices 5 and 6).

Aims 2 & 3 Data Collection

A semi-structured interview guide was piloted with an emergency management official and revised based on feedback from pilot testing and several healthcare preparedness experts. The guide was organized into the following domains: authorities and responsibilities; decision processes; information and decision-making aids; and lessons learned (Appendix 7). Semi-structured interviews were conducted in-person or via phone

when an in-person meeting was not feasible. One health department opted for a facilitated group discussion. Interviewees were assigned a unique, random study identification number, which was used for all study materials. Interviews were audio-recorded and transcribed with the permission of interviewees (Appendix 8). Transcripts were compared to the audio recordings and any transcription errors were corrected.

Aims 2 & 3 Data Analysis

After each interview, a contact summary sheet was completed documenting immediate reflections (Appendix 9) (Miles, Huberman & Saldana, 2014). To enhance analytic rigor and reliability, peer debriefing was conducted throughout data collection and analysis (Lincoln & Guba, 1985). An impartial peer with expertise in the subject matter and research methods, but no other role in the study, reviewed and critiqued data collection and analysis processes.

A framework analytical approach was used to systematically search for patterns and generate descriptions for understanding the phenomenon of hospital evacuation and shelter-in-place decision-making (Gale, Heath, Cameron, Rashid & Redwood, 2013). Transcripts were thematically coded using QSR Nvivo for Mac v10.1.3 (Burlington, MA, U.S.). A codebook was developed with a priori codes based on research questions and conceptual models of healthcare facility evacuation decision-making from the peer-reviewed literature (Dobalian et al., 2010; McGlown, 2001). Additional themes were

inductively identified and iteratively applied. Structural codes (e.g., state, informant's sector, evacuation status) were applied to organize the data.

The Johns Hopkins Bloomberg School of Public Health Institutional Review Board determined this study was not human subjects research and was therefore exempt from full review (Appendices 10 and 11).

Paper 1

Manuscript 1: Hospital Evacuation and Shelter-in-Place Decision-Making During Hurricane Sandy – An Analysis of Influential Mid-Atlantic State Laws

Abstract

Once thought to be bastions, hospitals have proven unable to ensure the safety of patients and staff and continuity of medical care during recent catastrophic disasters including Hurricanes Katrina and Sandy. Given its duty to safeguard public health, the government has a responsibility to ensure appropriate protective action is taken when impending disasters threaten or impair the ability of hospitals to sustain essential services. The law enables the government to fulfill this duty by providing necessary authority to order preventive or reactive response when safety is imperiled. State emergency preparedness laws that may have affected evacuation and shelter-in-place of hospitals during Hurricane Sandy in 2012 were systematically identified and analyzed to understand *public health legal preparedness* of the Mid-Atlantic region. At the time of Hurricane Sandy, all four Mid-Atlantic states of interest had enacted laws empowering their governor to declare an emergency. However, these states were less consistent in enacting complementary laws including the authority to declare a *health* emergency, order evacuation, or order shelter-in-place. Empirical analyses to enhance *public health legal preparedness* and ensure the Mid-Atlantic is better able to respond to future natural disasters like Hurricane Sandy, which are predicted to be more severe and frequent as a result of climate change, are presented.

Introduction

In 2012, Hurricane Sandy[****] ravaged the Mid-Atlantic[††††] region of the United States (U.S.). Hurricane Sandy was the biggest named storm on record in the Atlantic Ocean and the second – only to Hurricane Katrina – costliest cyclone in U.S. history (Blake, 2013). At least 148 deaths were directly attributed to Hurricane Sandy with nearly half of those fatalities occurring in the Mid-Atlantic and Northeastern U.S. (Blake, 2013). Besides resulting in direct mortality, Hurricane Sandy significantly threatened the health and safety of Mid-Atlantic residents. In New York City alone, to ensure their safety and continuity of medical care, approximately 6,300 patients were evacuated from 37 healthcare facilities (Farley, 2013).

During recent catastrophic hurricanes including Katrina in 2005 and Sandy in 2012, essential hospital services including power, steam, water, and sanitation were interrupted hindering both continuity of patient care and the safety of patients and staff. Because a fundamental duty of government is to protect the health and safety of its citizens, the government must ensure an appropriate response to natural disasters (Gostin, 2008). To cope with hurricane threats, such a response may necessitate sheltering-in-place[‡‡‡‡] (i.e.,

[****] Although Sandy evolved from a Category 3 hurricane in the Caribbean to an intense extratropical cyclone before landfall in the U.S., to avoid any confusion, it will be referred to as a hurricane throughout this chapter.

[††††] For the purpose of this research, Mid-Atlantic states are defined as states located in the middle of the Eastern Seaboard (i.e., the east coast) of the United States off of the Atlantic Ocean. The study area of this research consisted of four contiguous states within this region – Delaware, Maryland, New Jersey, and New York – that Hurricane Sandy was predicted to significantly impact.

[‡‡‡‡] Shelter-in-place means "to take immediate shelter where you are – at home, work, school, or in between (CDC, n.d.)." This research focuses specifically on sheltering-in-place at a hospital.

taking refuge within a hospital) or evacuating[§§§§] (i.e., the mass physical movement of patients and staff) hospitals. *Public health legal preparedness* plays an essential role in enabling the government to fulfill its duty by providing the necessary legal framework to respond to catastrophic disasters (Jacobson, Wasserman, Botoseneanu, Silverstein & Wu, 2012; Moulton, Gottfried, Goodman, Murphy & Rawson, 2003).

Public health legal preparedness is defined as the attainment by a public health system (e.g., a community, state, region, or nation) of legal benchmarks essential to the readiness of that system to respond to health threats. Scholars identify four core elements requisite to achieving *public health legal preparedness*: (1) *laws or legal authorities*; (2) *competencies* (i.e., abilities, skills) of those responsible for applying the law; (3) *information* to aid these individuals in applying the law; and (4) *coordination* across sectors and jurisdictions (Benjamin & Moulton, 2008; Moulton, 2003). This chapter examines the first core element – laws or legal authorities – to understand *public health legal preparedness* of the Mid-Atlantic region for catastrophic coastal storms such as Hurricane Sandy.

State emergency preparedness laws that may have affected evacuation and shelter-in-place of hospitals during Hurricane Sandy in 2012 were systematically identified and analyzed. Within the Mid-Atlantic region of the U.S., organizations or individuals who had legal authority to declare an emergency, declare a *health* emergency, and order

[§§§§] Evacuation is defined as "mass physical movements of people, of a temporary or permanent nature, that collectively emerge in coping with community threats, damages, or disruptions (Dobalian et al., 2010)."

evacuation or shelter-in-place during Hurricane Sandy were identified. The nature of these authorities was subsequently described and analyzed.

Methods

Data Collection

Consistent with established public health law research methods, emergency preparedness laws in four contiguous Mid-Atlantic states were systematically analyzed (Wagenaar et al., 2013). These state-level laws concerned each government's authority to: (1) declare an emergency, (2) declare a *health* emergency, and (3) order evacuation or shelter-in-place. Utilizing an electronic legal database, LexisNexis® State Capital (Bethesda, MD, USA), Delaware, Maryland, New Jersey, and New York statutory and administrative codes were searched to identify emergency preparedness laws in place on October 22, 2012. Initial keywords, which were based on *a priori* knowledge, included: "emergency," "disaster," "public health emergency," "health emergency," "evacuation," "shelter," and "sheltering-in-place." These keywords were piloted and refined through an iterative process including review of preliminary findings by the study team in order to create three separate keyword search strings corresponding to each of the three authorities of interest. Distinct queries were then conducted of the Delaware, Maryland, New Jersey, and New York statutory and administrative codes for each of the authorities of interest using the following finalized keyword searches:

(1) Authority to declare an emergency: "disaster" OR "emergency" AND "governor"

(2) Authority to declare a *health* emergency: "health emergency" OR "health disaster"

(3) Authority to order evacuation or shelter-in-place: "shelter" OR "evacuate"

The full text of every state statute and regulation returned by each query was subsequently reviewed and duplicates were removed (Table 5). The following exclusion criteria were applied to the identified laws:

(1) Executive orders, which are codified in some states, were excluded because they themselves do not confer authority but rather are examples of the exercise of authority granted by statute or regulation;

(2) Laws in which the keyword had a meaning unrelated to health emergency preparedness were excluded (e.g., bus shelters);

(3) Laws pertaining to the evacuation of vehicles (e.g., trains) or rides (e.g., fun houses) were excluded;

(4) Laws addressing only fire-related evacuation were excluded;

(5) Laws addressing only casino emergencies were excluded.

As a quality control measure, the identified laws were compared to existing, publically available lists of emergency health laws from the Network for Public Health Law and the Johns Hopkins Center for Law and the Public's Health (NPHL, 2012; Center for Law and the Public's Health, 2013). When a discrepancy arose, members of the study team consulted the law's text to determine whether it should be included in the data set.

Data Abstraction

Three electronic data extraction forms (one for each of the three searches) were created in Qualtrics (Provo, UT, U.S.), an online survey and data collection program. These forms were then used to abstract information from the full text of the statutes and regulations previously determined to be relevant for each of the authorities of interest. The Association of State and Territorial Health Officers (ASTHO) Emergency Declarations & Authorities–State Analysis Guide (2011), as well as the study's research questions, informed the development of the fields in each data extraction form. Abstracted data allowed for a comparison of the four states' laws with respect to the three types of emergency authorities and an understanding of the legal context that existed in Delaware, Maryland, New Jersey, and New York at the time of Hurricane Sandy.

The final materials included: a study protocol, which documents each step in the identification of laws and subsequent data abstraction; a list of all query results; the full text of all relevant laws; three data extraction forms; and an abstracted legal data set. To foster reliability of findings, the study protocol and data extraction forms are provided in Appendices 1, 2, 3, and 4 (Wood, 2012).

Results

When Hurricane Sandy struck, Delaware, Maryland, New Jersey, and New York all had laws in place allowing their state government to declare an emergency. In contrast, only

two of the four Mid-Atlantic states – Maryland and New Jersey – had laws enabling the government to declare a distinct *health* emergency, which generally refers to a situation in which the occurrence or threat of exposure to a hazard would result in significant morbidity or mortality (Table 6) (Md. Code Ann., Public Safety, 2013e; NJ. Code Ann., 2013a). While none of the Mid-Atlantic states had explicitly authorized the government to order shelter-in-place, all four Mid-Atlantic states had enacted laws explicitly enabling the government to order evacuation at the time of Hurricane Sandy. Table 7 summarizes the legal variation among the Mid-Atlantic states for declaring an emergency, declaring a distinct *health* emergency, and ordering an evacuation.

Authority to Declare an Emergency

When Hurricane Sandy occurred, through statutory law Delaware, Maryland, New Jersey, and New York all had empowered the governor to declare an emergency.

Delaware: Delaware assigns responsibility for addressing "the dangers to life, health, environment, property or public peace within the State by emergencies or disasters" to its governor. The governor is responsible for directing the Delaware Emergency Management Agency and may issue any order, proclamation, or regulation necessary to manage the emergency. When an emergency is beyond local government control, the Delaware governor may also assume operational control over emergency management functions (Del. Code Ann., 2013a).

Maryland: When the governor declares a state of emergency, state and local emergency response plans are activated and the deployment, distribution, and use of resources is

authorized. The Director of the Maryland Emergency Management Agency (MEMA) is responsible for coordinating emergency response activities of state agencies and affected political subdivisions (Md. Code Ann., Public Safety, 2013b). After declaring a state of emergency, the Maryland governor may also promulgate reasonable orders, rules, and regulations necessary to protect life and property or to manage and end the emergency (e.g., control traffic in the emergency area, designate emergency zones, compel evacuation, etc.) (Md. Code Ann., Public Safety, 2013b; Md. Code Ann., Public Safety, 2013c).

New Jersey: In addition to authorizing the governor to proclaim an emergency if he or she deems it necessary, New Jersey law allows the governor to assume control of all emergency management operations and commandeer the services and property necessary to protect or promote public health, safety, and welfare (NJ. Code Ann., 2013d).

New York: In the event of an emergency declaration due to a radiological accident, the New York governor or his designee is responsible for overseeing the execution of the radiological emergency preparedness plan. New York law does not address oversight of emergency management operations for other types of emergencies or the issuing of emergency orders subsequent to a disaster emergency declaration (NY. Code Ann., 2013b).

While all four Mid-Atlantic states allocate this authority to the governor, the mechanism for declaring an emergency, the threshold for declaring an emergency, the required

content of a declaration, the requirements for notifying the public about and filing of the declaration, the period of effect, and the process for termination and renewal of orders vary by state (See Table 8).

Authority to Declare a Health Emergency

At the time of Hurricane Sandy, through statutory law, both Maryland and New Jersey had empowered the governor to declare a distinct *health* emergency (See Table 9) (Md. Code Ann., Public Safety, 2013e; NJ. Code Ann., 2013a). In Maryland, upon determination that a "situation in which extensive loss of life or serious disability is threatened imminently because of exposure to a deadly agent," the governor can declare a "catastrophic health emergency" by issuing a proclamation (Md. Code Ann., Public Safety, 2013e). The New Jersey governor may declare a "public health emergency" in the event of a biological, chemical, or nuclear attack (or accidental release); the appearance of a novel or previously eradicated biological agent; or a natural disaster (NJ. Code Ann., 2013a). This authority is exercised by issuing an executive order, but the governor is explicitly required to consult with the Commissioner of Health and Senior Services and the Director of the State Office of Emergency Management. Once declared, the Commissioner is responsible for coordinating the public health response to the health emergency in conjunction with the State Office of Emergency Management and in accordance with the State Emergency Operations Plan (NJ. Code Ann., 2013a). Although Delaware law defines a "public health emergency," it does not explicitly allocate this authority to a specific government official or indicate how such authority would be

exercised (Del. Code Ann., 2013c). New York has no law allowing for the declaration of a health emergency (Table 6).

Authority to Order Shelter-in-Place or Evacuation

At the time of Hurricane Sandy, none of the four Mid-Atlantic states had enacted statutes or regulations explicitly granting the government the authority to order "shelter-in-place," the protective action in which people take immediate refuge wherever they are (CDC, n.d.). While all four Mid-Atlantic states had enacted laws enabling the government to order evacuation (i.e., mass physical movement of people in response to a threat), the nature of this authority and the individuals empowered to execute it vary (See Table 10) (Quarantelli, 1980). In general, laws either allow the government to order evacuation of the public from an area when safety is imperiled or evacuation of a facility when conditions at that facility pose a threat.

Both Delaware and Maryland have established two types of evacuation authority – the authority to direct and compel the evacuation of a geographical area (i.e., evacuation of the general population) or the authority to order evacuation of a specific facility. In the event of an emergency, the Delaware governor is authorized to "direct and compel the evacuation of all or part of the population from any stricken or threatened area within the State if this action is necessary for the preservation of life (Del. Code Ann., 2013b). Similarly, "after declaring a state of emergency, the [Maryland] governor, if the governor finds it necessary in order to protect the public health, welfare, or safety, may… direct and compel the evacuation of all or part of the population from a stricken or threatened area" of Maryland (Md. Code Ann., Public Safety, 2013b). Both governors can also

prescribe routes for evacuation, modes of transportation, and destinations. Additionally, when the Delaware Division of Public Health "reasonably believes that it is more likely than not that [a] facility or material may seriously endanger the public health" the Division is authorized to close, evacuate, or decontaminate said facility or material (Del. Code Ann., 2013d). Likewise, Maryland law establishes the authority to close, evacuate, and decontaminate a facility "if necessary and reasonable to save lives or prevent exposure to a deadly agent" (Md. Code Ann., Public Safety, 2013f). In contrast to DE, it is the governor in Maryland who is empowered with this authority and he or she must first proclaim a catastrophic health emergency.

New Jersey law only addresses facility evacuation; it does not explicitly authorize ordering evacuation of the general population. In New Jersey, during a health emergency, the Commissioner of Health can close, evacuate, and decontaminate any facility that endangers public health (NJ. Code Ann., 2013b). The written order, which must be provided to the facility within 24 hours, must specify the facility to which it applies, the terms of and justification for the order, when the order becomes effective, and the potential for a hearing to contest the order. New Jersey regulations authorize the Commissioner of Health to suspend the license of a healthcare facility or the Commissioner of Human Services to suspend the license of a substance abuse treatment facility upon finding patient care violations or when unsafe conditions in the facility's physical structure pose an immediate threat to the health, safety, and welfare of either patients or the general public (N.J.a.C., 2013a; N.J.a.C., 2013b). Upon the suspension of

its license, the healthcare or substance abuse treatment facility must transfer its patients, a process which is approved and coordinated by the respective licensing department.

In New York, a county or city can order the evacuation of any person who either has no home or the use of their home jeopardizes their safety or the safety of others in the event of or in anticipation of an attack that threatens public health or safety (NY. Code Ann., 2013d). Additionally, after declaring a local state of emergency, the chief executive of any county, city, town or village in New York is authorized to "promulgate local emergency orders to protect life and property or to bring the emergency situation under control" (NY. Code Ann., 2013a). As an example, the law notes that if safety is imperiled, the chief executive can designate zones that people are prohibited from occupying (and presumably need to evacuate).

Discussion

When natural disasters such as hurricanes strike, public officials are faced with complex decisions to ensure the public's health and safety. A common, crucial decision is whether to evacuate the vulnerable population of hospitalized patients or whether to have these patients and their care providers shelter-in-place for the duration of an emergency (Fairchild, Colgrove & Jones, 2006). Hospitalized patients, unlike the general public, cannot self-evacuate. They rely on public officials and hospital administrators not only to ensure their safety but also to ensure continuation of their health care regardless of whether they shelter-in-place or evacuate.

Unfortunately, during recent disasters – including Hurricanes Katrina and Sandy – hospitals have proved unable to sustain essential services after deciding to shelter-in-place (Fink, 2009; Uppal et al., 2013). In such circumstances, the government has a core duty to ensure that hospitals are evacuated. *Public health legal preparedness* plays an essential role in enabling the government to fulfill this duty by providing the necessary legal framework including the authority to declare an emergency, to declare a *health* emergency, and to order evacuation or shelter-in-place.

At the time of Hurricane Sandy, the Mid-Atlantic states had achieved varying levels of *public health legal preparedness* for catastrophic coastal storms. All four Mid-Atlantic states had enacted laws empowering the governor to declare an emergency. However, the Mid-Atlantic states were less consistent in codifying the authority to declare a *health* emergency, order evacuation, or order shelter-in-place – public health measures which can enable the government to ensure health security and, in particular, protect already vulnerable populations such as hospitalized individuals.

While Maryland and New Jersey have codified the authority to declare a health emergency, Delaware and New York have not. Codifying the ability to declare a *health* emergency typically ensures that the governor coordinates with the state's senior health official, which may not occur with a general emergency declaration. For example, New Jersey law specifically provides that, "the governor, in consultation with the

commissioner [of health] and the Director of the State Office of Emergency Management, may declare a public health emergency" (NJ. Code Ann., 2013a).

Moreover, codifying the authority to declare a distinct *health* emergency is important because it establishes and clarifies public health officials' responsibility for and role in response operations. In New Jersey, when a *health* emergency is declared, a New Jersey statute specifies that the Commissioner of Health:

> *Shall coordinate all matters pertaining to the public health response to a public health emergency, and shall have primary jurisdiction, responsibility and authority for: (1) planning and executing public health emergency assessment, prevention, preparedness, response and recovery for the State; (2) coordinating public health emergency response between State and local authorities; (3) collaborating with relevant federal government authorities, elected officials and relevant agencies of other states, private organizations or companies; (4) coordinating recovery operations and prevention initiatives subsequent to public health emergencies; and (5) organizing public information activities regarding public health emergency response operations(NJ. Code Ann., 2013a).*

During a coastal storm, this might mean assessing whether it is necessary to evacuate a hospital, coordinating with relevant agencies of other states or the federal government and private organizations to arrange for the transport of patients from one hospital to another, or arranging for the delivery of extra supplies to hospitals that shelter-in-place. In contrast, the law authorizing the New Jersey governor to declare a general emergency

has no requirement for the governor to coordinate with health officials nor does it identify any activities for which health officials would specifically be responsible (NJ. Code Ann., 2013d).

Similarly, the Maryland law codifying the authority to declare a *health* emergency addresses the role of the Secretary of Health (Md. Code Ann., 2013f). In 2009 Maryland Governor Martin O'Malley declared a health emergency in response to the H1N1 influenza pandemic, exercising this authority for the first time since it was codified. This declaration conveyed the expectation for health authorities to lead response operations by explicitly authorizing the Secretary of Health and Mental Hygiene "to take other steps as are necessary to reduce the public health consequences of this influenza outbreak" (General Assembly of Maryland, 2010).

Even without a codified authority to declare a health emergency, states may still be able to take necessary emergency management actions to control public health threats via a general emergency declaration or through the routine police powers delegated to health officials. For example, in New York, after the declaration of an emergency, the governor can direct state agencies to provide assistance including "distributing medicine, medical supplies, food and other consumable supplies…[and] performing on public or private lands temporary emergency work essential for the protection of public health and safety…" (NY. Code Ann., 2013c). The ability to address public health and safety and, more specifically, to make public health and medical countermeasures available through an emergency declaration may be one reason New York has not codified the authority to

declare a health emergency. However, even if states can manage health threats through a general emergency declaration, it is important to codify to authority to declare a distinct health emergency. Codifying the authority to declare a distinct *health* emergency not only contributes to improved *public health legal preparedness* by establishing clear lines of legal authority but also can improve the competence of the agents responsible for implementing such laws and enhance coordination between all parties with a role in a public health emergency response.

In states that have codified the authority to declare a health emergency, challenges may still arise because their definition of "health emergency" is limited and may not include natural disasters. Recent hurricanes such as Katrina and Sandy have demonstrated that natural disasters have significant physical and mental health consequences (Shultz, Russell & Espinel, 2005). While the occurrence or imminent threat of a natural disaster constitutes a health emergency in New Jersey, it does not in Maryland or Delaware. Maryland defines a health emergency as "a situation in which extensive loss of life or serious disability is threatened imminently because of exposure to a deadly agent," where "deadly agent" refers to "anthrax, ebola, plague, smallpox, tularemia; or other bacterial, fungal, rickettsial, or viral toxin; mustard gas, nerve gas; or other biological or chemical agent or radiation levels capable of causing extensive loss of life or serious disability" (Md. Code Ann., 2013d). In Delaware, neither a natural disaster nor nuclear or radiologic incident constitutes a health emergency. Due to these limited definitions, a health emergency could not have been declared in Maryland or Delaware in anticipation of Hurricane Sandy. Consequently, the Maryland Secretary of Health would not have had

the authority to order evacuation. While the Maryland Governor could have ordered evacuation, as discussed above, under a general emergency declaration, there is no explicit requirement for coordination with health officials. Similarly, a declaration of a state of emergency in Delaware would not require coordination with state health officials, who are most familiar with and regulate hospital operations.

At the time of Hurricane Sandy, none of the four Mid-Atlantic states had explicitly authorized the government to order people to seek immediate refuge wherever they were (i.e., "shelter-in-place"). Sheltering-in-place may be necessary during an emergency to ensure safety, health, and welfare. For example, after the Boston Marathon bombing in 2013, Massachusetts Governor Deval Patrick requested that Bostonians shelter-in-place while law enforcement officers were in pursuit of one of the bombing suspects. Bostonians submitted to this voluntary request, leaving the streets of Boston deserted (Salsberg, 2014).

Whether this remarkable compliance was motivated by fear or the intense desire for officials to apprehend the suspect, the public may not be as willing to voluntarily shelter-in-place in different emergency circumstances. To protect the public in instances of terrorism, as well as natural disasters and chemical or radiological accidents, it may be necessary for the government to mandate shelter-in-place. There may be little warning for incidents necessitating shelter-in-place such as active shooter situations, tornados, or chemical spills. In such circumstances, public health officials must be able to expeditiously order shelter-in-place. The lack of laws explicitly authorizing officials to

mandate shelter-in-place could delay the issuing of such orders by hindering the development of "implementation tools" (e.g., pre-drafted orders) or the ability and skills of public officials to understand and apply the law (Moulton, 2003). Without explicit legal authorities, public officials may be unaware of their powers and responsibilities relative to shelter-in-place or may be confused about how to exercise it.

While the government will, at times, need to order people or entire facilities to shelter-in-place, other emergencies will necessitate evacuation to ensure individuals' safety. When Hurricane Sandy was approaching, all four Mid-Atlantic states had enacted laws enabling the government to order evacuation, but the scope and nature of these authorities differed. New Jersey only explicitly empowers the government with the authority to close, evacuate, and decontaminate a facility, which endangers public health, or to suspend the license of a healthcare or substance abuse facility and subsequently evacuate its patients (i.e., New Jersey does not codify area evacuation authority). The ability to order facility evacuation is an important public health tool that may be necessary in more contained emergencies (e.g., biological, chemical or radiological contamination of a hospital) or in response to emergencies that result in confined damage (e.g., earthquake or tornado resulting in infrastructure damage necessitating evacuation of individual hospitals). However, this authority alone may be inadequate to protect public health and safety since it does not enable preventive or area-wide action, which may be necessary with an approaching coastal storm. For example, these authorities would not permit ordering the evacuation of the general public from a threatened area prior to a storm's landfall or ordering the evacuation of a hospital, which has not yet sustained physical damage, but

for which there is a reasonable threat of damage that would hinder continuity of patient care. Moreover, the nature of this authority, which requires the opportunity for a hearing to contest the order, is incongruent with the urgency necessary to achieve evacuation prior to the arrival of a hurricane – particularly evacuation of a hospital, which requires even more time than evacuation of the general public.

Limitations

This research has several limitations. Although a thorough and systematic search methodology was employed, relevant laws may have been inadvertently excluded from the results. The scope of this research is limited to state-level statutes and regulations in four Mid-Atlantic states in place prior on October 22, 2012. Our findings do not include local (e.g., county, city, town, or village) ordinances, regulations, or orders. Practitioners and researchers have noted that disasters – and thus the most effective response to them – are local (Anderson & Hodge, 2013). At the time of Hurricane Sandy, both New Jersey and New York had state-level statutes that granted broad authority to local officials to declare and manage an emergency in their jurisdiction to protect health and safety (NJ. Code Ann., 2013c; NY. Code Ann., 2013a). In contrast, neither Maryland nor Delaware grant authority for declaring an emergency to their localities via statute. Local officials are uniquely positioned to respond to their communities' needs in a disaster, as they are physically closer to those affected by an emergency and therefore, unless overwhelmed, typically able to respond more quickly. Moreover, they are more likely to understand their community's needs and local officials are known within their communities. Future

studies should therefore examine local laws, which may also impact emergency response and evacuation of hospitals. In addition, to better understand *public health legal preparedness* on a national scale, future research should examine evacuation and shelter-in-place laws in the remaining 46 states, Washington, D.C., and the U.S. territories.

Conclusion

In an era of changing climate, where natural disasters are likely to occur with more force and more frequency, governments urgently need to prepare to fulfill their core duty to protect public health and safety. The law enables the government to fulfill this duty by providing necessary authority to order preventive or reactive response when safety is imperiled but clear authorities and responsibilities are essential. By providing a systematic inventory of existing emergency preparedness laws relevant to ensuring continuity of hospital care during coastal storms, this empirical research contributes to enhancing *public health legal preparedness*. States can further improve their readiness for catastrophic disasters by ensuring the explicit authority to declare a *health* emergency, order evacuation, or order shelter-in-place where is does not already exist.

Paper 2

Hospital Evacuation and Shelter-in-Place: Who is responsible for decision-making?

Abstract

Objective: During natural disasters, hospital evacuation may be necessary to ensure patient safety and care. However, little is known about how evacuation/shelter-in-place decision-making occurs. We aimed to examine perceptions of stakeholders involved in these decisions throughout the Mid-Atlantic region of the United States during Hurricane Sandy in October 2012.

Methods: Semi-structured interviews were conducted from March 2014 to February 2015 to characterize stakeholders' perceptions about authority and responsibility for acute care hospital evacuation/shelter-in-place decision-making in Delaware, Maryland, New Jersey, and New York during Hurricane Sandy. Interviews were recorded, transcribed, and thematically analyzed using a framework approach.

Results: We interviewed 42 individuals from 32 organizations. Hospital executives from all states reported having authority and responsibility for evacuation/shelter-in-place decision-making. In New York and Maryland, government officials stated they could order hospital evacuation whereas officials in Delaware and New Jersey said the government lacked enforcement capacity and therefore could not mandate evacuation.

Conclusions: Among government officials, perceived authority for hospital evacuation/shelter-in-place decision-making was viewed as a prerequisite to ordering evacuation. When both hospital executives and government officials perceive themselves

to possess decision-making authority, there is the potential for inaction. There is value in a single entity bearing ultimate responsibility for hospital evacuation/shelter-in-place decision-making.

Word count: 200/200

Keywords: hospital evacuation, hospital shelter-in-place, organizational decision-making, emergency preparedness, disasters

Introduction

Extreme weather events such as hurricanes can disrupt the delivery of healthcare services by damaging healthcare facilities and the infrastructure upon which they depend (The City of New York, 2013). Natural disasters have necessitated the evacuation of hospitals to ensure continuity of medical care (Bagaria et al., 2009). Moreover, failure to preemptively evacuate may endanger patient and staff safety (Powell, 2012). However, evacuation is not without consequences.

During Hurricane Sandy in October 2012, several hospitals sustained flooding and damage to their electrical systems and emergency generators (Farley, 2013). The subsequent loss of lighting, elevators, and water pressure placed patients and workers at risk of injury and illness and resulted in post-event evacuation. At Bellevue Hospital in New York City, to maintain power after fuel pumps failed, hundreds of hospital staff formed a bucket brigade passing 5-gallon drums of fuel up 13 flights of stairs to the fuel tank (Uppal et al., 2013). At neighboring New York University Langone Medical Center (NYULMC), when a 14-foot storm surge caused the emergency generator to fail, staff members evacuated 322 patients down as many as 17 flights of stairs (Adalja et al., 2014).

In addition to causing staff to perform strenuous, unfamiliar tasks – a known risk factor for occupational injury – power loss may necessitate consideration or implementation of altered standards of care (McGwin, Taylor, MacLennan & Rue, 2005). In the Intensive Care Unit (ICU) at Bellevue, when power loss seemed imminent during Hurricane Sandy,

staff considered which patients should be prioritized for access to six outlets powered by a backup generator; those not prioritized would have been manually ventilated had power been lost. Additionally, diagnostic imaging and laboratory services were unavailable (Uppal et al., 2013). At NYULMC, Neonatal ICU patients were manually ventilated under minimal lighting as they were evacuated down the stairs (Davies, 2012).

Although extreme weather may compel hospital evacuation, decisions to shelter-in-place or evacuate hospitals are complex and involve many stakeholders. A "hospital evacuation decision team" typically includes an incident commander, hospital administrators, and emergency staff (Zane et al., 2010). Other stakeholders include public health, emergency management, and emergency medical service (EMS) officials. In addition, hospital trade associations, which represent evacuating and receiving facilities, may be key stakeholders in the decision-making process (Adalja et al., 2014).

Limited peer-reviewed research on hospital evacuation and shelter-in-place decision-making exists (Bagaria et al., 2009). With a few exceptions (Downey et al. 2013a; Downey et al., 2013b; McGlown, 2001), the majority of studies have considered the experience of single healthcare facilities (Kline, 2007; McSwain, 2010), units within hospitals (Espiritu et al., 2014), or individual patients (Ramme et al., 2015). Although there has been increasing emphasis on the development of hospital evacuation plans post-Katrina (Center for Bioterrorism Preparedness and Planning, 2006; Minnesota DOH, n.d.), as well as guidance, including the creation of an extensive Agency for Healthcare Research and Quality decision guide (California Hospital Association, 2010; HSPH

EPREP, 2012; Zane et al., 2010), little is known about how decision-making occurs in practice. Examinations of entire facility evacuations during Hurricane Sandy have been limited to case reports from two public hospitals (Ofri, 2012; Ricci et al., 2015; Uppal et al., 2013) and two studies focused on experiences at receiving facilities (Adalja, 2014; VanDevanter et al., 2014). There remains a lack of information on decision-making processes (i.e., how information is gathered, weighed, and acted upon), particularly when evacuation must be decided upon for multiple healthcare institutions in close proximity to one another.

The tremendous size of Hurricane Sandy provided a unique opportunity to study hospital evacuation and shelter-in-place decision-making at numerous hospitals. To address this gap in the literature, this study examined, *what are the perspectives of Mid-Atlantic government officials and hospital executives regarding authority and responsibility for hospital evacuation and shelter-in-place decision-making during Hurricane Sandy?*

Methods

Between March 2014 and February 2015, semi-structured interviews were conducted with key informants in Delaware, Maryland, New Jersey, and New York to examine acute care hospital evacuation and shelter-in-place decision-making during Hurricane Sandy.

Selection and Recruitment of Participants

News media stories, press releases, and governmental reports were reviewed to identify organizations for inclusion. Interviewees, who were selected based on their functional role, were purposively sampled to include at least one hospital representative per state and a public health and emergency management official from the hospital's jurisdiction. Hospital interviewees included executives (e.g., chief executive officer) or senior managers (e.g., director of emergency management). Governmental interviewees were senior leaders (e.g., commissioner/secretary of health). Snowball sampling was used to identify additional participants.

To be eligible for inclusion, during Hurricane Sandy, an interviewee must have been employed in Delaware, Maryland, New Jersey, or New York, by either a(n): 1) hospital, 2) health department, 3) office of emergency management, or 4) other organization, which was responsible for or significantly involved in the decision to shelter-in-place or evacuate hospitals during Hurricane Sandy. Hospitals were excluded if they never considered whether to evacuate, which was confirmed by asking the hospital itself. Potential interviewees were excluded if they lacked direct knowledge of decision-making. Each state's health department and hospital association– except for New York, where the trade association for the metropolitan New York area was contacted – validated hospitals for inclusion.

Data Collection

We developed a semi-structured interview guide organized into the following domains: authorities and responsibilities; decision processes and lessons learned. The guide was piloted with an emergency management official and revised based on feedback from pilot testing and several healthcare preparedness experts.

Semi-structured interviews were conducted in-person or via phone when an in-person meeting was not feasible. One health department opted for a facilitated group discussion. Interviewees were assigned a unique, random study identification number, which was used for all study materials. Interviews were audio-recorded with the permission of interviewees and transcribed. The interviewer listened to audio recordings and corrected any transcription errors.

Data Analysis

After each interview, a contact summary sheet was completed documenting immediate reflections (Miles et al., 2014). To enhance analytic rigor and reliability, peer debriefing was conducted throughout data collection and analysis (Lincoln et al., 1985). An impartial peer with expertise in the subject matter and research methods, but no other role in the study, reviewed and critiqued data collection and analysis.

A framework analytical approach was used to systematically search for patterns and generate descriptions for understanding the phenomenon of hospital evacuation/shelter-in-place decision-making (Gale et al., 2013). Transcripts were thematically coded using QSR Nvivo for Mac v10.1.3 (Burlington, MA, U.S.). A codebook was developed with a priori codes based on research questions and conceptual models of healthcare facility evacuation decision-making from the peer-reviewed literature (Dobalian et al., 2010; McGlown, 2001). Other thematic codes were inductively identified and iteratively applied (Appendix 12). Structural codes (e.g., state, informant's sector, evacuation status) were applied to organize the data.

The Johns Hopkins Bloomberg School of Public Health Institutional Review Board determined this study was not human subjects research and was therefore exempt from full review.

Results

Sixty-one representatives from 41 organizations were contacted for interviews. Of the 50 individuals meeting study inclusion criteria, 84% (n=42) agreed to be interviewed (Table 11). One public health official and one hospital representative each from New York declined to participate. In both cases, other representatives from these organizations participated in this research. Non-response was also minimal. Only three emergency management officials and one hospital representative did not respond to initial or follow-up recruitment messages. In one instance, another representative from their organization

participated in this research. Additionally, two individuals – one emergency management official and one hospital representative – agreed to be interviewed but ultimately did not participate in an interview due to logistical challenges.

Between March 2014 and February 2015, semi-structured interviews were conducted with 42 key informants from 31 organizations. Additionally, one organization provided a written statement, which was analyzed in the same manner as interview transcripts, but was unable to participate in an interview due to ongoing emergency response activities. Key informants worked for organizations representing 5 public health emergency response sectors: hospital (45%), hospital association (5%), public health agency (26%), emergency management agency (17%), and EMS agency (7%). Twelve percent were employed in Delaware, 29% in Maryland, 31% in New Jersey, and 29% in New York (Table 12).

Key informants were asked to describe their perceptions about authority and responsibility for hospital evacuation and shelter-in-place decision-making during Hurricane Sandy. These perceptions are organized into views of hospital and hospital association informants[17] and government informants (i.e., public health, emergency management, and EMS officials).

[17] As individuals from only one hospital association were interviewed in this study, perspectives of its employees are presented with those of hospital sector interviewees. Additionally, perspectives of interviewees from two public sector hospitals were included among hospital interviewees as they reflect their views as hospital administrators rather than as public sector employees.

Hospital Perspectives

The perspectives of hospital key informants (n=21) were consistent across Mid-Atlantic states and are accordingly presented collectively below. Hospital informants perceived their institutions to have authority and responsibility to decide whether to shelter-in-place or evacuate hospitals during a disaster. They ascribed decision-making authority to their hospital's chief executive officer (CEO). In some cases, hospital informants indicated that this authority had been delegated to other members of the executive leadership team (e.g., chief operating officer or chief nursing officer), often referred to as the "C-Suite" or administrators acting as incident commander of a disaster. One hospital executive stated, *"I'm the CEO of the hospital, right, and the ultimate decision on whether to evacuate or not rests with me*. " In discussing the decision during Hurricane Sandy, another CEO said, *"Quite frankly, it was my decision based on just input of a couple of hours with a lot of people and I just used my instincts and my experience and made the decision."*

There was one exception in which an informant from a public hospital perceived evacuation and shelter-in-place decision-making authority to rest not with the hospital but with leadership of the overarching hospital system in coordination with the senior-most local public health official. This hospital executive stated,

> *"[I]t's not a decision that would be made by [my hospital][18] alone or even certainly not by me as Incident Commander in my role and not by the [CEO]…it was pretty much [a local health official], [president of our health system] decision."*

[18]Throughout this paper, the names of specific people, their titles and their institutions have been replaced in quotations with generic terminology to ensure anonymity of interviewees and their organizations.

One CEO noted that fulfilling the responsibility to shelter-in-place or evacuate hospitals is challenging since emergency preparedness is often not a top priority for healthcare executives. This CEO stated,

> *"In the C-suite…[w]e have managing expenses, strategic development, electronic health records, what is ICD-10 coding, all that stuff. So where's community preparedness? And the answer is it's not there...usually the life safety stuff and the emergency preparedness stuff ends up getting delegated to an assistant administrator or to the director of safety and security or...the chief engineer or something like that."*

This perspective was confirmed by emergency management officials who indicated that although hospitals participated in preparedness activities, they often assigned lower-level staff, who do not possess decision-making authority and may not even be consulted by senior hospital administrators during disasters, to collaborate with emergency management.

Hospital informants also recognized that their facilities could be ordered or mandated to evacuate by the state or local government with the exception of Veterans Administration facilities, which are under federal jurisdiction. Yet, several hospital informants perceived the state government as unwilling or unable to provide guidance or exercise this authority. One informant described their hospital's experience during Hurricane Irene stating,

> *"The state was not requiring or mandating any kind of evacuation, and they really left it up to the hospital to decide with truly very little guidance. And as the guy sitting in the hot seat as incident commander during that event it made us feel very much alone. The state was not willing to recommend a course of action."*

Other hospital informants perceived state government officials, who are located in the capital or a significant distance away, as lacking the situational awareness necessary to

provide relevant guidance. When asked whether their state department of health provided decision-making guidance during Hurricane Sandy, one hospital informant stated,

> *"Well, we didn't even try with the health department. We didn't even think to try. I mean I don't know what they would've done. They're in [the capital]. We're on the ground. And I guess I would respond the same way to [the Department of Health and Human Services] (HHS) or anybody else. I mean I think at that time and place having drilled and having gone through all the what-ifs at some point I think you have to make your own decision. Somebody's not going to make it for you."*

Despite knowledge of the government's legal authority to mandate evacuation, the perceived inability of state government to provide useful guidance furthered the belief among hospital informants that they bore ultimate responsibility for evacuation and shelter-in-place decision-making.

Government Perspectives

In contrast to hospital key informants, government officials' (n=21) perceptions about authority and responsibility for evacuation and shelter-in-place decision-making during Hurricane Sandy varied by state and are therefore presented separately by state.

New York

New York government informants (n=3) described a locality's chief executive as having the authority to order evacuation. They clarified, however, that this authority did not infringe upon a hospital's right to evacuate. One government informant explained, *"[A]*

healthcare facility, if they feel that they need to evacuate, they can evacuate any time for any reason." Another government informant believed healthcare facilities had not only authorization but moreover an obligation to evacuate when necessary. This informant stated,

> *"[A] facility always has a right to evacuate themselves for patient safety, always, always. And it's their responsibility…. At the end of the day, it's not the government's responsibility to evacuate you, it's the facilities [that are] responsible for the patient."*

New York government informants perceived hospital evacuation and shelter-in-place decisions as complicated because the state department of health licenses and regulates healthcare facilities. While they recognized the local chief executive's evacuation authority, they described how only the state commissioner of health has authority to permit healthcare facilities to shelter-in-place. Furthermore, New York government officials defined "shelter-in-place" differently from neighboring states as well as New York hospitals. New York government officials perceived shelter-in-place to be a protective action that would occur only when a mandatory evacuation was ordered by the chief executive. One New York government official explained,

> *"Without that ordered evacuation, there is no shelter-in-place because there's no evacuation being ordered. It's a technical nuance that you need to understand because what happened in Sandy was there were no ordered evacuations for healthcare facilities therefore there was no authorized shelter in place…therefore those facilities that stayed technically were not sheltering place they just were stuck in the storm...."*

In contrast, and similar to key informants from all sectors in Delaware, Maryland, and New Jersey, New York hospitals perceived shelter-in-place as an alternative to evacuation where everyone within a hospital takes refuge or "shelters" onsite. New York

hospitals that did not evacuate during Hurricane Sandy described themselves as having sheltered-in-place.

Due to the complexity of these regulatory and emergency authorities, New York government informants described healthcare facility evacuation and shelter-in-place decision-making in New York as a necessarily collaborative process involving the state commissioner of health, the city commissioner of health, and the mayor.

Maryland

In Maryland, government informants (n=8) described possessing "*clear lines of authority*" to mandate hospital evacuation. Most government informants ascribed this authority to their governor or public health officials (i.e., secretary of health; local health officer). Maryland government officials described evacuation and shelter-in-place decision-making as a collaborative process between government officials and hospitals, noting that the government's authority would only be exercised if a hospital failed or refused to evacuate and public health was endangered. One government informant stated,

> *"Before the decision to order the [hospital] evacuation [during Hurricane Irene] was done, there was a-- we've always attempted more of a collaborative approach with the folks who are in charge of these facilities. The other two nursing homes that we approached said, 'We don't want to go, but if you guys feel uncomfortable about it, we're out of here.' When we approached [the hospital], of course they said, 'We just rebuilt our facility, we are good to go, leave us alone' and then… we ended up forcing them...."*

New Jersey

Government informants from New Jersey (n=8) did not describe themselves as able to order hospital evacuation. Some New Jersey government informants doubted whether laws granted them authority to order evacuation. Other government officials were aware of laws authorizing them to order evacuation, but they believed they could not mandate hospital evacuation because they lacked any means of enforcement. One New Jersey government informant stated,

> *"[T]he Commissioner's broad powers do allow her -- and frankly, and I unfortunately have to go back to OEM [Office of Emergency Management], because they have the operational capability -- yes, the Commissioner respectfully has broad powers. But the Commissioner's broad powers are not going to be carried out by the quote/unquote health department police."*

New Jersey government informants perceived evacuation and shelter-in-place decision-making as being ultimately a hospital decision. According to one informant, *"[W]e can recommend an evacuation of a hospital, but really the decision to evacuate a hospital resides solely with the owner of that hospital, the CEO or the president..."*

Delaware

Though Delaware government informants (n=2) acknowledged the government's legal authority to order evacuation, they believed "mandatory" evacuation was a misnomer because the government lacks the capacity to enforce compliance. One Delaware government official noted,

> *"There's actually no mandatory evacuation law. In other words, it is a recommendation really. I mean, we can say it's, 'Hey, we're ordering this evacuation by order of the Governor,' but a private entity or a private resident does not have to abide by that law because there is no enforcement leg or penalty."*

This informant explained,

> "*The only time we can physically force somebody out of a structure-- residential structure or a commercial structure, is for a residential or a commercial building code violation that would violate the safety, health and welfare that-- and we can order the shutdown of the building and the removal of the occupants. However, then that has to follow the normal code enforcement violation process, which is a ten-day hearing. It can be emergency order."*

Delaware government informants perceived the nature of their authority as incongruent with the urgency necessary to achieve evacuation prior to the arrival of a hurricane.

Discussion

The wide geographic area impacted by Hurricane Sandy provided a rare opportunity to examine hospital evacuation and shelter-in-place decision-making at numerous acute care hospitals throughout the U.S. Mid-Atlantic region. This research centered on stakeholders' perceptions of authority and responsibility for these decisions.

A key finding was that hospital executives in the Mid-Atlantic region, consistent with those in other regions of the country, perceive themselves to have authority and responsibility for hospital evacuation and shelter-in-place decisions (GAO, 2006). Our results also indicated that in New York and Maryland, government officials, too, perceived themselves as having authority to order evacuation. One concern raised by these findings is that if both hospital executives and government officials have authority

for these decisions, each party might assume the other will act and neither will decide to evacuate despite necessity. For example, in a statement to the press, NYULMC representatives tried to deflect blame when flooding and power loss forced the hospital to evacuate in the middle of Hurricane Sandy (Farley, 2013; Italie & Marchione, 2012). Yet, in testimony before the New York City Council, Thomas Farley, Commissioner of the New York City Department of Health and Mental Hygiene, stated, "Healthcare facilities could have decided on their own to evacuate" (Farley, 2013). These findings suggest that, while it may be feasible for multiple parties to have authority to order evacuation, a single party should bear ultimate responsibility for the decision.

In 2012, when Hurricane Sandy was approaching the Mid-Atlantic, Delaware, Maryland, New Jersey, and New York had laws in place that allowed their respective governments to order evacuation (McGinty, Rutkow, & Burke, 2015). New York City Mayor Michael Bloomberg exercised this authority during Hurricane Irene in 2011 when he ordered the evacuation of at least 7,000 patients from all hospitals and most chronic care facilities in New York City's Evacuation Zone A (Bloomberg, 2011; Farley, 2013).[19] In advance of Hurricane Irene, Maryland Governor Martin O'Malley ordered the evacuation of McCready Foundation, an acute care hospital with an attached nursing and rehabilitation center in Somerset County (General Assembly of Maryland, 2012). In contrast, despite possessing the authority, neither New Jersey nor Delaware ordered hospital evacuations during Hurricanes Irene or Sandy. This information, coupled with our finding that

[19] At the time of Hurricanes Irene and Sandy, Zone A was New York City's most at-risk area for inundation by storm surge. As part of the City's coastal storm plan, this was the first area of the City what would be evacuated. Since Sandy, the zones have been redefined with Zone 1 being the most likely to flood (NYC OEM, n.d.).

officials from Delaware and New Jersey did not perceive themselves as able to enforce hospital evacuation, suggests that confidence in one's authority is likely requisite to the exercise of said authority. Public health law researchers should educate government leadership about existing laws that enable them to order hospital evacuation when public safety is endangered. Additionally, further research should examine whether existing authorities could be enhanced to address concerns about lack of compliance with mandatory evacuation orders.

Our results confirm a lack of engagement by hospital executives in emergency preparedness activities, which is consistent with prior research (ACHE, 2014; Batts, 2015). Given their perceived authority and responsibility for evacuation and shelter-in-place decisions, senior hospital executives in the Mid-Atlantic region will likely be the ultimate decision-makers for future facility-initiated evacuations. Therefore, more efforts should be made to engage them in emergency preparedness activities. The 2014 Joint Commission standards for emergency management are an important step forward for improving leadership accountability for and engagement in preparedness activities (The Joint Commission, 2013). However, to guarantee their engagement throughout the disaster management life cycle, it may be necessary to link emergency preparedness to hospital executives' existing priorities. For example, the Centers for Medicare and Medicaid Services has proposed a regulation that would tie disaster planning to conditions of participation for Medicare and Medicaid (ACHE, 2014; NARA, 2013). Additional steps could include emergency management training during masters-level degree programs commonly completed by healthcare executives (e.g., MHA, MBA).

Finally, the American College of Healthcare Executives could incorporate emergency preparedness training and experience into its credentialing requirements for fellowship and continuing education (ACHE, 2009; ACHE, n.d.).

Another key finding from this study is that lack of a shared definition of "shelter-in-place" resulted in miscommunication between public health and emergency management officials and hospitals in New York City during Hurricane Sandy. The lack of common, clear terminology has the potential to result in undesired and even harmful emergency management actions. The use of common terminology is a key tenet of the National Incident Management System and the Incident Command System for emergency response. Besides being a condition of federal preparedness grant funding since fiscal year 2006, employing plain language and common vocabulary in emergency response ensures that all incident managers and responders understand one another (FEMA, 2009). At minimum, public health officials should explicitly define and publically communicate – both to hospitals and patients – what it means for a hospital to "shelter-in-place." Given the increasing number of health systems that operate across jurisdictional boundaries and that major emergencies could necessitate evacuating patients to neighboring states, states should consider adopting terminology and definitions that are consistent with neighboring jurisdictions.

Limitations

This research considered perspectives of hospital and government key informants from four Mid-Atlantic states. A systematic methodology was employed to identify and recruit participants who were responsible for hospital evacuation and shelter-in-place decision-making during Hurricane Sandy; however, relevant informants may have been inadvertently omitted and there is potential for selection bias. Due to the retrospective design of this study, participants' responses may have been limited by recall bias. The perspectives of these informants – particularly those operating in New York City, where there is a high density of healthcare facilities – may have limited generalizability. It is likely, however, that study findings will be applicable to other big cities, as well as during future hurricanes and other natural disasters.

Conclusion

Decisions to shelter-in-place or evacuate hospitals during extreme weather events are complex and further complicated by the numerous stakeholders involved. This research addresses gaps in the literature about how these complex decisions occur in practice by examining stakeholders' perceptions of authority and responsibility for decision-making during Hurricane Sandy. Among government officials, perception of authority for hospital evacuation and shelter-in-place decision-making was a prerequisite to ordering hospital evacuation. Some hospital executives in the Mid-Atlantic region had limited prior engagement in disaster preparedness. Given their perceived authority and

responsibility for evacuation and shelter-in-place decisions, increased efforts should be made to prepare hospital executives for their anticipated role in crisis decision-making. In jurisdictions where hospital executives and government officials both perceive themselves to possess authority for hospital evacuation and shelter-in-place decision-making, there is the potential for no decision to be made. To ensure that implementation of either hospital evacuation or shelter-in-place is not delayed by confusion regarding who has authority and responsibility for these decisions, a single entity should bear ultimate responsibility for decision-making.

Paper 3

Decision Processes and Determinants of Hospital Evacuation and Shelter-in-Place during Hurricane Sandy

Abstract

Context: Evacuation and shelter-in-place decision-making for hospitals is complex and existing literature contains little information about how these decisions are made in practice.

Objective: To describe decision-making processes and identify determinants of acute care hospital evacuation and shelter-in-place during Hurricane Sandy.

Design: Semi-structured interviews were conducted from March 2014 to February 2015 with key informants who had authority and responsibility for evacuation and shelter-in-place decisions for hospitals during Hurricane Sandy in 2012. Interviews were recorded, transcribed, and thematically analyzed.

Setting and Participants: Interviewees included hospital executives and state and local public health, emergency management, and emergency medical service officials from Delaware, Maryland, New Jersey, and New York.

Main Outcome Measure(s): Interviewees identified decision processes and determinants of acute care hospital evacuation and shelter-in-place during Superstorm Sandy.

Results: We interviewed 42 individuals from 32 organizations. Decisions-makers reported relying on their instincts and not employing guides or tools to make evacuation

and shelter-in-place decisions during Hurricane Sandy. Risk to patient health from evacuation, prior experience, cost, and ability to maintain continuity of operations were the most influential factors in decision-making. Flooding and utility outages, which were predicted to or actually impacted continuity of operations, were the primary determinants of evacuation.

Conclusions: Evacuation and shelter-in-place decision-making for hospitals can be improved by ensuring hospital emergency plans address flooding and include explicit thresholds that, if exceeded, would trigger evacuation. Comparative risk assessments that inform decision-making would be enhanced by improved collection, analysis and communication of data on morbidity and mortality associated with evacuation versus sheltering-in-place of hospitals.

Word Count: 248 of 300

Key words: hospital evacuation, shelter-in-place, decision-making, emergency preparedness, disasters

Introduction

On October 29, 2012, Hurricane Sandy made landfall in Brigantine, New Jersey, ravaging the Mid-Atlantic region of the United States. Hurricane Sandy was the second costliest cyclone in U.S. record-keeping history and the largest named storm on record in the Atlantic Ocean. Of the 147 deaths directly attributed to Hurricane Sandy, nearly half occurred in the Mid-Atlantic and Northeastern U.S (Blake et al., 2013). In addition to resulting in direct mortality, Hurricane Sandy had devastating impacts on the Mid-Atlantic region's healthcare systems, particularly hospitals (The City of New York, 2013; OIG, 2014). In New York City alone, to ensure safety and continuity of medical care, approximately 6,300 patients were evacuated from 37 healthcare facilities (Farley, 2013).

In Hurricane Sandy's aftermath, researchers and news media questioned why hospitals that were in close proximity to one another and had ostensibly similar risk profiles made differing decisions about evacuation and shelter-in-place (i.e., stay onsite until danger passes) (Hartocollis et al., 2012). For example, due to a 14-foot storm surge, fuel pumps supplying backup generators at New York University Langone Medical Center were damaged necessitating the urgent evacuation of 322 patients – including 21 infants from the hospital's Neonatal Intensive Care Unit – overnight during the storm (Espiritu et al., 2014 ; VanDevanter et al., 2014). A short while later, nearby Bellevue Medical Center was evacuated for the first time in its 275-year history (Ofri, 2012; Uppal et al., 2013). In contrast, the Veterans Administration New York Harbor Healthcare System's Manhattan Campus, which neighbors these facilities, had evacuated preemptively, thus avoiding the

need for any emergency evacuation during the storm. There was also lingering uncertainty about why New York government officials had not ordered evacuation of hospitals in low-lying areas as they had in anticipation of Hurricane Irene in 2011 (Fink, 2012). Commentators called for "clear and consistent criteria to guide evacuation decisions," as well as integrated local and regional decision-making for sentinel events (Powell et al., 2012; Hanfling et al., 2013).

In response to similar calls after Hurricane Katrina in 2005, the U.S. Department of Health and Human Services funded the development of tools to support hospital evacuation and shelter-in-place decision-making (Hassol et al., 2013; Zane et al., 2010). Additionally, the Centers for Medicare and Medicaid Services and the Joint Commission require hospitals to have emergency plans, which could include evacuation procedures (CMS, 2004; The Joint Commission, 2012; 42 CFR 482.41). Given the existence of these resources and requirements, questions arise about whether decision-makers are familiar with and employ these tools, as well as whether these resources are effective.

In November 2012, the Institute of Medicine convened an expert working group to establish a *Science Preparedness* agenda for Hurricane Sandy (HHS, 2015; NYAM, 2013). Participants identified determining what criteria informed healthcare facility evacuation decision-making during Sandy as a top priority, as well as whether decision-makers used guidelines, tools, and literature to assist them in these decisions. The existing literature contains little information about these priority areas. One study has examined hospital evacuation and shelter-in-place decision-making processes during

Hurricane Sandy, but its generalizability is limited as it considers a single federal hospital facility (Ricci et al., 2015). Our study presents the results of interviews with government and hospital officials throughout the Mid-Atlantic region regarding evacuation and shelter-in-place decision-making during Hurricane Sandy. Findings may enable hospital executives and the public health emergency management community to better prepare for, respond to, and recover from future major public health emergencies.

Methods

Selection and Recruitment of Participants

From March 2014 to February 2015, semi-structured interviews were conducted with key informants in four Mid-Atlantic states to identify factors that significantly influenced decisions to evacuate or shelter-in-place acute care hospitals during Hurricane Sandy. Interviewees were purposefully sampled to include at least one hospital representative from Delaware, Maryland, New Jersey, and New York, and one public health and one emergency management official whose areas of responsibility encompassed each hospital. Additional interviewees were added through snowball sampling.

Hospital interviewees were senior leaders (e.g., chief executive officers (CEOs); directors of emergency management). Government participants included in the study were those who held senior leadership roles during Sandy (e.g., secretary/commissioner of health; director of emergency management). Potential interviewees were excluded if they lacked

direct knowledge about decision-making or if their employer never considered evacuation during Hurricane Sandy.

Each state hospital association validated hospitals for inclusion, with the exception of New York, where the association for the metropolitan New York area was consulted. Additionally, each state health department and the New York City Department of Health and Mental Hygiene were consulted to ensure relevant hospitals were not omitted.

Data Collection and Analysis

Semi-structured interviews were conducted in-person or via phone with the exception of one health department that preferred a facilitated group discussion. A semi-structured interview guide was piloted and revised based on feedback from the pilot interview and experts in healthcare emergency management. The guide included the following domains: decision processes, information and decision-making aids, and lessons learned. Interviews were audio recorded and transcribed with participant permission. Transcripts were compared to recordings and any errors were corrected. Study materials were labeled with unique, random identification numbers.

To capture immediate reflections, contact summary sheets were completed after each interview (Miles et al., 2014). Peer debriefing was conducted throughout data collection and analysis to foster reliability and validity of findings (Lincoln et al., 1985). A combined deductive and inductive approach was used to identify themes. A priori themes

were selected based on relevant literature and our research objective (Dobalian et al., 2010; McGlown & Campbell, 2002). Additional themes were generated through open, unrestricted coding. Transcripts were coded using QSR Nvivo for Mac v10.1.3 (Burlington, MA, U.S.).

A Johns Hopkins Bloomberg School of Public Health Institutional Review Board determined this study was not human subjects research and was therefore exempt.

Results

Of the 50 individuals meeting study inclusion criteria, 84% agreed to be interviewed. Between March 2014 and February 2015, we interviewed 41 key informants from 32 organizations. Additionally, one public health agency, which was unable to participate in an interview due to ongoing emergency response activities, provided a written statement (Table 11). Key informants (n=42) worked for organizations representing 5 sectors involved in public health emergency response: hospitals (n=19), hospital associations (n=2), public health agencies (n=11), emergency management agencies (n=7), and EMS agencies (n=3). Five key informants were employed in Delaware, 12 in Maryland, 13 in New Jersey, and 12 in New York (Table 12). Key informants described their institutional and community decision-making processes and identified determinants in the decisions to evacuate or shelter-in-place 15 acute care hospitals during Hurricane Sandy in 2012.

Hospital Evacuation - A Difficult Decision and Last Resort

Key informants from all sectors and states reported that hospital evacuation and shelter-in-place decision-making is extremely difficult. One informant remarked, "*the evacuation order is the hardest thing that we will ever have to do in our career*s…." Many informants expressed that these decisions could have no positive outcome. One informant said, *"It is always going to be a hard decision because if you move everybody and [the storm] doesn't come then you get criticized and if you don't move everyone and it hits you, you get criticized."* Some key informants perceived the decision to evacuate as having catastrophic consequences for decision-makers and their institutions. As one informant said,*"[T]his whole evacuation decision is like a career-ending decision."* He continued to describe consequences for hospitals stating, *"There [are] hospitals in New Orleans, they evacuated, that's the last thing they ever did. They never opened again."*
Ultimately, key informants viewed evacuation as a last resort. One decision-maker said, *"As a healthcare administrator, one of the things you learn early on is evacuation is like the last thing you do…."* Reflecting on the decision not to evacuate during Hurricane Sandy, another informant stated, *"Evacuating that facility is not something that we want to do. We really don't. We want to keep it open at all costs…."*

Use and Adequacy of Decision-Making Aids and Emergency Plans

Key informants from all states and sectors characterized hospital evacuation and shelter-in-place decision-making as a collaborative process where decision-makers consulted

trusted advisors and then made a decision based on their implicit understanding of what needed to be done. Key informants recounted using weather forecast data; however, the majority did not report using decision-making guides to determine whether hospitals should be evacuated in light of these forecasts.

When asked whether the hospital relied on any tools or checklists, one CEO whose hospital evacuated said, "*One would think. That day we did not. We just worked on our instincts."* A public health official stated,

> *"I use a common sense approach in terms of garnering all the facts, in terms of determining whether the patient is going to be in danger, and that to me is what the decision parameter is going to be. So maybe I'm old school and just common sense, I'm not going to rely on a lot of tools, I'm going to gather as much information as I can, and we're going to have to make some credible decisions based upon what we know about their ability to continue to provide the service for the patients."*

There was one exception to this sentiment: one hospital employed an existing decision tree, which was designed to help leadership determine whether to evacuate or shelter-in-place, from its emergency operations plan.

Some key informants explained that existing emergency plans did not meet their needs during Hurricane Sandy. For example, in New York City informants perceived the citywide coastal storm plan to be inadequate because its decision-making algorithm, developed after Hurricane Irene, described the roles of key stakeholders involved in decision-making but not *how* to determine whether a hospital should be evacuated. One New York City informant said,

> *"T]here wasn't a formalized decision-making process with criteria. I mean there was a decision-making algorithm but there wasn't criteria for when to evacuate or not. There was a city storm plan and it said if there's a hurricane you evacuate.*

> *But [Sandy was] borderline between a tropical storm and a hurricane. And second of all, everyone recognizes that in some cases evacuating is risky. And so the written plan did not provide guidance really for the situation we were in and so we just used our judgment without any hard criteria…."*

Similarly, a CEO whose hospital evacuated reported that their emergency plans did not address the circumstances faced during Hurricane Sandy:

> *"I mean we have emergency plans for a lot of different kinds of situations. Let's say you have a shooter drill in town or mass casualties, something or other. I mean they have checklists and how-to's for a lot of different situations. At the time, they did not have one anticipating this flooding."*

While two hospital officials articulated thresholds for tolerable storm surge and wind that would have necessitated evacuation had they been exceeded, all other key informants indicated that their respective plans lacked explicit, pre-defined criteria or triggers for evacuating.

Influential Factors and Determinants of Hospital Evacuation and Shelter-in-Place

Key informants considered several factors, discussed below, in their determinations of whether to evacuate or shelter-in-place hospitals during Hurricane Sandy. The most influential factors were risk to patients, ability to maintain continuity of operations, and prior experience. Hospital executives also identified cost as an influential factor. The primary determinants of acute care hospital evacuations that occurred during Hurricane Sandy are presented in Table 2.

Risk to Patients

All key informants perceived evacuating hospitalized patients as a "*risky undertaking*." Many informants stated that hospitalized patients would be at risk of death or increased morbidity from the physical transportation and transfer of care. According to one informant,

> *"[T]here's a lot of risk in moving patients that are sick. Whether they're critically sick or marginally sick or still need hospitalization, there's a lot of risk and a lot of disruption, and a lot of uncertainty and discomfort for families. And then you have to assure the continuity of care for that patient. So that patient is starting over; and they're starting over at a time when everyone is gearing up for a major emergency."*

Another key informant explained their hospital's hesitancy to evacuate stating, "*we don't want to move these patients because some of them might die*." Some key informants explicitly referenced literature on adverse health effects of evacuation, which influenced their decision-making during Sandy. One public health official stated, "*[T]here's literature of there being a mortality rate from evacuation itself. So there was no non-risky decision, so we're weighing the risk of evacuating versus the risk of sheltering in place.*"

Continuity of Operations – Impact of Flooding and Utility Outages

Key informants characterized their decisions as comparative risk assessments where they weighed the risks associated with evacuation against the potential for essential hospital services to fail while sheltering-in-place and the risk such interruptions would pose to patients. Although informants did not employ formal decision-making aids, they informally assessed whether hospitals could maintain continuity of operations (COOP).

Key informants were primarily concerned with whether hospitals would be able to sustain power though there was consideration of disruption to other essential utilities (e.g., water, steam, sewage, oxygen). They perceived storm surge or flooding as the primary threat to COOP. For hospitals that evacuated, disruption of utility services – whether pre-planned, anticipated, or sustained – was the most common determinant.

Prior Experience

Key informants perceived prior experience to significantly influence shelter-in-place and evacuation decision-making during Hurricane Sandy. Decision-makers reported relying on both their personal previous experience, as well as institutional knowledge of how their facilities had fared in prior storms. Hurricane Irene, which occurred one year before Hurricane Sandy, was perceived to influence shelter-in-place and evacuation decisions during Sandy. One informant stated, "*the experience with Hurricane Irene and those evacuations, you know, it colored the response then to Sandy."* Another informant described the prior experience evacuating for Hurricane Irene as "*the little boy that cried wolf*." The majority of informants perceived hospital evacuations during Irene as unnecessary and having resulted in decision-makers being hesitant to evacuate the following year. According to one New York informant,

> "*We had been through Hurricane Irene. We had evacuated hospitals and nursing homes from Zone A for that and found it to be disruptive and dangerous. So we had that image in the back of our mind. And so when Sandy came in it looked like it was going to be not that bad as far as structurally so we decided not to evacuate."*

Hospital key informants from two different facilities reported that although evacuation during Hurricane Irene was ultimately unwarranted, the experience had a positive impact on decision-making during Hurricane Sandy. Serving as "*the best exercise you could ever ask for*," it gave their hospitals confidence that they could successfully evacuate.

Cost – A Consideration for Hospitals

Government officials were adamant that cost was not a factor in their decision-making and that public safety was their primary concern. One public health official said, "*I know there were questions in the wake of this, oh, well did you not evacuate because of a cost issue? And that absolutely never got into the conversation. Decisions were strictly based upon what we thought was the safest option."*

In contrast, hospital key informants presented cost as a significant factor in evacuation and shelter-in-place decisions. Hospital informants felt the cost of evacuation and repatriation were nominal compared to the potential for lost revenue while their facilities were evacuated. One hospital informant who evacuated stated,

"We took obviously a financial hit. When you cancel all elective surgeries, you cancel all your outpatient visits, that's a financial hit. Again you have to look at risk and benefit obviously to put someone in harm's way for financial reasons is absurd, but I would be not truthful if I didn't say that's a consideration. You have to be fairly confident that you are going to sustain some kind of damage or risk for your patients before you make a decision that you are going to send your patients away."

Discussion

Hospital evacuation is rare (Bagaria et al., 2009). This study capitalizes on a significant disaster to learn from the experiences of hospital executives and government officials who were faced with evacuation and shelter-in-place decisions during Hurricane Sandy. Results provide insight as to how evacuation and shelter-in-place decisions for acute care hospitals are made in practice as well as opportunities to increase resilience to future public health emergencies.

This study revealed that key informants perceived hospital evacuation and shelter-in-place decision-making as challenging. Our findings suggest that to improve decision-making it is important to: (1) ensure decision-makers have and use objective data, (2) address deficiencies in existing emergency plans, and (3) ensure the use of decision-making aids and tools when considering whether to shelter-in-place or evacuate a hospital.

Results of this study illustrate that government officials and hospital executives perceived evacuation to be risky. Studies have demonstrated that evacuation significantly exacerbates existing physical and mental health conditions among nursing home residents (Brown et al., 2012; Dosa et al., 2010). Yet, similar data on the effects of hospital evacuation are lacking. To our knowledge, only one study has examined morbidity and mortality associated with acute care hospital evacuation. This study, which analyzed a 1983 evacuation of the Denver Veterans Administration Medical Center, found no increased mortality and limited excess morbidity in the month following evacuation (Blaser et al., 1985). The generalizability of this study may be limited given the hospital's patient population and access to government and military resources.

Many questions remain about the downstream health effects of hospital evacuation: Do hospital patients suffer delayed adverse health effects after evacuation? Do evacuation-related deaths occur weeks or months later? Do pre- and post-event evacuations pose the same risks to patients? Given that decision-makers in our study reported basing evacuation and shelter-in-place decisions on health risks, additional research should be conducted to quantify longer-term mortality and morbidity (e.g., 30- and 90-day consequences) associated with evacuation versus sheltering-in-place for acute care hospitals. Objective data about differential mortality and morbidity associated with evacuation versus shelter-in-place will enable decision-makers to more accurately access risks.

Another important finding from our research is that cost was recognized as an influential factor for hospital executives when making evacuation and shelter-in-place decisions. This represents an important contribution to hospital evacuation literature, which has not previously identified cost as a factor in healthcare or disaster managers' decisions to evacuate (McGlown et al., 2002). Concerns about lost revenue from business interruptions should be used to incentivize hospital executives to invest in preparedness and mitigation initiatives to stave off evacuation.

A significant problem identified by this study is that emergency plans did not meet the needs of decision-makers during Hurricane Sandy. Although the Joint Commission emergency planning requirements were updated post-Sandy, neither the standards in effect during Sandy nor the 2014 standards require hospital emergency plans to address *how* evacuation and shelter-in-place decisions will be made (The Joint Commission, 2013). Both hospital and government emergency plans should include processes and criteria for determining whether hospitals should evacuate or shelter-in-place. The intensity of extreme precipitation and flooding are predicted to increase with climate change (Walsh et al., 2014). Given that this study identified flooding as one of the most common determinants of hospital evacuation during Hurricane Sandy, evacuation triggers should not be based solely on a storm's designation as a hurricane or its Saffir-Simpon categorization, both of which are determined by wind speed. The scope of emergency plans should be broadened to address at minimum all coastal storms, not just hurricanes.

Finally, this study revealed that decision-makers relied on instincts rather than tools or guidance to make hospital evacuation and shelter-in-place decisions. Presumably, hospitals that opted to shelter-in-place genuinely thought they could sustain COOP, although this was too often not the case. Using checklists or decision-making aids can ensure that important factors are not inadvertently overlooked, which may be more likely in decisions made under stress. Facility-specific decision-making aids should have objective criteria that, when informed by weather forecasts, would trigger evacuation. However, decision-making tools, aids, and guidance are of little utility if those responsible for evacuation and shelter-in-place decisions do not utilize them. While there is inherent uncertainty in weather forecasts and storms may exceed predictions, employing decision-making aids may enable hospital executives and government officials to more accurately assess risks.

Limitations

Our study is based on interview data collected 18 months after the event in question, and is therefore subject to recall bias and selection bias. However, the combination of purposeful and snowball sampling was most appropriate for identifying participants who possessed first-hand knowledge of evacuation and shelter-in-place decision-making for hospitals during Sandy. Our study findings may also be limited by social desirability bias particularly given the high stakes and scrutiny of the decisions examined. Due to the density of acute care hospitals in the New York/New Jersey metropolitan area, the

generalizability of some findings may be limited, but it is likely most findings will be applicable to other major cities and future natural disasters.

Conclusion

Decisions to shelter-in-place or evacuate hospitals during extreme weather events are challenging. This research, which addresses a priority area in the Hurricane Sandy *Science Preparedness* agenda, examines how these complex decisions occur in practice. Hospital and government emergency plans were inadequate during Hurricane Sandy. Responses to future public health disasters can be improved by ensuring that hospital emergency plans address flooding hazards and consider all coastal storms, not just those technically defined as hurricanes. Hospital emergency plans should specify how protective actions will be decided upon and include explicit criteria that would trigger evacuation, if exceeded. Additionally, access to morbidity and mortality data for hospital evacuation and sheltering-in-place would enable decisions-makers to more accurately compare risks and select the most appropriate protective action given the circumstances.

Discussion and Policy Implications

Limitations

Relevant laws may have been inadvertently excluded from the results of aim 1. The scope of the aim 1 research is limited to state-level statutes and regulations in four Mid-Atlantic states in place prior on October 22, 2012, when Sandy became a named storm. Selection of this date was intended to allow for a characterization of the legal environment that existed at the time public officials and hospital executives were faced with evacuation and shelter-in-place decisions for hospitals. Laws may have since been updated. Findings do not include local (e.g., county, city, town, or village) ordinances, regulations, or orders. Practitioners and researchers have noted that disasters – and thus the most effective response to them – are local (Anderson et al., 2013). At the time of Hurricane Sandy, both New Jersey and New York had state-level statutes that granted broad authority to local officials to declare and manage an emergency in their jurisdiction to protect health and safety (NJ. Code Ann., 2013c; NY. Code Ann., 2013a). In contrast, neither Maryland nor Delaware state law granted authority for declaring an emergency to their localities. Local officials are uniquely positioned to respond to their communities' needs in a disaster, as they are physically closer to those affected by an emergency and therefore, unless overwhelmed, typically able to respond more quickly. Moreover, they are more likely to understand their community's needs and local officials are known within their communities. Future studies should therefore examine local laws, which may also impact emergency response and evacuation of hospitals.

In addition, this study only examined laws in four states that were significantly impacted by Hurricane Sandy. To better understand *public health legal preparedness* for future coastal storms, similar analyses should be conducted for all areas that typically are (or as a result of climate change are predicted to be) affected by such storms (e.g., the gulf coast, the east and west coasts, pacific islands, great lakes basin). Lastly, while analysis of evacuation and shelter-in-place legal authorities in coastal zones should be prioritized, other emergencies besides coastal storms may necessitate evacuation or shelter-in-place of hospitals. To comprehensively prepare for all-hazards on a national scale, future research should examine evacuation and shelter-in-place laws in all of the remaining states, Washington, D.C., and the U.S. territories.

The second and third aims of this research considered the perspectives of hospital executives and government officials who were responsible for evacuation and shelter-in-place decision-making for hospitals in four Mid-Atlantic states during Hurricane Sandy. The combination of purposeful and snowball sampling was most appropriate for identifying participants who possessed first-hand knowledge of evacuation and shelter-in-place decision-making for hospitals during Sandy. However, there is the potential for selection bias with this sampling strategy. A limitation of the key informant interview methodology it that its success is dependent upon participants' ability and willingness to answer questions. Due to the retrospective design of this study, participants' responses may have been limited by recall bias. It is possible that such recall bias might be more pronounced among participants who were not involved in a hospital evacuation, which was a significant and impressionable event for those who experienced it. Additionally,

findings may be subject to social desirability bias. Key informants may have been reluctant to share information that would reflect negatively on themselves or their organizations and thus could have responded in a way that they perceived as desirable or flattering. To reduce risk to organizations and participants, facilitate candor, and minimize social desirability bias, interviewees were granted anonymity and quotes were identified by stakeholder category and/or state only.

Due to the density of acute care hospitals in the New York/New Jersey metropolitan area, the generalizability of some findings may be limited. It is likely, however, that study findings will be applicable to other big cities with similarly dense healthcare systems, as well as during future hurricanes and other natural disasters where healthcare facilities are once again faced with evacuation and shelter-in-place decisions.

Lastly, although it would have been ideal to complement key informant interviews with direct or participant observation, Hurricane Sandy had already occurred when this research was conceptualized. Given the unpredictability of disasters and emergencies, as well as the lengthy time required to propose research and obtain institutional review board approval, it may be unrealistic for researchers to be present when crisis decisions are being made. Academic and other research institutions should consider how they can expedite institutional review board approval to enable important research to occur as soon as possible during and after a disaster to ensure that the finite window of opportunity to collect and analyze critical data and information is not missed. Moreover, the broader public health emergency management community should consider how to embed disaster

researchers in practice settings so that research and evaluation can occur while emergency response is ongoing.

Strengths

A comprehensive and systematic search methodology was employed in aim 1 to identify state statutes and regulations that may have affected evacuation and shelter-in-place of hospitals during Hurricane Sandy in 2012. This research translates legal information, which can be challenging to retrieve and understand, and makes it accessible to public health, healthcare, and emergency management practitioners and in doing so contributes to improving public health legal preparedness.

A significant strength of this study is its very high response rate for key informant interviews. Eight-four percent of eligible key informants participated in interviews, the majority of which occurred in person allowing for rich discussion. Unlike prior studies, which with rare exception have examined the evacuation of single units or individual hospitals, this study investigated decision-making for 15 acute care hospitals located across four states. During Hurricane Sandy, there were 8 acute care hospitals that fully evacuated. Results of this study capture the perspectives of leaders involved in decision-making for 6 of these 8 evacuating hospitals. In addition to including results related to facilities that evacuated both pre- and post-impact, findings also reflect the experiences of facilities that considered whether to evacuate but ultimately decided to shelter-in-place. Previous research has not typically captured the perspective of these "negative cases."

Another major strength of this research is that key informants were purposefully sampled to ensure representation of a variety of stakeholders who were responsible for and involved in hospital evacuation and shelter-in-place decision-making. By including representatives from the healthcare, public health, emergency management, and emergency medical service sectors, as well as hospitals located in four states, this research was able to capture competing or divergent perspectives, as well as inter-state differences. The measures to validate the facilities and key informants who were included in this research were another strength of this study. By conferring with hospital associations and health departments, I was able to ensure that appropriate facilities were invited to participate and that the right key informants – those who had first-hand knowledge of decision-making in question – partook in this research.

Hospital evacuation is rare (Bagaria et al., 20009). This study capitalized on an uncommon but significant event in which decision-making occurred simultaneously across multiple states and hospitals. Given the strengths discussed above, findings of this research are likely transferable to other geographic locations (e.g., other localities beyond the Mid-Atlantic region of the U.S. and potentially other countries with similar public health and healthcare infrastructure). These research findings may also be applicable to other types of emergencies (e.g., other natural disasters or man-made emergencies that occur with warning) or different healthcare organizations (e.g., nursing homes, long term care facilities). Lastly, the findings may be generalizable to other circumstances in which public health organizations face difficult decisions. By applying lessons identified in this research to future hurricanes and other circumstances (i.e., other geographies,

emergencies, and organizations), the external validity of these findings can be further assessed.

Policy Implications

With the launch of the U.S. Sustainable and Climate Resilient Health Care Facilities Initiative, the White House noted that "American communities depend on hospitals to provide essential services at all times, and under all circumstances, and climate change places our hospitals and those services at risk" (The White House, 2014). While no one storm can be attributed to climate change, there is widespread recognition that global environmental change is occurring and that the severity of natural disasters, like Hurricane Sandy, has and will continue to increase as a consequence (Karl et al., 2009). Although the U.S. Climate Action Plan takes steps to reduce carbon pollution responsible for climate change, there is an urgent need to prepare for the impacts that are too late to be avoided and specifically to ensure that hospitals are able to respond to and are resilient to these impacts (Executive Office of the Presidents, 2013). This research identifies important steps that can be taken to facilitate public health legal preparedness for disasters and to improve evacuation and shelter-in-place decision-making during future public health emergencies.

Ensuring Public Health Legal Preparedness

A core duty of government is to ensure the health and safety of its citizens (Gostin, 2008). As is evidenced by recent hurricanes including Katrina in 2005 and Sandy in 2012, at

times hospitals are unable to sustain essential services when sheltering-in-place and must be evacuated to ensure continuity of patient care, as well as the safety of patients and staff. It is incumbent upon the government to ensure that hospitals are evacuated when (and ideally before) these circumstances arise. Public health legal preparedness plays an essential role in enabling the government to fulfill this duty by providing the necessary legal authorities to respond (Benjamin et al., 2008). At the time of Hurricane Sandy, the Mid-Atlantic states had achieved varying levels of public health legal preparedness for catastrophic coastal storms. Implementing the following recommendations will enable policymakers to enhance their state's preparedness for more severe, frequent natural disasters that threaten health security.

Authority to Declare a Public Health Emergency

Recommendation 1.1: *All states should empower their governor and/or senior health official, in consultation with the state's senior emergency management official, to declare a separate, distinct "health emergency." This codified authority should specify the mechanism of declaration and any subsequent actions that can be taken to manage a health emergency once a declaration has been made.*

The absence of explicit laws and legal authorities may hinder response to public health emergencies. Lack of overt legal authority and responsibility may encumber the competence (i.e., the ability and skills necessary to understand and apply laws) of people who serve as agents of public health legal preparedness (Benjamin et al., 2008; Moulton

et al., 2003). If health officials are not overtly authorized to and delegated responsibility for managing public health emergencies, their role in a response may be unclear or delayed. For example, in Delaware officials may be unclear about who is responsible for declaring a public health emergency or how such a declaration can be made since the law does not specify this. Such confusion could lead to a delay in exercising this authority and in turn a delay in executing response operations. The ambiguity in state law may explain why Delaware has never proclaimed a health emergency (Rutkow, 2014). Moreover, in the absence of explicit responsibility for managing public health emergencies, public health agencies may not engage in or spearhead necessary and important preparedness activities.

Recommendation 1.2: *To mitigate redundancy and potential confusion from dual declarations, state laws should directly address what happens when both a general emergency declaration and a public health emergency declaration are issued.*

The potential for confusion and conflict exists when a general emergency (or disaster) and a health emergency are declared concurrently (Hodge & Anderson, 2008). However, explicitly codifying the authority to declare a health emergency will improve public health legal preparedness by establishing clear legal authority, fostering competence of the agents responsible for exercising this authority, and ensuring involvement of public health agencies. Therefore, to avoid potential confusion when dual declarations are issued, states should codify how processes differ when both a public health emergency and general emergency have been declared.

Recommendation 1.3: *Given the potential for natural disasters to result in a significant excess of morbidity and mortality, all states should include natural disasters among the hazards for which a health emergency can be proclaimed. Ideally, states should define a "health emergency" as the occurrence or threat of all-hazards with a high probability of a large number of deaths and/or a large number of serious or long-term cases of disability.*

A broader definition of a "health emergency" may make dual declarations more likely to occur, but it may also enhance our ability to ensure national health security. Legislation can be difficult and time-consuming to enact. States may have little motivation to codify the authority to declare a public health emergency if they have not experienced a disaster in which their laws and legal authorities were perceived to be inadequate. States may also be reluctant to modify their definition of a health emergency, particularly if such an emergency has never been declared. However, these recommendations have the potential to enhance public health legal preparedness and ensure states are better able to respond to the challenges posed by climate change including more severe, frequent natural disasters like Hurricane Sandy, as well as other emergencies, which threaten health security.

Authority to Order Evacuation

Recommendation 2.1: *All states should empower the government to order the evacuation of an area or a facility that is threatened (i.e., pre-event evacuation) or impacted by an*

emergency if necessary in order to protect public health, welfare, or safety. The governor and/or a state's senior emergency management official should be responsible for ordering general evacuation in consultation with the state's senior public health and transportation officials. The governor and/or a state's senior public health official should be responsible for ordering evacuation of a healthcare facility in consultation with senior emergency management, emergency medical service, and transportation officials.

Given the increasing probability of coastal flooding due to climate change, to ensure health security and safety, it is increasingly important for state governments to be able to order evacuation of an endangered area (Melillo, Richmond, & Yohe, 2014). All states, which do not already authorize the government to order evacuation, should codify this authority. Additionally, given the vulnerability of patients and healthcare infrastructure, state governments should be able to order the evacuation of healthcare facilities specifically.

Recommendation 2.2: *Future research should examine whether explicit delegation of the authority to order evacuation (as opposed to possessing implicit authority under broad emergency powers) impacts the competence of agents responsible for executing this authority.*

New York explicitly authorizes a county or city to mandate evacuation of an area but only in the event of a civil attack (NY. Code Ann., 2013d). Though this is a vital public health power, it would not have been applicable in anticipation of Hurricane Sandy or

another natural disaster. Although neither New Jersey nor New York law explicitly authorizes the government to order area evacuation, the governor of each state (and the chief executive of a jurisdiction in New York or the emergency manager of a municipality in New Jersey) can order area evacuation under his or her broad emergency powers (NJ. Code Ann., 2013d; NY. Code Ann., 2013a). In advance of Hurricane Sandy, New York City Mayor Michael Bloomberg (2011) ordered the evacuation of Zone A under his broad authority to "promulgate local emergency orders to protect life and property or to bring the emergency situation under control" (NY. Code Ann., 2013a). New Jersey Governor Chris Christie also exercised this authority when he empowered the State Director of Emergency Management to order the evacuation of all persons from any area where their continued presence could present a danger to their health, safety, or welfare because of the conditions created by Hurricane Sandy (The State of NJ, 2012). Subsequently, the Barrier Islands, from Sandy Hook South to Cape May, and the Atlantic City casinos were placed under a mandatory evacuation order (Christie, 2011). Although it was not problematic in New York or New Jersey during Hurricane Sandy, lack of explicit authority to order evacuation may leave public officials unclear about their powers or their ability to apply the law in an emergency. In contrast, during Katrina, there was a delay in ordering the evacuation of New Orleans because Mayor Ray Nagin was unsure if he possessed the authority (Hurricane Katrina, 2006). Future research should study the impact of explicit authority (vs. implicit authority) on the competence of public officials charged with exercising said authority.

Recommendation 2.3: *Given the regular turnover of government officials, emergency management agencies should have a repository of all emergency laws in their jurisdiction. Newly elected or appointed officials should be briefed on their legal authorities and possible responses to health emergencies in order to enhance their competence. Emergency plans should include draft orders (e.g., declarations of emergency and public health emergency, and evacuation and shelter- in-place orders) that can be edited and updated at the time of a disaster in order to expedite response.*

Mayor Ray Nagin's delay in ordering the evacuation of New Orleans prior to Hurricane Katrina demonstrates not only that clear legal authorities and responsibilities are necessary for effective emergency response, but also that the individuals empowered need to be aware of their authority and how to exercise it (Hurricane Katrina, 2006). Public officials must be competent in their ability to apply the authorities vested in them. Developing information resources like the *New Jersey Summary of Emergency Management Laws, Executive Orders and Legal Opinions in the New Jersey State Hazard Mitigation Plan,* or the *New York State Public Health Legal Manual – A Guide for Judges, Attorneys and Public Health Professionals* can facilitate improved competence, as well as assist these officials in applying the law during emergencies (Colodner, 2011; The State of NJ, 2011).

Recommendation 2.4: *States and local governments should plan together in advance of disasters to determine how they will coordinate with one another during an event.*

Overlapping state and local authority may hinder the ability to protect public health and safety by resulting in mixed messages. After Governor Christie ordered the mandatory evacuation of Atlantic City during Hurricane Sandy, the City's Mayor Lorenzo Langford stated, "We want our residents to take every precaution to get out of town if they can. If they can't or for whatever reason they won't, then at least go to a shelter located in the city" (Baxter, 2012). Clear and consistent messaging is a tenet of effective risk communication; conflicting messages resulted in poor compliance with the gubernatorial order and many residents sheltering in Atlantic City and ultimately needing to be rescued (Baxter, 2012). Inconsistent laws across neighboring states may exacerbate these management and communication challenges when disasters cross local and state jurisdiction boundaries. Although gubernatorial authority legally supersedes that of local public officials, it is important to consider in advance of a disaster how conflicting orders from multiple levels of government will be interpreted and implemented both by the government itself and by healthcare facilities.

Authority to Order Shelter-in-Place

Recommendation 3.1: *All states should empower the government to order shelter-in-place of an area or a facility that is threatened or impacted by an emergency if necessary in order to protect public health, welfare, or safety. The governor and/or a state's senior emergency management official should be responsible for ordering shelter-in-place in consultation with the state's senior public health official. The governor and/or a state's senior public health official should be responsible for ordering shelter-in-place of a*

healthcare facility in consultation with senior emergency management and emergency medical services.

Sheltering-in-place may be necessary during an emergency to ensure safety, health, and welfare. For example, after the Boston Marathon bombing in 2013, Massachusetts Governor Deval Patrick requested that Bostonians shelter-in-place while law enforcement officers were in pursuit of one of the bombing suspects. Bostonians submitted to this voluntary request, leaving the streets of Boston deserted (Salsberg, 2014). Whether this remarkable compliance was motivated by fear or the intense desire for officials to apprehend the suspect, the public may not be as willing to voluntarily shelter-in-place in different emergency circumstances. In contrast, when Baltimore Mayor Stephanie Rawlings-Blake issued a citywide curfew in response to rioting that occurred after Freddie Gray was injured and died in police custody in April 2015, the city struggled to achieve complete compliance and those who defied the curfew were arrested (Baltimore City, 2015; News Channel 8, The Associated Press, ABC News & ABC 7 News, 2015). To protect the public in instances of terrorism and civil unrest, as well as natural disasters and chemical or radiological accidents, it may be necessary for the government to mandate shelter-in-place. Explicitly codifying the authority to order shelter-in-place will improve public health legal preparedness.

Recommendation 3.2: *Future research should examine whether explicit delegation of the authority to order shelter-in-place (as opposed to possessing implicit authority under*

broad emergency powers) impacts the competence of agents responsible for executing this authority.

At the time of Hurricane Sandy, none of the four Mid-Atlantic states had explicitly authorized the government to order shelter-in-place. However, shelter-in-place could be mandated under broad emergency authorities. For example, in New Jersey after the emergency manager of a municipality proclaims a state of local disaster emergency, he or she is empowered to issue and enforce any order necessary to manage the emergency and protect the health, safety, and resources of residents of the municipality (NJ. Code Ann., 2013c). Similarly, the chief executive of a jurisdiction in New York has broad law-making authority, which could include issuing orders for the public to shelter-in-place if he or she deemed it necessary to protect life (NY. Code Ann., 2013a). Delaware, Maryland, and New York's general emergency powers contain similar clauses that would enable the governor to mandate shelter-in-place (Del. Code Ann., 2013a; Md. Code Ann., Public Safety, 2013a; NJ. Code Ann., 2013e). However, lack of overt legal authority and responsibility to order shelter-in-place may encumber the competence (i.e., the ability and skills necessary to understand and apply laws) of people who serve as agents of public health legal preparedness. Therefore, future research should examine explicitly or implicitly delegating authority to order shelter-in-place impacts competence.

Improving Evacuation and Shelter-in-Place Decision-Making for Hospitals

After Hurricanes Katrina and Rita in 2005, Dobalian et al. developed a conceptual model to study future healthcare facility evacuations and specifically to understand decision-making processes of facility administrators (Figure 1). This conceptual model for understanding evacuation includes five components: community context, threat conditions, social processes, patterns of behavior, and consequences for preparedness (Dobalian, 2010). Community is the context in which a disaster occurs. The ability of a community to deal with a disaster is influenced by the resources it has, social linkages (i.e., how well community members and organizations are able to work together and prior collaboration), and its social climate (i.e., socio-economic, political, and psychological factors affecting community resources and linkages). The threat conditions created by a specific disaster are determined by characteristics of the disaster agent (e.g., size and duration of the hurricane); situational variables unique to a community (e.g., what day of the week and time a hurricane impacts a community); and the community's belief about the disaster. Social processes – including communication, decision-making, coordination and task manifestation – arise from the interaction of the threat conditions with the community context. These social processes result in a pattern of behavior such as evacuation or shelter-in-place of the healthcare facility. Ultimately, the behavior implemented has consequences for preparedness for future disasters. This conceptual model provided context in which to examine the social process of decision-making and how it influenced evacuation or shelter-in-place of hospitals during Hurricane Sandy in 2012.

Key informants considered several factors in their determinations of whether to evacuate or shelter-in-place hospitals during Hurricane Sandy (Table 16). Community context factors they reported considering included the availability of supplies and personnel, as well as resources needed to execute evacuation such as transportation and beds at receiving hospital facilities. Decision-makers reported that concurrent hospital evacuations created competition and influenced the availability of resources for individual facilities. Hospital executives also identified cost and lost revenue as an influential factor in their decisions. Key informants considered several threat conditions created by Hurricane Sandy including those determined by characteristics of an agent (e.g., forecasted storm characteristics including track, size, wind speed, storm surge), situational variables (e.g., Monday timing of impact, hospital patient census and acuity), and hospital location and the ability to access it once the storm hit. Decision-makers also considered threat conditions that might arise as a result of the impact Hurricane Sandy including infrastructure damages, loss of power, and loss of other utilities. Hospital decision-makers reported considering the social process of mandates or orders (i.e., the lack thereof of an evacuation mandate or order from the government influenced their pattern of behavior). Prior experience – specifically Hurricane Irene the year prior in 2011 – had consequences for preparedness (e.g., coastal storm zones in New York City were in the process of being redrawn, hospitals had hardened infrastructure since Irene). Prior experience also influenced the community's belief about the significance of the threat from Hurricane Sandy. Lastly, risk of adverse health effects for patients from either evacuation or shelter-in-place was a significant factor in decision-making. Dobalian's

conceptual model does not have a category that captures risk (i.e., the probability and severity) of adverse health effects. The most influential factors in evacuation and shelter-in-place decision-making were risk of adverse health effects for patients, ability to maintain continuity of operations as dictated by threat conditions and prior experience.

Recommendation 4.1: *A category of "Risk" should be added to Dobalian's Conceptual Model for Understanding Evacuation of Healthcare Facilities.*

While risk perception may be captured under threat conditions (the community's belief about the disaster), the existing conceptual model for understanding evacuation of healthcare facilities does not capture threats resulting from patterns of behavior. Risk is influenced by the threat of the agent (from the storm itself), but also by the threat from the pattern of behavior, as well as the community context (e.g., threats resulting from evacuation itself). For healthcare facilities, which are responsible for ensuring the health and safety of their patients, it is particularly important to consider the risk of adverse health effects. Therefore, I propose modifying Dobalian's Conceptual Model for Understanding Evacuation of Healthcare Facilities to improve its applicability. This conceptual model would be enhanced by the addition of a new category of risk, which would be defined as the probability and severity of adverse effects, in particular health effects (Figure 2). Risk would be the product of threat conditions and community context. There would also be a feedback loop from patterns of behavior.

Recommendation 4.2: *Degree programs for healthcare executives should require candidates to complete training in emergency management. Professional organizations that credential or certify healthcare executives should require candidates to complete emergency management training as part of initial and re-certification processes.*

A key finding of this research was that hospital executives in the Mid-Atlantic region, consistent with those in other regions of the country, perceive themselves to have authority and responsibility for hospital evacuation and shelter-in-place decisions (GAO, 2006). However, this research also found a lack of engagement by hospital executives in emergency preparedness. Given their perceived authority and responsibility for evacuation and shelter-in-place decisions and the likelihood that hospital executives will make future facility-initiated evacuation decisions, more efforts should be made to prepare them for this role. Emergency management training should be required in degree programs intended to prepare people to be healthcare executives (e.g., master of health administration, master of business administration in healthcare). Additionally, organizations that credential hospital executives should require training in emergency management as part of initial and renewed certification. For example, the American College of Healthcare Executives could incorporate emergency preparedness training and experience into its credentialing requirements for fellowship and continuing education.

Recommendation 4.3: *Data on morbidity and mortality associated with pre- and post-event evacuation versus sheltering-in-place of hospitals should be collected and analyzed*

by public health officials. This data should then be communicated to all stakeholders involved in evacuation and shelter-in-place decision-making for hospitals.

This research revealed that risk to patients was a primary factor in the determination of whether to evacuate and shelter-in-place hospitals during Hurricane Sandy. Moreover, decision-makers reported that they thought hospitalized patients would be at risk of death or increased morbidity from the physical transportation and transfer of care. While studies in nursing homes have demonstrated that evacuation significantly exacerbates existing physical and mental health conditions of residents, similar data on the effects of hospital evacuation are lacking (Brown et al., 2012; Dosa et al., 2010). Objective data about differential mortality and morbidity associated with evacuation (both before and after impact) versus shelter-in-place will enable decision-makers to more accurately assess risks.

Recommendation 4.4: *Hospitals should have independent third party engineers conduct facility assessments to identify vulnerabilities, opportunities for facility hardening, and thresholds or triggers for hospital evacuation. Hospitals should update their emergency plans based on the findings of these engineering assessments.*

Key informants in this research reported that a primary factor in the decision of whether to evacuate or shelter-in-place hospitals was the ability to maintain continuity of operations. However, most hospitals indicated that their plans lacked explicit, pre-defined criteria or triggers for evacuating. Hospitals that opted to shelter-in-place genuinely

thought they could sustain continuity of operations (COOP), although this was too often not the case. To enable hospitals to more accurately assess risks and their ability to sustain COOP, emergency plans must include facility-specific thresholds that would trigger protective actions including evacuation and shelter-in-place. Given that this research identified flooding as the primary determinant of hospital evacuation, hospital emergency plans should articulate thresholds for tolerable storm surge and other flooding in addition to wind speed that, if exceeded, would trigger evacuation. Additional facility vulnerabilities that could necessitate evacuation can be identified through professional engineering assessments. Such engineering assessments can also identify opportunities for facility hardening, which, if undertaken, may mitigate the need for evacuation in future emergencies. The results of these independent engineering assessments should be shared with government officials so they are aware of facility vulnerabilities and can better assist in decision-making.

Recommendation 4.5: *A risk index that integrates weather forecast data, morbidity and mortality data for evacuation and shelter-in-place of hospitals, and facility specific vulnerability data from engineering assessments should be created. Hospital executives, public health officials, and emergency management officials should use this dynamic index to inform evacuation and shelter-in-place decision-making.*

This research revealed that during Hurricane Sandy decision-makers weighed the risk of evacuation – specifically, the potential for adverse health effects – against the potential for essential hospital services to fail while sheltering-in-place and the risk such

interruptions would pose to patients in order to determine whether to evacuate or shelter-in-place hospitals. However, this study also revealed that decision-makers did not employ existing static decision-making tools to help them determine the likelihood that COOP would be interrupted by the storm. Additionally, data on the health effects of evacuation for hospital patients are lacking; consequently, decision-makers made determinations that evacuation posed adverse health effects based on experiences in a comparable population (nursing home patients) and their intuition. Comparative risk assessments that inform evacuation and shelter-in-place decision-making can be improved by relying on new and existing objective data, as well as using decision-making tools, which can enable decision-makers to recognize harbingers of evacuation. A risk index that integrates existing available data, in particular local weather forecast data (e.g., storm surge forecasts), with new data on morbidity and mortality of evacuation and shelter-in-place of hospitals and results of facility engineer assessments would enable decision-makers to objectively assess and compare risks. While existing decision-making tools are often static and paper-based, ideally, such an index should be digital and dynamic in order to take advantage of real-time weather data.

Conclusion

Recognizing that climate change is no longer a remote threat to be borne by future generations, on June 25, 2013, President Obama released his climate action plan. One of the three key pillars of this plan is preparing the U.S. for the impacts of global climate change. The plan asserts, "As we act to curb the greenhouse gas pollution that is driving climate change, *we must also prepare for the impacts that are too late to avoid*." In an era of changing climate, where hurricanes are predicted to occur with more force and more frequency, there is an urgent need to ensure hospitals are prepared to safeguard patient safety and provide for continuous medical care.

Given its duty to safeguard the public's health, the government has a responsibility to ensure appropriate protective action is taken when impending disasters threaten or impair the ability of hospitals to sustain essential services. The law can enable the government to fulfill this duty by providing necessary authority to order preventive or reactive response when safety is imperiled. States can further improve their readiness for catastrophic disasters by ensuring the explicit authority to order evacuation and to order shelter-in-place where it does not already exist. There is value in a single entity bearing ultimate responsibility for hospital evacuation and shelter-in-place decision-making.

Evacuation and shelter-in-place decision-making for hospitals can be further enhanced through improved risk assessment. To enable hospitals to more accurately assess risks and their ability to sustain continuity of operations, emergency plans must include

facility-specific thresholds that, if exceeded, would trigger protective actions including evacuation and shelter-in-place. Professional engineering hazard vulnerability assessments should be conducted to identify such triggers, as well as opportunities for mitigation. Hospitals' emergency plans must explicitly detail decision-making processes, in particular how evacuation will be decided upon. Comparative risk assessments that inform decision-making would also be enhanced by improved collection, analysis, and communication of data on morbidity and mortality associated with both pre- and post-evacuation versus sheltering-in-place of hospitals.

Finally, evacuation and shelter-in-place decision-making for hospitals can be improved by ensuring that those who are expected to make these difficult decisions are equipped to do so. The most senior decision-makers from hospitals and public health agencies should be trained in emergency management and practiced in using decision support tools and resources.

By examining how public health officials and hospital administrators made evacuation and shelter-in-place decisions during Hurricane Sandy in 2012, this research contributes to our ability to ensure more resilient hospitals that are prepared for the health consequences of climate change. This research will enable public health and healthcare leaders to take important steps to improve public health legal preparedness for disasters and enhance evacuation and shelter-in-place decision-making during future natural disasters, which is critical to protect public health and ultimately save lives.

Appendices

Tables

Table 1 – Federal Geographic Regions of the East Coast of the United States

Census Bureau[1]	National Oceanic and Atmospheric Administration	General Services Administration	Federal Emergency Management Agency	Environmental Protection Agency	Department of Health and Human Services
Region 3: South, Division 5: South Atlantic Delaware District of Columbia Maryland Virginia West Virginia North Carolina South Carolina Georgia Florida	*Mid-Atlantic and Northeast Regions* New York New Jersey Delaware Maryland Virginia Connecticut Massachusetts New Hampshire Rhode Island Maine	*Region 3: Mid-Atlantic* Southern New Jersey Delaware Pennsylvania District of Columbia Maryland* Virginia* West Virginia	*Region 3: Mid-Atlantic* Delaware Pennsylvania District of Columbia Maryland Virginia West Virginia		
Region 1: Northeast, Division 2: Middle Atlantic New Jersey New York Pennsylvania		*Region 2: Northeast & Caribbean* New York New Jersey Puerto Rico US Virgin Islands			

*Excludes the areas of Maryland and Virginia that directly surround Washington, DC, which is part of the National Capital Region.
(Census Bureau, n.d.; EPA, n.d.; FEMA, 2015; GSA, n.d.; HHS, 2014; NOAA, n.d.)

Table 2 – Tropical Cyclone Classifications

Classification	Tropical Cyclone's Maximum Sustained Surface Wind Speed
Tropical Depression	38 mph (33 knots) or less
Tropical Storm	39 to 73 mph (34 to 63 knots)
Hurricane	74 mph (64 knots) or higher
Major Hurricane	111 mph (96 knots) or higher*

*Corresponds to a Category 3, 4, or 5 on the Saffir-Simpson Hurricane Wind Scale.
(NWS, n.d.c)

Table 3 – Tropical Storm Terminology

Term	Definition
Cyclone	A rotating, organized system of clouds and thunderstorms with closed-circulation. Also the term used to describe what are known as hurricanes (see below) in the U.S that occur in the Indian Ocean and South Pacific Ocean.
Tropical Cyclone	Cyclone originating in tropical or sub-tropical water. Tropical cyclones rotate counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. Tropical cyclones include tropical depressions, tropical storms and hurricanes.
Hurricane	Term used to describe a tropical cyclone with sustained wind speeds equal to or greater than 74 mph (64 kt) that occurs east of the International Dateline to the Greenwich Meridian.
Typhoon	A synonym for hurricane or cyclone. This term is used north of the Equator west of the International Dateline.
Atlantic Hurricane	Hurricane originating in the Atlantic Basin, which includes the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico.
Superstorm	Hurricane Sandy was nicknamed "Superstorm Sandy." It was anticipated that Sandy would be a devastating storm because of its unusual right-to-left pathway and its intact core.

(AOML, n.d.; Nolan, 2012)

Table 4 – Saffir-Simpson Hurricane Wind Scale

Category	Wind Speed	Damage Due to Winds
I	74-95 mph 64-82 kt 119-153 km/h	Very dangerous winds will produce some damage
II	96-110 mph 83-95 kt 154-177 km/h	Extremely dangerous winds will cause extensive damage
III	111-129 mph 96-112 kt 178-208 km/h	Devastating damage will occur
IV	130-156 mph 113-136 kt 209-251 km/h	Catastrophic damage will occur
V	157 mph or higher 137 kt or higher 252 km/h or higher	Catastrophic damage will occur

Adapted from http://www.nhc.noaa.gov/aboutsshws.php
(NWS, n.d.b)

Table 5 – Aim 1 Query Results

Total Number of Laws Produced by Each Search Query, Number of Laws Excluded, and Number of Laws from which Data Were Abstracted

Search 1: Authority to Declare an Emergency

	Query Results	Laws Excluded	Data Abstracted
DE Statutes	100	92	8
DE Regulations	34	34	0
MD Statutes	158	149	9
MD Regulations	54	54	0
NJ Statutes	158	151	7
NJ Regulations	116	116	0
NY Statutes	221	213	8
NY Regulations	472	472	0

Search 2: Authority to Declare a Health Emergency

	Query Results	Laws Excluded	Data Abstracted
DE Statutes	14	11	3
DE Regulations	6	5	1
MD Statutes	21	16	5
MD Regulations	15	15	0
NJ Statutes	28	25	3
NJ Regulations	25	22	3
NY Statutes	10	10	0
NY Regulations	10	10	0

Search 3: Authority to Order Evacuation or Shelter-in-Place

	Query Results	Laws Excluded	Data Abstracted
DE Statutes	87	83	4
DE Regulations	70	61	9
MD Statutes	173	167	6
MD Regulations	323	282	41
NJ Statutes	251	235	16
NJ Regulations	563	527	36
NY Statutes	238	230	8
NY Regulations	558	506	52

Table 6 – State Definitions of Disaster, Emergency, and *Health* Emergency

State	*Definition of Disaster or Emergency*	*Definition of Health Emergency*
DE	"'Disaster' means a catastrophic condition caused by a man-made event (including, but not limited to, industrial, nuclear or transportation accident, explosion, conflagration, power failure, act of domestic terrorism, natural resource shortage or other condition resulting from man-made causes, such as hazardous materials spills and other injurious environmental contamination), natural event (including, but not limited to, any hurricane, tornado, storm, flood, high water, wind-driven water, tidal wave, earthquake, landslide, mud slide, snowstorm, drought, fire or explosion) or war-caused event (following an attack upon the United States caused by use of bombs, missiles, shellfire or nuclear, radiological, chemical or biological means, or other weapons, or overt paramilitary actions, or other conditions such as sabotage) which results in substantial damage to property or the environment, and/or hardship, suffering, injury or possible loss of life." "'Emergency' means any situation which requires efforts and capabilities to save lives or to protect property, public health and safety, or to lessen or avert the threat of a disaster in Delaware." **20 Del. C. § 3102**	"A "public health emergency" is an occurrence or imminent threat of an illness or health condition that: a. Is believed to be caused by any of the following: 1. Bioterrorism; 2. The appearance of a novel or previously controlled or eradicated infectious agent or biological toxin; or 3. A chemical attack or accidental release; and b. Poses a high probability of any of the following harms: 1. A large number of deaths in the affected population; 2. A large number of serious or long-term disabilities in the affected population; or 3. Widespread exposure to an infectious or toxic agent." **20 Del. C. § 3132**
MD	"'Emergency' means the threat or occurrence of: (1) a hurricane, tornado, storm, flood, high water, wind-driven water, tidal wave, earthquake, landslide, mudslide, snowstorm, drought, fire, explosion, and any other disaster in any part of the State that requires State assistance to supplement local efforts in order to save lives and protect public health and safety; or (2) an enemy attack, act of terrorism, or public health catastrophe." **Md. PUBLIC SAFETY Code Ann. § 14-101**	"'Catastrophic health emergency' means a situation in which extensive loss of life or serious disability is threatened imminently because of exposure to a deadly agent." "'Deadly agent' means: (1) anthrax, ebola, plague, smallpox, tularemia, or other bacterial, fungal, rickettsial, or viral agent, biological toxin, or other biological agent capable of causing extensive loss of life or serious disability; (2) mustard gas, nerve gas, or other chemical agent capable of causing extensive loss of life or serious disability; or (3) radiation at levels capable of causing extensive loss of life or serious disability." **Md. PUBLIC SAFETY Code Ann. § 14-3A-01**
NJ	"'Emergency' means any flood, hurricane, storm, tornado, high water, wind-driven water, tidal wave, drought, fire, explosion, civil disorder or other catastrophe which is or threatens to be of sufficient severity and magnitude to substantially endanger the health, safety and property of the citizens of this State." **N.J. Stat. § 52:14E-3**	"Public health emergency" means an occurrence or imminent threat of an occurrence that: a. is caused or is reasonably believed to be caused by any of the following: (1) bioterrorism or an accidental release of one or more biological agents; (2) the appearance of a novel or previously controlled or eradicated biological agent; (3) a natural disaster; (4) a chemical attack or accidental release of toxic chemicals; or (5) a nuclear attack or nuclear accident; and b. poses a high probability of any of the following harms: (1) a large number of deaths, illness, or injury in the affected population; (2) a large number of serious or long-term impairments in the affected population; or (3) exposure to a biological agent or chemical that poses a significant risk of substantial future harm to a large number of people in the affected population. **N.J. Stat. § 26:13-2**
NY	"'Disaster" means occurrence or imminent threat of wide spread or severe damage, injury, or loss of life or property resulting from any natural or man-made causes, including, but not limited to, fire, flood, earthquake, hurricane, tornado, high water, landslide, mudslide, wind, storm, wave action, volcanic activity, epidemic, air contamination, terrorism, cyber event, blight, drought, infestation, explosion, radiological accident, nuclear, chemical, biological, or bacteriological release, water contamination, bridge failure or bridge collapse. " 'State disaster emergency' means a period beginning with a declaration by the governor that a disaster exists and ending upon the termination thereof." **NY CLS Exec § 20**	Not Applicable – Not defined in NY statutes or regulations.

Table 7 – State Emergency Authorities Relevant to Hospital Evacuation

Mid-Atlantic state laws pertaining to emergency declarations, *health* emergency declarations, and evacuation orders

State	Authority to Declare an Emergency	Authority to Declare a *Health* Emergency	Authority to Order Evacuation
DE	20 Del. C. § 3115	20 Del. C. § 3132*	16 Del. C. § 508 20 Del. C. § 3116
MD	Md. Public Safety Code Ann. § 14-107 Md. Public Safety Code Ann. § 14-303	Md. Public Safety Code Ann. § 14-3A-02	Md. Public Safety Code Ann. § 14-107 Md. Public Safety Code Ann. § 14-3A-03
NJ	N.J. Stat. § App. A:9-51	N.J. Stat. § 26:13-3Â	N.J. Stat. § 26:13-8 N.J.A.C. 10:161B-2.21 N.J.A.C. 8:43E-3.8
NY	NY CLS Exec § 28		NY CLS Exec § 24 NY CLS Unconsol Ch 131, § 25

* Although Delaware does not explicitly allocate the authority to declare a health emergency, 20 Del. C. § 3132 defines "public health emergency." It states, "A "public health emergency" is an occurrence or imminent threat of an illness or health condition that: a. Is believed to be caused by any of the following: 1. Bioterrorism; 2. The appearance of a novel or previously controlled or eradicated infectious agent or biological toxin; or 3. A chemical attack or accidental release; and b. Poses a high probability of any of the following harms: 1. A large number of deaths in the affected population; 2. A large number of serious or long-term disabilities in the affected population; or 3. Widespread exposure to an infectious or toxic agent that poses a significant risk of substantial future harm to a large number of people in the affected population."

Table 8 – Emergency Declarations

Emergency declaration authorities in Mid-Atlantic states: who can declare an emergency, how, when and why?

State	Law	What is Declared?	Mechanism of Declaration	Authorized Party	Threshold for Declaration	Required Content of Declaration	Notification Requirements	Period of Effect Limit	Termination and Renewal Conditions
DE	20 Del. C. § 3115	"state of emergency"	Proclamation	Governor	Emergency or disaster has occurred or is imminent	• Conditions giving rise to declaration or conditions that would make a termination of the state of emergency possible; • Area(s) affected or threatened by disaster; • Description (nature) of disaster	N/A	30 days	State of emergency continues until Governor finds threat has passed or emergency has been dealt with to the extent that conditions necessitating a state of emergency no longer exist and terminates the state of emergency by subsequent order. No state of emergency can continue for more than 30 days without being renewed by the Governor. Termination order shall specify the reasons for its termination and shall be promptly disseminated to the public.
MD	Md. Public Safety Code Ann. § 14-107; Md. Public Safety Code Ann. § 14-303	"state of emergency"	Executive order or proclamation	Governor	Emergency has occurred or is impending due to any cause; at the request of the Secretary of State Police or the chief executive of a county or municipal corporation, or on Governor's own initiative if public safety is threatened	• Conditions giving rise to declaration or conditions that would make a termination of the state of emergency possible; • Area(s) affected or threatened by disaster; • Description (nature) of disaster	Must be disseminated promptly by means calculated to publicize its contents and filed with MEMA, the State Archives, and the chief local records-keeping agency in the affected area	30 days	State of emergency continues until Governor finds threat has passed or emergency has been dealt with to the extent that emergency conditions no longer exist and terminates the state of emergency by executive order or proclamation. State of emergency may not continue for longer than 30 days unless renewed by Governor. General Assembly may terminate a state of emergency at any time by joint resolution.
NJ	N.J. Stat. § App. A:9-51	"emergency"	Proclamation	Governor	Whenever, in Governor's opinion, the control of any disaster is beyond the capabilities of local authorities	Nothing specified	N/A	No limit	State of emergency continues until Governor determines emergency has passed and issues a proclamation declaring its end.
NY	NY CLS Exec § 28	"disaster emergency"	Executive order	Governor	At request of a chief executive or whenever the Governor finds that a disaster has occurred or is imminent for which local governments are unable to respond adequately	• Area(s) affected or threatened by disaster; • Description (nature) of disaster	For radiological accidents, governor or his designee must direct chief executive(s) and emergency services organizations to notify the public	6 months	Remains in effect for a period not to exceed six months or until rescinded by the governor, whichever occurs first. The governor may issue additional orders to extend the state disaster emergency for additional periods also not to exceed six months.

Table 9 – Health Emergency Declarations

Health emergency declarations in Mid-Atlantic states: who can declare a health emergency, how, when and why?

State	Law	What is Declared?	Definition of Health Emergency	Mechanism of Declaration	Authorized Party	Threshold for Declaration	Required Content of Declaration	Notification Requirements	Period of Effect Limit	Termination and Renewal Conditions
MD	Md. Public Safety Code Ann. § 14-3A-02	"catastrophic health emergency"	A situation in which extensive loss of life or serious disability is threatened imminently because of exposure to a deadly agent, where deadly agent means: anthrax, ebola, plague, smallpox, tularemia, or other bacterial, fungal, rickettsial, or viral agent, biological toxin, or other biological agent capable of causing extensive loss of life or serious disability; or mustard gas, nerve gas, or other chemical agent capable of causing extensive loss of life or serious disability; or radiation at levels capable of causing extensive loss of life or serious disability.	Proclamation	Governor	If the Governor determines that a health emergency exists	Conditions giving rise to declaration; Description (nature) of health emergency; Area(s) affected or threatened by health emergency	N/A	30 days	Governor shall rescind proclamation whenever he/she determines that catastrophic health emergency no longer exists. Unless renewed, proclamation expires 30 days after issuance. The Governor may renew the proclamation for successive periods, each not to exceed 30 days, if the he/she determines that a catastrophic health emergency continues to exist.
NJ	N.J. Stat. § 26:13-3	"public health emergency"	Occurrence or imminent threat that is caused by: bioterrorism or accidental release of biological agent; novel or previously controlled or eradicated biological agent; natural disaster; chemical attack or accidental release of toxic chemicals; or nuclear attack or nuclear accident; and poses a high probability of large number of deaths, illness, or injury in the affected population; large number of serious or long-term impairments in the affected population; or exposure to a biological agent or chemical that poses a significant risk of substantial future harm to a large number of people in the affected population.	Executive order	Governor	Governor, in consultation with the commissioner and the Director of the State Office of Emergency Management, may declare a health emergency.	Conditions giving rise to declaration; Description (nature) of health emergency; Geographic areas covered by declaration; Expected duration (if less than 30 days); May also prescribe necessary actions or countermeasures to protect the public's health.	Commissioner must notify elected municipal officials and health care facilities in jurisdiction of the nature and extent of the emergency Commissioner of Health and Senior Services must notify the Secretary of Agriculture if emergency conditions could affect animals, plants, or crops.	30 days	Terminates automatically after 30 days unless renewed by the Governor under the same standards and procedures for the initial declaration.

Table 10 – Evacuation Authorities

Evacuation authorities in Mid-Atlantic states: what can be evacuated, when, and by whom?

State	Law Allocating Authority to Evacuate	Who can order evacuation?	What can be evacuated?	When can evacuation be ordered?
Delaware	16 Del. C. § 508	The Division of Public Health	A facility	If the facility may seriously endanger public health.
	20 Del. C. § 3116	Governor	All or part of the population from a stricken or threatened area within the State.	If this evacuation is necessary for the preservation of life.
Maryland	Md. PUBLIC SAFETY Code Ann. § 14-107	Governor	All or part of the population from a stricken or threatened area in the State.	If necessary in order to protect the public health, welfare, or safety.
	Md. PUBLIC SAFETY Code Ann. § 14-3A-03	Governor	Any facility	After proclaiming a catastrophic health emergency .
New Jersey	N.J. Stat. § 26:13-8	Commissioner of Department of Health	Any facility	During a health emergency, when there is reasonable cause to believe that a facility may endanger the public health.
	N.J.A.C. 10:161B-2.21	Commissioner of Department of Human Services	Substance abuse treatment facility	Upon a finding that violations pertaining to the care of clients or because of hazardous or unsafe conditions of the physical structure pose an immediate threat to the health, safety, and welfare of the public or the clients of the facility.
	N.J.A.C. 8:43E-3.8	Commissioner of Department of Health	Health care facility	Upon a finding that violations pertaining to the care of patients or to the hazardous or unsafe conditions of the physical structure pose an immediate threat to the health, safety, and welfare of the public or the residents of the facility.
New York	NY CLS Exec § 24	Chief executive of any county, city, town, or village	Anything within the territorial limits of a county, city, town or village.	Upon a finding by the chief executive that public safety is imperiled; after a local state of emergency has been proclaimed.
	NY CLS Unconsol Ch 131, § 25	A county or city	Any person	In the event or in anticipation of attack.

* Abbreviations: Delaware Code (Del. C.); Annotated (Ann.); Statute (Stat.); New Jersey Administrative Code (N.J.A.C.); and Consolidated Laws (CLS).

Table 11 – Key Informant Recruitment, Response, and Participation

Response Rate	Interviewees (n)
Total Contacted	61
Less Excluded (Did not meet inclusion criteria)	11
Total Recruited	50
Total Interviewed*	42
Declined	2
No response	4
Willing to participate, unable to schedule	2
Response Rate	84%

Table 12 – Organizations and Key Informants by Sector, State, and Location of Interview

	Organizations Interviewed (n=32)		Individuals Interviewed (n=42)	
Sector	#	%	#	%
Hospitals and Associations	*16*	*50%*	*21*	*50%*
Hospital	15	47%	19	45%
Hospital Association	1	3%	2	5%
Government	*16*	*50%*	*21*	*50%*
Public Health	8	25%	11	26%
Emergency Management	6	19%	7	17%
Emergency Medical Services	2	6%	3	7%
Total	*32*	*100%*	*42*	*100%*
State	#	%	#	%
Delaware	4	13%	5	12%
Maryland	10	31%	12	29%
New York	10	31%	12	29%
New Jersey	8	25%	13	31%
Total	*32*	*100%*	*42*	*100%*
Interview Location	#	%	#	%
In-person	25	78%	33	79%
Phone	6	19%	8	19%
Email	1	3%	1	2%
Total	*32*	*100%*	*42*	*100%*

Table 13 – Key Informant Organizations by Sector and State

	Sector	Delaware	Maryland	New Jersey	New York
	Hospital	• Beebe Healthcare • Nemours	• Shore Regional Health • Garrett County Memorial Hospital • McCready Foundation	• AtlantiCare Regional Medical Center • Hoboken University Medical Center (CarePoint) • Jersey City Medical Center (Barnabas Health) • Palisades Medical Center	• Bellevue Hospital • New York Presbyterian Lower Manhattan Division • New York Veterans Administration (VA) Harbor Healthcare System • New York University Langone Medical Center • Richmond University Medical Center • Staten Island University Hospital
	Hospital Association				• Greater New York Hospital Association
Government	Public Health	• Delaware Division of Public Health[§§§§§]	• Maryland Department of Health and Mental Hygiene • Dorchester County Health Department • Garrett County Health Department • Somerset County Health Department	• New Jersey Department of Health	• New York State Department of Health • New York City Department of Health and Mental Hygiene
	Emergency Management	• New Castle Emergency Management	• Maryland Emergency Management Agency • Somerset County Department of Emergency Services	• Atlantic County Department of Public Safety • Hudson County Office of Emergency Management	• New York City Office of Emergency Management
	Emergency Medical Services		• Maryland Institute of Emergency Medical Services	• Hudson County Emergency Medical Service Taskforce	

[§§§§§] Written statement provided; No interview conducted

Table 14 – Characteristics of Interviewees' Hospitals

State	
New York Hospitals	6
New Jersey Hospitals	4
Maryland Hospital	3
Delaware Hospitals	2
Evacuation Status for Hurricane Sandy	
Pre-event Evacuation	3
Post-event Evacuation	3
Shelter-in-Place	9
Total Hospitals Interviewed	**15**

Table 15 – Primary Determinants of Acute Care Hospital Evacuation During Hurricane Sandy as Reported by Decision-Makers

Hospital	Type of Evacuation	Determinant
Hospital A	Pre-impact evacuation*	***Planned Utility Outages (Steam, Electric):*** Utility company proactively turned off steam service and underground electric grid supplying hospital to prevent damage from flooding and saltwater intrusion and enable quicker restoration of service post-storm.
Hospital B	Pre-impact evacuation*	***Prior Experience:*** Institutional memory of a 1992 nor'easter storm during a full moon, its impact on the facility, and similarity to circumstances during Hurricane Sandy (arrival of storm coinciding with high tide).
Hospital C	Pre-impact evacuation*	***Anticipated Utility Outage (Electric) and Flooding:*** Anticipated flooding and subsequent damage to electrical switchgear, which was located below expected storm surge level.
Hospital D	Post-impact evacuation+	***Sustained Utility Outages (Sewage and Power) and Flooding:*** Primary power from electrical grid was lost due to an explosion of a transformer at power company substation. Loss of water pressure and functional sewage systems prompted evacuation. Also, flooding of basement resulted in damage to fuel pump supplying generator. Full power loss was imminent.
Hospital E	Post-impact evacuation+	***Sustained Utility Outage (Power) and Flooding:*** Primary power from electrical grid was lost due to an explosion of a transformer at power company substation. Storm surge flooding resulted in failure of back up electrical systems (specifically fuel pumps).
Hospital F	Post-impact evacuation+	***Sustained Utility Outage (Power) and Flooding:*** Failure of primary and secondary (external) backup generators that became damp and shorted out, as well as facility flooding.

* Pre-impact evacuations were anticipatory evacuations that occurred prior to Hurricane Sandy's arrival.

+ Post-impact evacuations were reactive evacuations that occurred after facilities sustained damage. Reactive evacuations occurred either while the storm was ongoing or in its immediate aftermath.

Table 16 – Factors Considered in Hospital Evacuation and Shelter-in-Place Decision-Making During Hurricane Sandy

Conceptual Model Category	Variable	Variable Description
Threat Conditions	Weather forecast	Predicted weather including storm track, size, wind speed (Saffir-Simpson Hurricane Category), and storm surge.
Threat Conditions	Weather conditions	Current and future weather conditions – i.e., conditions under which hospital would have to continue to operate or evacuate (e.g., high tide, nor'easter that occurred after Sandy)
Threat Conditions	Flooding/Storm surge	Flooding or storm surge that is anticipated or has occurred. History of flooding.
Threat Conditions	Timing	When storm is expected to impact area (e.g., weekend, nighttime, high tide)?
Threat Conditions	Facility location and access	Where is the facility located? Is it in a flood plane or evacuation zone? Is it in close proximity to water? Will access to facility be limited or completely cut off by the storm (e.g., do you have to cross a bridge that will be flooded to get to hospital)?
Threat Conditions	Infrastructure vulnerability and hardening	Ability to resist physical threats (wind, flooding). How old is facility? What mitigation has been done to limit impacts of a storm on facility (e.g., installation of submarine doors or hurricane grade windows)?
Threat Conditions	Utilities	Are or will essential utilities be impacted by the storm? Are service disruptions planned or anticipated? Essential utilities considered included: electricity, steam, gas, potable water, sewage, HVAC, and fire protection.
Threat Conditions	Electricity/Power	Specific consideration given to electricity. Has electricity been interrupted or are disruptions anticipated? Where are the generator(s), switchgear and fuel pump located? Is damage to any part of the primary or backup electrical system anticipated or has it occurred? Is their adequate fuel to operate backup generators?
Threat Conditions	Infrastructure damage	Has physical destruction to the plant occurred or is it anticipated (e.g., flooding, shorting of switchgear)?
Threat Conditions	Patient census and acuity	Number, type (e.g., psychiatric, trauma, other specialty care) and severity of patients in hospital; Ability of hospital to safely decant the census or discharge patients (i.e., do patients live in flood zone? Do they have a safe place they can be discharged to?)

Conceptual Model Category	Variable	Variable Description
Community Context	Supplies	Does facility have adequate inventory of essential supplies (e.g., food, linens, medications, oxygen, fuel, and heating oil)? Are disruptions to future supply deliveries anticipated?
Community Context	Staffing	Is adequate staff present? Is staff able to travel to facility?
Community Context	Cost	What is the financial cost associated with evacuation and repatriation? Who will bear this cost? Who has assumed the cost of past evacuations? Has disaster declaration been issued and is there potential government subsidy?
Community Context	Resource availability	Are other healthcare facility evacuations occurring simultaneously? Is there competition for logistical support or resources to execute evacuation?
Community Context	Transportation	Availability of ambulances or other vehicles (e.g., medical ambulance buses) to transport patients being evacuated; Competition for transportation resources
Community Context	Receiving facilities	Receiving facilities with the ability to treat patient mix including unique patient populations (e.g., prisoners, psychiatric patients, patients requiring isolation); Availability of and competition for beds at these receiving hospitals.
Community Context	Community reliance	Expectation that hospital will be a community resource during and after the storm. What other healthcare resources are in the area (e.g., is this the only hospital in county)? Are there other acute care hospitals that patients can seek care at in the aftermath of storm?
Risk	Continuity of patient care	Ability to provide adequate, uninterrupted standards of care
Risk	Risk to patients	Potential for morbidity and mortality resulting specifically from evacuating or sheltering-in-place; Patient safety
Risk	Employee health and safety	Potential for occupational injury/illness from evacuation or sheltering-in-place
Social process	Evacuation order/mandate	Has government mandated or ordered hospital evacuation?
Patterns of behavior	Internal evacuation	Ability to relocate patients internally (horizontally or vertically) within hospital
Consequences for Preparedness	Prior experience	Decision-maker or organization's previous experience with disasters and specifically hurricanes; Also referred to as institutional or "corporate memory"
Consequences for Preparedness	Hurricane Irene	A subset of prior experience; Specifically, did hospital(s) evacuate year prior for Hurricane Irene? How was this decision and experience perceived?

Figures

Figure 1 – Dobalian's Conceptual Model for Understanding Evacuation of Healthcare Facilities

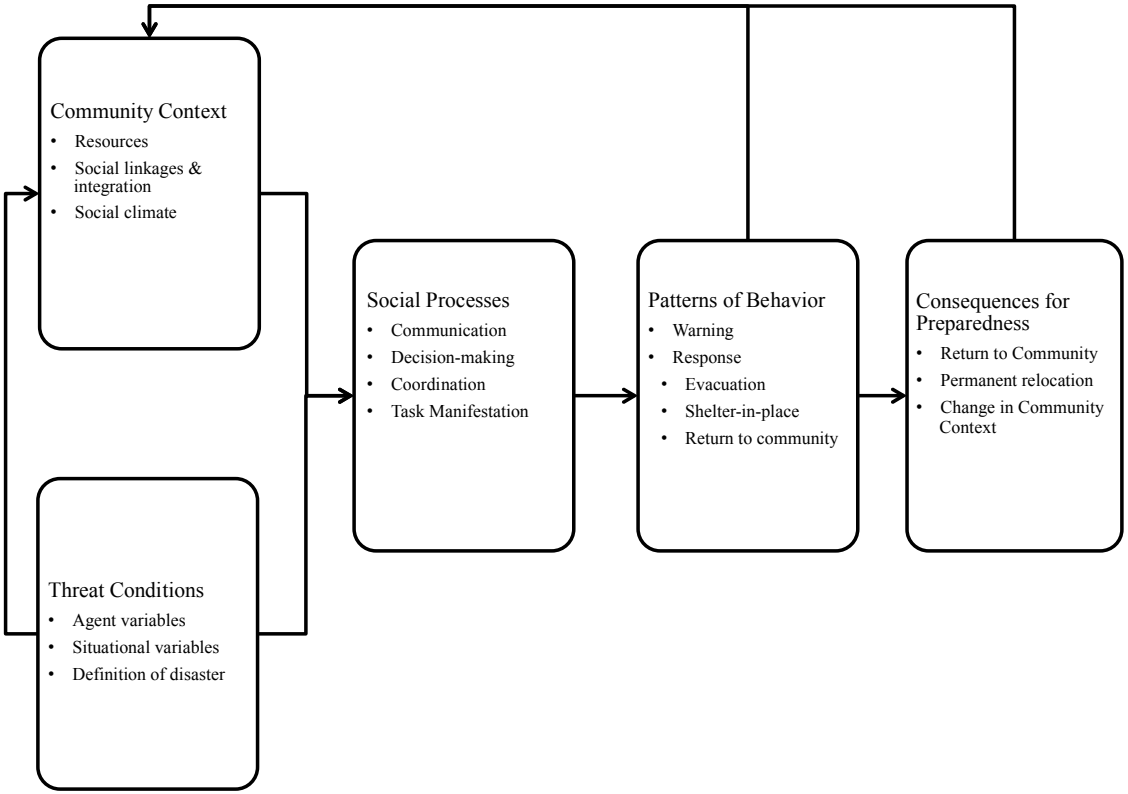
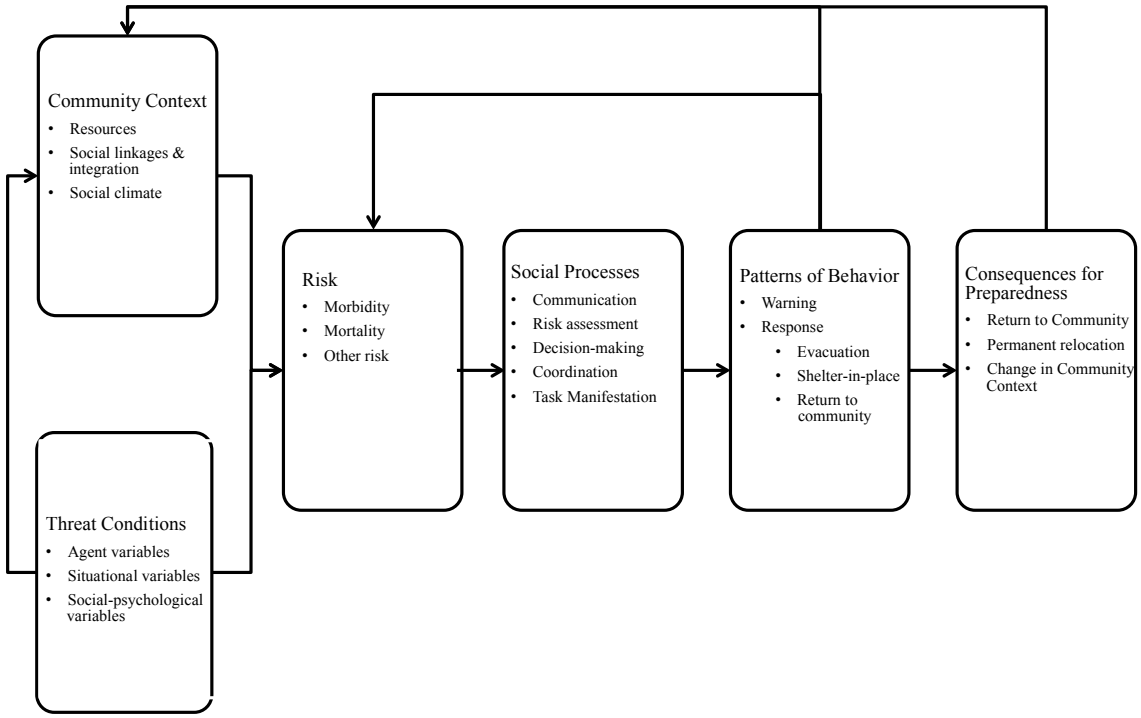


Figure 2 – McGinty's Conceptual Model for Understanding Evacuation of Healthcare Facilities



Supplemental Materials

Appendix 1 – Study Protocol

Aim: To systematically identify and characterize state-level laws in existence in Delaware, Maryland, New Jersey, and New York at the time Hurricane Sandy occurred for the following areas within emergency preparedness:

1. Authority to declare an emergency
2. Authority to declare a health emergency
3. Authority to order evacuation or shelter-in-place

Data Collection

1. Search for and collected laws regarding the above areas of emergency preparedness by:
    a. Running searches in LexisNexis State Capital of Delaware, Maryland, New Jersey, and New York statutory and administrative codes:
        i. Search terms for power to declare an emergency: (disaster OR emergency) AND (governor)
        ii. Search terms for power to declare a health emergency: (health emergency OR health disaster)
        iii. Search terms for power to order evacuation or shelter-in-place: (shelter! OR evacuat!)[******]

Note: Search terms were developed through an iterative process and in consultation with members of my thesis advisory committee. "Pilot" keywords, which were based on *a priori* knowledge, included: emergency, disaster, public health emergency, health emergency, evacuation, shelter and sheltering-in-place. Selection of final search string required balancing the need to ensure search term was successful in locating record(s) that address the powers of interest and minimizing the number of query results returned (i.e., to avoid unwieldy number of search results).

2. Review query results in each category for laws related to the three abovementioned areas of interest within emergency preparedness.
3. Apply the following exclusion criteria:
    a. Executive orders, which are codified in some states, were excluded because they themselves do not confer authority but rather are examples of the exercise of authority granted by statute or regulation;
    b. Laws in which the keyword had a meaning unrelated to emergency preparedness were excluded (e.g., homeless shelters);
    c. Laws pertaining to the evacuation of vehicles (e.g., trains) or rides (e.g., fun houses) were excluded;

[******] Note: In order to retrieve variations of search terms, I used wildcard symbols. I used an exclamation mark (!) as a truncation, which replaced more than one letter at the end of a search term (e.g., evacuat! to locate records containing evacuate and evacuation and shelter! to locate records containing shelter and sheltering).

    d. Laws addressing only fire-related evacuation were excluded;
    e. Laws addressing only casino emergencies were excluded.
4. Downloading laws into folders (one for each of the 3 authorities of interest) and subfolders (state and statute or regulation).
5. Reviewing bill history of downloaded laws to ensure laws were in effect on October 22, 2012.[††††††]

Quality Control

After completing all searches, I compared laws identified for inclusion to publically available data sets of emergency health powers from the Network for Public Health Law and the Johns Hopkins Center for Law and the Public's Health (Center for Law and the Public's Health, 2013; NPHL, 2012). When a discrepancy arose, it was resolved by consulting the law's text and through discussion with my thesis advisory committee. Duplicate laws were removed.

Data Analysis

1. I developed three electronic data extraction forms (one for each of the three emergency authorities of interest) in Qualtrics (Provo, UT, USA), an online survey and data collection program. The Association of State and Territorial Health Officers (ASTHO) Emergency Declarations & Authorities–State Analysis Guide (2011), as well as the study's research questions, informed the development of the fields in each data extraction form.
2. I used these forms to abstract information from the full text of the statutes and regulations previously determined to be relevant for each of the authorities of interest.
3. I downloaded an Excel spreadsheet of all abstracted data.
4. I reviewed abstracted data to characterize the legal context that existed in Delaware, Maryland, New Jersey, and New York at the time of Hurricane Sandy.

[††††††] This date was selected because on Monday, October 22, 2012, the National Weather Service of the National Oceanic and Atmospheric Administration issued a public advisory declaring that Tropical Depression 18 had officially become Tropical Storm Sandy (i.e., when it became a named storm).

Appendix 2 – Data Abstraction Form 1

Authority to Declare an Emergency

Q1 Which search term(s) are found in this document?
- ❑ Emergenc(ies) (1)
- ❑ Disaster(s) (2)
- ❑ Governor (3)

Q2 State
- ❍ Delaware (1)
- ❍ Maryland (2)
- ❍ New Jersey (3)
- ❍ New York (4)

Q3 Is this document a statute or regulation?
- ❍ Statute (1)
- ❍ Regulation (2)
- ❍ Executive Order (3)
- ❍ Other (4) _____

Q4 Document number (e.g., Md. PUBLIC SAFETY Code Ann. § 14-107)

Q5 What is the subject of this document (e.g., § 14-107. State of Emergency -- Declaration by Governor)?

Q6 Was law in effect during Hurricane Sandy?
- ❍ Yes (1)
- ❍ No (2)

Q7 Does this law grant the authority to declare an emergency/disaster?
- ❍ Yes (If yes, what term is used?) (1) _____
- ❍ No (2)

If No Is Selected, Then Skip To End of Block

Q8 Under this law, by what mechanism is an emergency declared (e.g., proclamation, executive order, etc.)?

Q9 Under this law, to whom is the authority to declare an emergency/disaster granted (i.e., what officer is granted authority)?
- ❑ Governor (1)
- ❑ Other (4) _____

Q10 According to this law, what is this officer responsible for?

Q11 Per this law, under what conditions can this officer declare an emergency/disaster (i.e., upon finding...what is the threshold that must be met in order for an emergency/disaster to be declared)?

Q12 Under this law, what MUST declaration address?
- ❑ Description (nature) of disaster (10)
- ❑ Conditions giving rise to declaration (4)
- ❑ Area(s) affected or threatened by disaster (9)
- ❑ Effective dates of declaration (1)
- ❑ Geographic areas covered by declaration (3)
- ❑ Agencies responsible for overseeing response (5)
- ❑ Rules or regulations waived or suspended (6)
- ❑ Nothing specified (7)
- ❑ Other (8) _____

Q13 Does the law include requirements for notification regarding or dissemination of an emergency/disaster declaration?
- ❍ Yes (1)
- ❍ No (2)

Answer If Does the law include requirements for notification regarding or dissemination of an emergency/disaster declaration? Yes Is Selected

Q14 What are the requirements for publicizing or disseminating an emergency/disaster declaration (i.e., to whom must notification be made, through what mechanism, when, etc.)?

Q15 Under this law, for what period of time does a declaration of emergency/disaster remain in effect? What are the limits on how long the state of emergency may continue?

Q16 Does law specify terms of termination?
- ❍ Yes (1)
- ❍ No (2)

Answer If Does law specify terms of termination? Yes Is Selected

Q17 What does the law say about termination of a state of emergency/disaster?

Q18 Does law specify terms of renewal or extension (i.e., approval required to extend state of emergency)?
- ❍ Yes (1)
- ❍ No (2)

Answer If Does law specify terms of renewal or extension (i.e., approval required to extend state of emergency)? Yes Is Selected

Q19 What does the law say about renewal or extension of a state of emergency/disaster?

Q20 Does this law authorize the Governor or another state officer to make additional resources available (e.g., funds from rainy day fund)?
- ❍ Yes (1)
- ❍ No (2)

Answer If Does this law authorize the Governor or another state officer to make additional resources available (e.g., funds from rainy day fund)? Yes Is Selected

Q21 What additional resources may be made available in a state of emergency?

Q22 Does this law authorize the Governor or another state officer to take any other action besides declaring an emergency (e.g., assume control of all emergency operations, request federal assistance, etc.)?
- ❍ Yes (1)
- ❍ No (2)

Answer If Does this law authorize officer to take any other action besides declaring an emergency (e.g., assume control of all emergency operations, request federal assistance, etc.)? Yes Is Selected

Q23 What additional action is the officer authorized to take?

Answer If Does this document grant the authority to declare an emergency/disaster? No Is Selected

Q24 Does this document directly relate to the declaration of emergency or disaster (e.g., definitions, purpose, etc.)?
- ❍ Yes (1)
- ❍ No (2)

Answer If To what does this law pertain? Legislative intent, purpose or policy Is Selected

Q25 To what does this law pertain?
- ❑ Legislative intent, purpose or policy (1)
- ❑ Definitions (2)
- ❑ Other emergency powers (besides declaration) (3)
- ❑ Other (4) _____

Answer If Does this law grant the authority to declare an emergency/disaster? No Is Selected

Q26 What does this law address? (in my own words, provide a short description)

Answer If Does this law grant the authority to declare an emergency/disaster? No Is Selected

Q27 What does this law address? (provide quoted text)

Q28 Does this law address anything else not captured above?

Q29 Notes/Comments

Appendix 3 – Data Abstraction Form 2

Authority to Declare a *Health* Emergency

Q1 Which search term(s) are found in this document?
- ❑ Health Emergenc(ies) (1)
- ❑ Health Disaster(s) (2)

Q2 State
- ❍ Delaware (1)
- ❍ Maryland (2)
- ❍ New Jersey (3)
- ❍ New York (4)

Q3 Is this document a statute or regulation?
- ❍ Statute (1)
- ❍ Regulation (2)
- ❍ Executive Order (3)
- ❍ Other (4) _____

Q4 Document number (e.g., Md. PUBLIC SAFETY Code Ann. § 14-3A-03)

Q5 What is the subject of this document (e.g., § 14-3A-02. Governor's proclamation)?

Q6 Was this law in effect during Hurricane Sandy?
- ❍ Yes (1)
- ❍ No (2)

Q7 Does this law grant the authority to declare a health emergency/disaster?
- ❍ Yes (If yes, what term is used?) (1) _____
- ❍ No (2)

If No Is Selected, Then Skip To End of Block

Q8 Under this law, by what mechanism is a health emergency/disaster declared (e.g., proclamation, executive order, etc.)?

Q9 Under this law, to whom is the authority to declare a health emergency/disaster granted (i.e., what officer is granted authority)?
- ❑ Governor (1)
- ❑ Secretary of Health (or equivalent) (5) _____
- ❑ Health Officer (7)
- ❑ Other (4) _____

Q10 Per this law, under what conditions can this officer declare a health emergency/disaster (i.e., upon finding...)?

Q11 Per this law, what MUST declaration address?
- ❑ Description (nature) of health emergency (9)
- ❑ Conditions giving rise to declaration (4)
- ❑ Area(s) affected or threatened by health emergency (18)
- ❑ Effective dates of declaration (1)
- ❑ Geographic areas covered by declaration (3)
- ❑ Agencies responsible for overseeing response (5)
- ❑ Rules or regulations waived or suspended (6)
- ❑ Nothing specified (7)
- ❑ Other (8) _____

Q12 Does this law include requirements for notification regarding or dissemination of a health emergency/disaster declaration?
- ❍ Yes (1)
- ❍ No (2)

Answer If Does this law include requirements for notification regarding or dissemination of a health emergency/disaster declaration? Yes Is Selected

Q13 What are the requirements for publicizing or disseminating a health emergency/disaster declaration (i.e., to whom must notification be made, through what mechanism, when, etc.)?

Q14 Does state of health emergency/disaster terminate or expire automatically (e.g., yes, it automatically terminates after 30 days or no, Governor must revoke declaration)?
- ❍ Yes (1) _____
- ❍ No (2) _____

Q15 What does law say about duration of proclamation?

Q16 Does law specify terms of renewal or extension (i.e., approval required to extend state of health emergency)?
- ❍ Yes (1)
- ❍ No (2)

Answer If Does document specify terms of renewal or extension (i.e., approval required to extend state of health emergency)? Yes Is Selected

Q17 What does law say about renewal or extension of a state of health emergency/disaster?

Q18 Does this law address any other responsibilities or authorities (besides declaration)?
- ❍ Yes (1)
- ❍ No (2)

Answer If Does this law address any other responsibilities or authorities (besides declaration)? Yes Is Selected

Q19 Describe the additional responsibilities or authorities addressed in this law.

Answer If Does this document grant the authority to declare an emergency/disaster? No Is Selected

Q20 Does this document directly relate to the declaration of a health emergency or disaster (e.g., definitions, purpose, etc.)?

- ❍ Yes (1)
- ❍ No (2)

Answer If Does this document directly relate to the declaration of a health emergency or disaster (e.g., definitions, purpose, etc.)? Yes Is Selected

Q21 To what does this law pertain?

- ❍ Legislative intent, purpose or policy (1)
- ❍ Definitions (2)
- ❍ Other emergency powers (besides declaration) (3)
- ❍ Other (4) _____

Answer If Does this law grant the authority to declare a health emergency/disaster? No Is Selected

Q22 What does this law address (say)?

Q23 Does this law address anything else not captured above?

Q24 Notes/Comments

Appendix 4 – Data Abstraction Form 3

Authority to Order Evacuation or Shelter-in-Place

Power III Data Abstraction

Q1 Which search term(s) are found in this document?
- ❑ Shelter! (6)
- ❑ Evacuat! (7)

Q2 State
- ❍ Delaware (1)
- ❍ Maryland (2)
- ❍ New Jersey (3)
- ❍ New York (4)

Q3 Is this document a statute or regulation?
- ❍ Statute (1)
- ❍ Regulation (2)
- ❍ Executive Order (3)
- ❍ Other (4) _____

Q4 Document number (e.g., Md. PUBLIC SAFETY Code Ann. § 14-3A-03)

Q5 What is the subject of this document? (e.g., § 14-3A-03. Governor's orders)

Q6 Was law in effect during Hurricane Sandy?
- ❍ Yes (1)
- ❍ No (2)
- ❍ Unknown (3)

Q7 Does this law grant the authority to order evacuation?
- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To Does this law directly relate to evacuation...

Q8 Under this law, to whom is the authority to order evacuation granted (i.e., what officer is granted Power)?
- ❑ Governor (1)
- ❑ Secretary of Health (or equivalent) (2)
- ❑ Other (4) _____

Q9 Does this law specify a threshold that must be met in order to mandate evacuation? Or is there a trigger?
- ❍ Yes (1)
- ❍ No (2)

Answer If Does this law specify a threshold that must be met in order to mandate evacuation? Or is there a trigger? Yes Is Selected

Q10 Per this law, under what conditions can evacuation be ordered (i.e., upon finding...what is the threshold/trigger for ordering evacuation)?

Q11 Is approval required to order evacuation?

- ❍ Yes (1)
- ❍ No (2)

Answer If Is approval required (e.g., is Governor required to seek Legislature approval within 30 days)? Yes Is Selected

Q12 Whose approval is required?

- ❍ Governor (1)
- ❍ Legislature (2)
- ❍ Other (3) _____

Q13 Does the law address the content of the evacuation order (i.e., what should be specified in the order)?

- ❍ Yes (1)
- ❍ No (2)

Answer If Does the law address the content of the evacuation order (i.e., what should be specified in the order)?; Yes Is Selected

Q14 Per this law, which of the following should be included in the evacuation order?

- ❑ Effective date (when evacuation must begin) (1)
- ❑ Geographic areas to be evacuated (3)
- ❑ Relocation site(s)/Destination (2)
- ❑ Modes of transportation (7)
- ❑ Routes of transportation (10)
- ❑ Other (8) _____

Answer If Does this law grant the authority to order evacuation? No Is Selected

Q15 Does this law directly relate to evacuation?

- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To End of Block

Answer If Does this law grant the authority to order evacuation? No Is Selected

Q16 To what does this law pertain?

- ❍ Legislative intent, purpose, policy (1)
- ❍ Definitions (2)
- ❍ Other (3) _____

Q17 What does this law say about evacuation? (Quote)

Q18 Does this law grant the authority to order shelter-in-place?

- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To Does this law directly relate to evac...

Q19 Under this law, to whom is the authority to order shelter-in-place granted (i.e., what officer is granted Power)?
- ❑ Governor (1)
- ❑ Secretary of Health (or equivalent) (2)
- ❑ Other (4) _____

Q20 Does this law specify a threshold that must be met in order to mandate shelter-in-place? Or is there a trigger?
- ❍ Yes (1)
- ❍ No (2)

Answer If Does this law specify a threshold that must be met in order to mandate shelter-in-place? Or is there a trigger? Yes Is Selected

Q21 Per this law, under what conditions can shelter-in-place be ordered (i.e., upon finding...what is the threshold/trigger for ordering shelter-in-place)?

Q22 Is approval required to order shelter-in-place?
- ❍ Yes (1)
- ❍ No (2)

Answer If Is approval required to order shelter-in-place? Yes Is Selected

Q23 Whose approval is required?
- ❍ Governor (1)
- ❍ Legislature (2)
- ❍ Other (3) _____

Q24 Does the law address the content of the shelter-in-place order (i.e., what should be specified in the order)?
- ❍ Yes (1)
- ❍ No (2)

Answer If Does the law address the content of the evacuation order (i.e., what should be specified in the order)?; Yes Is Selected

Q25 Per this law, which of the following should be included in the shelter-in-place order?
- ❍ Effective date (when sheltering-in-place should begin) (1)
- ❍ Geographic areas to shelter-in-place (3)
- ❍ Other (8) _____

Q26 Does this law directly relate to shelter-in-place?
- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To End of Block

Q27 To what does this law pertain?
- ❍ Legislative intent, purpose, policy (1)
- ❍ Definitions (2)
- ❍ Other (3) _____

Q28 What does this law say about shelter-in-place?

Q29 Does this law require the development of emergency plans/procedures addressing evacuation and/or sheltering?

- ❍ Yes, evacuation (1)
- ❍ Yes, sheltering (2)
- ❍ Yes, both (3)
- ❍ No (4)

If No Is Selected, Then Skip To End of Block

Answer If Does this law require the development of emergency plans/procedures addressing evacuation and/or sheltering? No Is Not Selected

Q30 What types of hazards does this law say emergency plans should address?

- ❑ Fire (1)
- ❑ Chemical (8)
- ❑ Biological (7)
- ❑ Radiological (4)
- ❑ Nuclear (9)
- ❑ Explosive (2)
- ❑ Natural disaster (3)
- ❑ Other (5) _____
- ❑ Not specified (6)

Q31 To whom does planning requirement apply (i.e., who is required to develop plan)?

Q32 Per this law, to whom would plan apply?

Q33 Does this law require that emergency plans address evacuation routes?

- ❍ Yes (1) _____
- ❍ No (2)

Q34 Does law require plans to address destination(s) or relocation site(s)?

- ❍ Yes (1) _____
- ❍ No (2)

Q35 Does law require plan to comply with any standards (e.g., Joint Commission Standards)? (If yes, specify standard)

- ❍ Yes (1) _____
- ❍ No (2)

Q36 Does law specify any other planning requirements?

- ❍ Yes (1)
- ❍ No (2)

Answer If Does law specify any other planning requirements? Yes Is Selected

Q37 What additional planning requirements does the law provide?

Q38 Does this law require exercising or drilling evacuation and/or sheltering in place procedures?
- ❍ Yes, exercising/drilling of evacuation (1)
- ❍ Yes, exercising/drilling of shelter-in-place (2)
- ❍ Yes, both (3)
- ❍ No (4)

Answer If Does this law require exercising or drilling evacuation and/or sheltering in place? No Is Not Selected

Q39 What does the law require in terms of exercising or drilling?

Q40 Does this law require dissemination of or training on plan?
- ❍ Yes (1)
- ❍ No (2)

Answer If Does this law require dissemination of or training on plan?; Yes Is Selected

Q41 What does this law require with respect to dissemination? training?

Q42 Does this law address anything else not captured above?

Q43 Notes/Comments

Appendix 5 – Template Recruitment Letter

Meghan McGinty, MPH, MBA, CPH
PhD Candidate
Johns Hopkins Bloomberg School of Public Health
624 N Broadway, Room 509
Baltimore, MD 21205

Date

Name
Position
Organization
Address
Phone
Email

Dear [Title. Last Name],

My name is Meghan McGinty and I am a PhD candidate at the Johns Hopkins Bloomberg School of Public Health. I am conducting a research project entitled, Decision-Making During Disasters: *A Case Study of Hurricane Sandy Evacuation/ Shelter-in-Place Decision-Making Processes*. I am contacting you to ask if you would be willing to be interviewed for this study. The purpose of this research study is to understand how decisions to evacuate or shelter-in-place hospitals were made during Hurricane Sandy. Interview questions will focus on what processes your organization used to make decisions about sheltering-in-place or evacuating hospitals; what data, tools, or resources informed these decisions; and how you believe such decision processes can be improved during future disasters.

Your participation in this interview is completely voluntary. The interview will last approximately one hour, and with your permission it will be audio recorded. The interview will be scheduled at a time and location that are convenient for you. You may skip any questions or stop the interview at any time. Quotes will not be attributed to you or your organization in the written results of the study. Rather, quotes will be attributed to the type of organization (e.g., hospital, public health agency, emergency management agency, etc.) for which experts such as yourself work. If you are willing to participate or have questions about this research study, please contact me by email at mmcginty@jhu.edu or by phone at [redacted]. Thank you for your time and any assistance you may render in the completion of this valuable research project. I look forward to hearing from you.

Sincerely,

Meghan McGinty, MPH, MBA, CPH

Appendix 6 – Recruitment Flyer

Decision-Making During Disasters:
A Case Study of Hurricane Sandy Evacuation/Shelter-in-Place Decision-Making Processes

Overview
We are currently recruiting hospital executives, emergency managers, and public health officials from New York, New Jersey, Maryland, and Delaware to be interviewed for a research study on hospital evacuation and shelter-in-place decision-making during Hurricane Sandy in 2012. If you were responsible for or significantly involved in determining whether or not to evacuate or shelter-in-place hospitals, or maintain normal hospital operations prior to or in the aftermath of Hurricane Sandy, we want to speak with you.

Purpose
The purpose of this research study is to understand how decisions to evacuate or shelter-in-place hospitals were made during Hurricane Sandy. Interview questions will focus on what processes your organization used to make decisions about sheltering-in-place or evacuating (internally or externally) hospitals; what data, tools, or resources informed these decisions; and any lessons learned.

Logistics
Participation in this research study is completely voluntary. Interviews will last less than one hour, and with permission be audio recorded. Interviews will be scheduled at a time and location that are convenient for you. Quotes will not be attributed to you or your organization in the written results of the study.

Contact Information
If you are willing to participate or have questions about this research study, please contact Meghan McGinty by email at mmcginty@jhu.edu or by phone at [redacted]. You may also contact the Primary Investigator for this project, Dr. Thomas A. Burke, at 410-614-4587.

Appendix 7 - Interview Guide

Decision-Making During Disasters:
A Case Study of Hurricane Sandy Evacuation/ Shelter-in-Place Decision-Making Processes

Semi-Structured Interview Protocol for Hospital Representatives

Introduction

This interview is part of a broader exploratory study of hospital evacuation and sheltering decisions made during Hurricane Sandy. The interview portion of this project aims to understand perspectives of key stakeholders regarding how decisions to either evacuate or shelter-in-place hospitals were made during Hurricane Sandy and how such processes can be improved in the future to best protect public health and safety.

You have been identified as someone who was responsible for or was a key stakeholder significantly involved in evacuation/shelter-in-place decision-making during Hurricane Sandy.

This interview is designed to last less than an hour, depending on how the discussion goes. You may stop the interview at any time. I will be taking notes and referring to this guide in front of me to ensure I don't miss anything I wanted to ask you. When this project is completed, I can provide you with the final abstract and/or a full copy or the report.

Do you have any questions for me before we begin?

QUESTIONS

AUTHORITY and RESPONSIBILITY: I would like to begin with some background questions.

1. In your jurisdiction, who has the authority to evacuate hospitals?
    - *Prompt – If informant indicates hospital representative (e.g., CEO) has this authority, ask*: To your knowledge, are there government officials in your city, county, or state who have the authority to order or mandate evacuation or sheltering of hospitals? If so, who*?*
    - *Prompt:* Can you describe this authority? What does this authority entail?
    - *Prompt – If informant indicates non-hospital representative (e.g., governor or mayor) has this authority, ask:* Within your institution, who has authority to decide whether the institution evacuates or shelters-in-place during an emergency?

Now I would like to speak specifically about what happened during Hurricane Sandy.

2. Tell me about your experience during Hurricane Sandy. What was your role?

DECISION PROCESS

3. Tell me about [insert name of institution]'s decision to [evacuate/shelter-in-place] during Hurricane Sandy?
    - *Prompt: If facility evacuated ask:* Tell me about the extent of your facility's evacuation. Did you initially evacuate internally – either vertically or horizontally?
    - *Prompt:* Did you evacuate select units or floors in the hospital or did the entire hospital evacuate?
    - *Prompt – If all patient care units evacuated, ask:* Did some individuals (e.g., security or environmental services staff) have to shelter-in-place even though the facility was evacuated? If so, why did this happen?
    - *Prompt:* At what point in time relative to Sandy's landfall, did your institution decide to evacuate (e.g., the day before Sandy made landfall, during the storm, two days after landfall)? Please tell me about timing of the decision to evacuate.
    - *Prompt:* Do you have previous experience with hurricanes or evacuation?
4. How did [insert name of institution] determine it should [evacuate/shelter-in-place]? What processes were used to reach this decision?
    - *Prompt:* Was there agreement or consensus about the decision to evacuate your facility?

INFORMATION AND DECISION-MAKING AIDS

5. What influenced your decision to [evacuate/shelter-in-place]?
    - What information or data informed the decision to [evacuate/shelter-in-place]?
    - What other factors (cost, politics, social pressure) influenced the decision to [evacuate/shelter-in-place]? Who paid for the evacuation?
6. Did you conduct a risk assessment or decision analysis to determine whether [insert institution name] should evacuate or shelter-in-place?
    - *Prompt – If informant does not mention guidance, ask:* Did you use any guidance to help you decide whether or not to evacuate your facility? *If informant is unsure what you mean by guidance, mention some possible guidance documents such as the AHRQ Hospital Evacuation Decision Guide.*
    - *Prompt – If informant does not mention decision aids, ask:* Did you use any decision aids or tools to assist in determining whether you should shelter or evacuate patients and staff?
    - *Prompt – If facility evacuated and informant does not mention the motivation, ask:* What was the set of circumstances that prompted evacuation? What was the ultimate reason for evacuation?
    - *Prompt:* Did you assess risks to employee safety and health posed by evacuating or sheltering? If so, how?

LESSONS LEARNED

Now I would like to talk about lessons learned. I would like you to reflect back upon the conversation we have had so far about Hurricane Sandy and think about where the processes for evacuation/sheltering decision-making could have been improved.

7. Were you satisfied with the hospital evacuation/sheltering-in-place decision process?
   - *Prompt: What were the implications of evacuating/sheltering-in-place?*
   - *Prompt: Were there adverse outcomes as a result of evacuation/sheltering-in-place? Were any workers injured? Were there any patient deaths or adverse health outcomes?*

8. How do you believe hospital evacuation/sheltering decision-making can be improved in the future?
   - *Prompt:* What additional information would you have wanted to inform your decision?
   - *Prompt – If institution used existing guidance and informant does not mention how it can be improved, ask:* How can existing guidance be improved to better assist in evacuation decision-making?
   - *Prompt – If institution used existing decision-making aids and informant does not mention how they can be improved, ask:* How can existing decision-making aids or tools be improved to better assist in evacuation decision-making?
   - *Prompt – If institution did not use existing guidance or decision-making aids, ask:* What new decision-making guidance, tools, or aids would be helpful in evacuation/sheltering decision-making?
   - *Prompt:* How can decision processes be improved to better protect the safety and health of hospital workers during future emergencies?
   - *Prompt:* What are the three most important things that should be changed or done to improve hospital evacuation/sheltering decision-making in the future?

9. How can policies related to hospital evacuation and sheltering be improved?
   - *Prompt:* Was it clear who had authority to make evacuation and sheltering decisions? Are current policies related to evacuation and sheltering sufficient? Are current policies effective?
   - *Prompt:* Thinking specifically about the interaction between the government and hospitals, how can policies for hospital evacuation and sheltering be improved?

CLOSING REMARKS

- This conversation has been very helpful. Those are all the questions that I have for you today. Is there anything else you would like to tell me?
- Would you mind if I contacted you again if I have any follow-up questions?
  - *If ok to contact informant again, ask*: What is the best way to reach you for follow-up?

- Whom should I talk to in order to learn more?
    - *If they identify additional key informants, ask:* Do you mind if I let them know that you recommended I speak with them?
- Do you have any questions for me?

Thank you very much for your time.

Appendix 8 – Oral Informed Consent Script

Oral Informed Consent for Interviewees

PI Name: Thomas Burke, PhD, MPH
Institution: Johns Hopkins Bloomberg School of Public Health
Study Title: Decision-Making During Disasters: *A Case Study of Hurricane Sandy Evacuation/ Shelter-in-Place Decision-Making Processes*

Good Morning/Afternoon. I am a doctoral candidate at the Johns Hopkins Bloomberg School of Public Health. I would like to talk with you about a research study on Hurricane Sandy. We are working to understand how hospital evacuation and sheltering decisions were made during Hurricane Sandy. We ask you to join this study because of your knowledge of these decision processes. You do not have to join; it is your choice. You may change your mind at any time.

If you say yes, I will ask you to answer some questions about hospital evacuation and sheltering during Hurricane Sandy. The interview will last about one hour. With your permission, I will audio record this interview so that it can be transcribed and referred to later when I analyze all of the interviews. I may contact you later if I have more questions.

You may be uncomfortable answering questions. You do not have to answer all of the questions. You may skip any questions or stop the interview at any time. There is a risk that someone outside the study will see your information. We will do our best to keep your information safe by storing data on a password-protected computer. Caution will be taken to minimize the risk that your identity can be determined. In the written results of this study, quotes will not be attributed to you or your organization. Rather, quotes will be attributed to the type of organization (e.g., hospital, public health agency, emergency management agency, etc.) for which key informants such as yourself work. If I share your information with other researchers, they will use the same protections.

You will receive no direct benefit from participating in this study. Indirect benefits include the opportunity to contribute your thoughts and expertise on this topic. I will use the information from your answers to understand how hospital evacuation and sheltering decision processes can be improved in the future to best protect public health. Results of the study will be shared with you. You will not be paid to join this study.

Do you have any questions? You may ask me now, or contact the Principal Investigator, Thomas Burke, at 410-614-4587. You may also contact the Johns Hopkins Bloomberg School of Public Health Institutional Review Board (IRB), which reviewed this study about any problems or concerns at 1-888-262-3242 or irboffice@jhsph.edu.

May I begin?

Appendix 9 – Template Contact Summary Sheet

Contact Summary Sheet

Interview #:
Informant #:
Date of Interview:
Type of Interview: _____In-Person
_____Phone
State:
County:
Type of Organization: _____Hospital
_____Public Health
_____Emergency Management
_____Emergency Medical Services

Informant's Position:
Today's Date:

1. What were the main issues or themes that struck you in this interview?

2. Anything else that struck you as salient, interesting or important in this interview? Were there any new hypotheses, speculations, or hunches suggested by the contact?

3. What new (or remaining) questions do you have for this jurisdiction (either this county or this state)?

4. Snowball sampling

Appendix 10 – Initial Institutional Notice of Determination

FWA #00000287

JHSPH Institutional Review Board Office

615 N. Wolfe Street / Suite E1100
Baltimore, Maryland 21205
Office Phone: (410) 955-3193
Toll Free: 1-888-262-3242
Fax Number: (410) 502-0584
E-mail Address: irboffice@jhsph.edu
Website: www.jhsph.edu/irb

NOT HUMAN SUBJECTS RESEARCH
DETERMINATION NOTICE

Date: December 23, 2013

To: Meghan McGinty

Re: **PhD Dissertation Student Project Title:** "Decision-Making During Disasters: A Case Study of Hurricane Sandy Evacuation/ Shelter-in-Place Decision-Making Processes"

The JHSPH IRB reviewed the IRB Office Determination Request Form for Primary Data Collection (received 12/16/13) on **December 20, 2013**. We have determined that the proposed activity described in your request form will involve subjects who are key informants and collects expert opinions and judgments designed to elicit information from them in their professional capacity about hospital evacuation and sheltering during Hurricane Sandy. No personal or private information will be collected. Thus, the proposed activity does not qualify as human subjects research as defined by DHHS regulations 45 CFR 46.102, and does not require IRB oversight.

You are responsible for notifying the JHSPH IRB of any future changes that might involve human subjects and require IRB review.

If you have any questions regarding this determination, please contact the JHSPH IRB Office at (410) 955-3193 or via email at irboffice@jhsph.edu.

/teb

cc: Thomas Burke, PhD
Project Advisor
Professor, Health Policy & Management

Appendix 11 – Revised Institutional Notice of Determination

FWA #00000287

JOHNS HOPKINS
BLOOMBERG SCHOOL of PUBLIC HEALTH

Institutional Review Board Office

615 N. Wolfe Street / Room E1100
Baltimore, Maryland 21205-2179
Phone: 410-955-3193
Toll Free: 1-888-262-3242
Fax: 410-502-0584
Email: jhsph.irboffice@jhu.edu
Website: www.jhsph.edu/irb

NOT HUMAN SUBJECTS RESEARCH
DETERMINATION NOTICE
STUDENT PROJECTS

REVISED: January 7, 2015

Date: December 23, 2013

To: Meghan McGinty

Re: **PhD Dissertation Student Project Title**: "Decision-Making During Disasters: A Case Study of Hurricane Sandy Evacuation/ Shelter-in-Place Decision-Making Processes"

The JHSPH IRB reviewed the IRB Office Determination Request Form for Primary Data Collection (received 12/16/13) on **December 20, 2013**. We have determined that the proposed activity described in your request form will involve subjects who are key informants and collects expert opinions and judgments designed to elicit information from them in their professional capacity about hospital evacuation and sheltering during Hurricane Sandy. No personal or private information will be collected. Thus, the proposed activity does not qualify as human subjects research as defined by DHHS regulations 45 CFR 46.102, and does not require IRB oversight.

You are responsible for notifying the JHSPH IRB of any future changes that might involve human subjects and require IRB review.

If you have any questions regarding this determination, please contact the JHSPH IRB Office at (410) 955-3193 or via email at irboffice@jhsph.edu.

/teb

cc: Helaine Rutkow, PhD, JD
Faculty Advisor / Associate Professor
Department of Health Policy and Management

Appendix 12 – Thematic Codes

Thematic Code	Interviews	Total References
Influential Factors - Motivation for Evacuation or Sheltering	30	557
Accreditation standards/Joint Commission	4	5
Continuity of care/operations	16	34
Cost	15	25
Flooding/Storm surge	20	40
Location of facility	16	27
Mandate/Order	19	38
Patient acuity/Hospital type	6	14
Politics	16	26
Receiving facilities	10	14
Risk to patient's health	24	59
Social pressure	7	7
Staffing	8	13
Storm characteristics/Weather forecast	24	69
Structural damage/System failures	23	69
Supplies	4	6
Transportation/Access	20	50

Thematic Code	Interviews	Total References
Authority and responsibility	25	80
C-Suite engagement	3	5
Collaboration/Coordination	22	50
Community expectations/Reliance/Community resource	15	40
Consensus/Support for decision	20	27
Decision making process	23	70
Decisions support resources	17	29
Defend in place	5	10
Employee health and safety	16	30
Evacuation (task/process - not decision)	8	21
Last resort	6	12
Left behind	5	10
Nursing homes/Other healthcare facilities	14	48
Policy implications	2	4
Pre-storm preparations and preparedness	25	74
Prior experience	28	136
Irene	24	88
Risk/vulnerability assessment	21	45
Satisfaction	23	46
Social linkages	7	10
Speed of flooding	1	2
Timing of evacuation & decision	18	48

Thematic Code	Interviews	Total References
Improvements/Lessons Learned	29	271
Collaboration and competition	8	12
Communication systems and redundancies	11	20
Desired info to inform decision	5	12
Facility assessments and facility-specific decision-making	5	11
Facility construction standards	1	1
Funding	3	3
Gas	4	6
Outcome – mortality/morbidity data	4	5
Preparedness planning	13	25
Shelter-in-place definition	3	7
Transfer process	13	33
Transportation/access	3	4
Weather/Storm forecasting	14	27

Note: "Interviews" is the number of key informant interviews in which a particular thematic code was applied. "Total references" is the total number of times a particular thematic code was applied (i.e., some codes were applied in multiple instances within a single interview transcript).

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Curriculum Vitae

MEGHAN D. MCGINTY

December 2015

PERSONAL DATA

Business Address:
624 North Broadway, Room 429
Baltimore, MD 21205

Email: mmcginty@jhu.edu

Place of Birth: Brooklyn, New York, U.S.A.
Date of Birth: July 23, 1982

EDUCATION AND TRAINING

Johns Hopkins Bloomberg School of Public Health, *Baltimore, MD*
Doctor of Philosophy, Heath and Public Policy — Dec. 2015

Johns Hopkins Bloomberg School of Public Health, *Baltimore, MD*
Master of Public Health — May 2008
Graduate Certificate in Risk Sciences and Public Policy — May 2008

Johns Hopkins Carey Business School, *Baltimore, MD*
Master of Business Administration — May 2008

Georgetown University, *Washington, DC*
Bachelor of Arts, *cum laude* in Art, Theater and Music — May 2004

Health Resources and Service Administration (HRSA)
Trainee Fellowship — 2015

National Institute for Occupational Safety and Health (NIOSH)
Occupational Injury Epidemiology and Prevention Fellowship — 2011 – 2015

National Board of Public Health Examiners
Certified in Public Health (Charter Class) — 2008

PROFESSIONAL EXPERIENCE

UPMC Center for Health Security, *Baltimore, MD*
Research Assistant Sept. 2014 –

- Performed literature searches and conducted quantitative and qualitative data collection and analysis on topics including resilience, healthcare system preparedness, and risk communication.
- Authored professional manuscripts, technical reports, grant proposals, and progress reports for funders.

Johns Hopkins Bloomberg School of Public Health, *Baltimore, MD*
Research Assistant June 2012 – Present
Evacuation and Shelter-in-Place Decision-Making for Hospitals during Hurricane Sandy (PhD Dissertation)

- Researched and evaluated Mid-Atlantic state statutes and regulations on governmental authority to order evacuation or shelter-in-place of hospitals.
- Conducted 42 semi-structured qualitative interviews with key stakeholders to examine decision-making processes employed during Superstorm Sandy and identify indicators of hospital evacuation.

Community Values and Allocation of Scarce Medical Resources

- Facilitated community and medical provider focus groups as part of a research study designed to engage citizens and medical providers in Maryland in a dialogue about which values they feel ought to guide decisions about allocating scarce medical resources during a disaster such as a pandemic influenza.

Spring Valley Follow-up Health Study

- Developed community survey for a health study of a formerly used defense site (FUDS).
- Performed background environmental research, data entry, and analysis and then co-authored environmental health profile based on this research.

New York City Department of Health and Mental Hygiene, *New York, NY*
Director of Continuity Planning Sept. 2009 – July 2011

- Developed and implemented strategies to ensure continuity of agency operations during disasters.
- Supervised twelve professional staff in development of Continuity of Operations (COOP) Plans for their respective divisions.
- Provided technical assistance to Commissioner of Health, Chief Operating Officer, and executive leadership.
- Served on NYC H1N1 Planning Taskforce and co-chaired cross-divisional workgroup that prepared for the resurgence of H1N1 in the fall of 2009.
- Liaised with NYC Office of Emergency Management, other city agencies, and state and federal agencies with respect to COOP and emergency planning.
- Represented Chief Operating Officer in Citywide Business Continuity Working Group.

New York City Department of Health and Mental Hygiene, *New York, NY*
Continuity of Operations Program Analyst June 2008 – Aug. 2009

- Identified and engaged critical stakeholders to support the development and execution of continuity plans.
- Authored and coordinated the writing of COOP and other emergency plans, procedures, and strategies.
- Researched best practices to develop promising approaches for continuity planning.

Office of the Surgeon General, Department of Health and Human Services, *Rockville, MD*
Intern May 2007 – Mar. 2008

- Developed and delivered tactical field training at Camp Bullis, Texas utilizing the Incident Command System (ICS) structure for 15 teams composed of 621 U.S. Public Health Service Commissioned Corps Officers.
- Created business plan for the formation of advanced rapidly deployable public health and medical response teams.

Maryland Department of Health and Mental Hygiene, *Baltimore, MD*
Intern Nov. 2006 – May 2007

- Developed, administered, and analyzed competency assessment to determine staff's public health emergency preparedness knowledge, skills, and abilities; and identified training needs based on gaps identified.

SRA International, Inc., *Arlington, VA*
Emergency Management Analyst June 2004 – June 2006

- Supervised professional staff working on program planning and evaluation.
- Authored national directives, training curriculum, and materials to improve access to and quality of training.
- Developed, conducted, and evaluated workshops and emergency training programs (including an EPA methamphetamine train-the-trainer program) to ensure appropriate and effective emergency response.
- Provided organizational and logistical support to federal, state, and local agency preparedness missions.
- Created briefings, factsheets, and other outreach materials and maintained the www.nrt.org website.

Jersey City Medical Center, *Jersey City, NJ* May 2003 – Mar. 2004
Emergency Medical Technician

- Responded to 911 calls, performed assessments, and provided medical care to prevent and reduce mortality and morbidity due to illness and injury.
- Served as patient advocate in the healthcare continuum.

St. Vincent's Hospital, *Staten Island, NY* May 2002 – Sept 2002

- Completed a 200-hour internship to develop clinical care skills specific to 911 emergency responses.

Midwood Ambulance and Oxygen Inc., *Brooklyn, NY* May 2001 – Aug 2001

- Administered all facets of pre-hospital basic life support medical services to injured and sick persons.

PROFESSIONAL ACTIVITIES

Society Membership and Leadership

American Public Health Association

Member	2006 –
Environment Section Councilor	2014 – 2017
Co-Chair, Student Involvement Committee, Environment Section	2012 – 2014

International Association of Emergency Managers

Member	2014 –

EDITORIAL ACTIVITIES

Peer Review Activities

Disaster Medicine and Public Health Preparedness	2015 –
Health Security	2014 –
American Journal of Public Health	2011 –

Editorial Activities

Topic Editor, Special Feature on Climate Change, *Health Security*	2015 – 2016

HONORS AND AWARDS

Maryland Public Health Association Donald O. Fedder Student Poster Competition – Third Place (2015)
Victor Raymond Memorial Scholarship Award, Johns Hopkins Bloomberg School of Public Health (2015)
Lipitz Public Health Policy Award, Johns Hopkins Bloomberg School of Public Health (2013-2014)
Johns Hopkins University Environment, Energy, Sustainability and Health Institute (E^2SHI) Fellowship (2013-2014)
John C. Hume Doctoral Award, Johns Hopkins Bloomberg School of Public Health (2013)
United States Public Health Service Surgeon General's Service Commendation (2008)
National Society of Collegiate Scholars (2004)
Boston University Scholar (2000)
Siemens Westinghouse Science & Technology Competition – Regional Semi-Finalist (2000)
Prudential Insurance Company Spirit of Community Award (2000)

PUBLICATIONS

Journal Articles (Peer Reviewed)

Toner, E.S., Ravi, S., Adalja, A., Waldhorn, R.E., **McGinty, M.D.** & Schoch-Spana, M. (2015, August). *Doing Good by Playing Well with Others: Exploring Local Collaboration for Emergency Preparedness and Response.* Health Security. 13(4): 281-289.

Kansagra, S.M., **McGinty, M.D.**, Morgenthau, B.M., Marquez, M.L., Roselli-Frascilla, A., Zucker, J.R. & Farley, T.A. (2011, December). *Cost comparison of 2 mass vaccination campaigns against Influenza A H1N1 in New York City*. American Journal of Public Health. 102(7):1378-1383.

Reports

Fox, M.A, Resnick, B., Nachman, K.E., Truant, P., **McGinty, M.D., Le, J.,** & Burke T. "Follow-up On Spring Valley Health Study – Summary Report." July 2013. Accessed at: http://www.jhsph.edu/offices-and-services/practice-and-training/projects-and-communications/_documents/Summary-Report-July2013.pdf.

Nachman K.E., **McGinty, M.D.**, & Fox, M.A. "Follow-up On Spring Valley Health Study – Environment Assessment Technical Report." July 2013. Accessed at: http://green.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/JHU%20Environment%20Report%20FINAL.pdf.

TEACHING

Advising and Mentoring

New York City Department of Health and Mental Hygiene
Health Research Training Program Preceptor 2009 – 2010

Classroom Instruction

Universitat Pompeu Fabr
Graduate Instructor, *Barcelona, Spain* Nov. 2012

- Taught *Leadership Case Studies in Public Health Decision Making* Course in the Health Policy and Management Fall Institute organized in collaboration with the Agència de Salut Pública de Barcelona and the Universitat Pompeu Fabra.

Johns Hopkins Bloomberg School of Public Health
Graduate Teaching Assistant, *Baltimore, MD*

- Assisted professors in the instruction, advising, and evaluation of graduate and undergraduate students
- Developed curriculum for new graduate course, *Tools of Public Health Practice & Decision Making*
- Supervised other graduate teaching assistants

Johns Hopkins Bloomberg School of Public Health Courses

Academic Year 2006 – 2007
Summer Problem Solving in Public Health (550.608.19)

Academic Year 2007 – 2008
Summer Problem Solving in Public Health (550.608.19)
Intersession Problem Solving in Public Health (550.608.13)
3rd Term Public Health Preparedness Seminar
3rd & 4th terms Special Studies in Business

Academic Year 2011 – 2012
1st term Introduction to the Risk Sciences and Public Policy (300.603.01)
3rd term Introduction to the Risk Sciences and Public Policy – online (317.610.81)

Academic Year 2012 – 2013
Summer term Tools of Public Health Practice and Decision Making $^{\delta}$ * (300.603.01)
1st term Introduction to the Risk Sciences and Public Policy (317.600.01)
2nd term Risk Policy, Management and Communication* (317.610.01)
Intersession Case Studies in Communicating with the Media (301.771.51)
Intersession Making Effective Public Presentations (301.772.51)
3rd term Introduction to the Risk Sciences and Public Policy – online* (317.610.81)
Summer Case Studies in Communicating with the Media (301.771.51)
Summer Making Effective Public Presentations (301.772.51)
1st - 4th terms Current Issues in Public Health - online (550.862.81)

Academic Year 2013 – 2014
Summer Tools of Public Health Practice and Decision Making $^{\delta}$ * (300.603.01)
1st term Introduction to the Risk Sciences and Public Policy* (300.603.01)
Intersession Case Studies in Communicating with the Media (301.771.51)
Intersession Making Effective Public Presentations (301.772.51)
1st - 4th terms Current Issues in Public Health – online* (550.862.81)

Academic Year 2014 – 2015
Summer Tools of Public Health Practice and Decision Making $^{\delta}$ * (300.603.01)
1st - 4th terms Current Issues in Public Health – online* (550.862.81)

Academic Year 2015 – 2016
1st term Current Issues in Public Health – online* (550.862.81)

Total: 32 Course offerings
$^{\delta}$ Course had over 200 students enrolled
* Indicates I was the supervisory teaching assistant

American Red Cross
Cardio-Pulmonary Resuscitation (CPR) and First Aid Instructor, New York, NY
2002

- Directed health and safety education and training, including first aid, CPR, AED, and blood-borne pathogens courses, as part of a national preparedness program aimed to help people lead healthier and safer lives.

Guest Lecturer
McGinty, M.D. (2015, October). "Occupational Health and Safety During Hospital Evacuation." Presented in *Graduate Seminar in Injury Research and Policy*, Bloomberg School of Public Health, The Johns Hopkins University.

McGinty, M.D. (2014, March). "Risk Communication: Using Twitter and Voicethread." Presented Online in *Risk Policy, Management and Communication*, Bloomberg School of Public Health, The Johns Hopkins University.

McGinty, M.D. (Online). "Orientation for Teaching Assistants" in *Teaching Assistantships 1: Essential Elements*, Bloomberg School of Public Health, The Johns Hopkins University.

McGinty, M.D. (2013, October). "Hurricane Sandy: A Case Study of Public Health Hurricane Preparedness and Response." Presented in *Public Health and Disasters*, Krieger School of Arts and Sciences, The Johns Hopkins University.

VOLUNTEER AND SERVICE ACTIVITIES

Johns Hopkins Bloomberg School of Public Health, *Baltimore, MD*
Student Member June 2012 – May 2013
Academic Policy and Admission Committee

The Johns Hopkins University, *Baltimore, MD*
Advisory Committee Member 2013 – 2015
The Public Health Policy Practicum, PhD Innovation Initiative

House of Delegates Maryland General Assembly, *Annapolis, MD*
Staff, Delegate Dan Morhaim, Deputy Majority Leader Jan. 2012 – April 2013

- Researched and provided scientific evaluation of public health implications of policies under consideration.

Athletes for Health Inc., *New York, NY*
Founder and Director Jan. 2001 – Dec. 2010

- Founded and directed this 501c3 organization, which provided CPR training pro-bono to over 300 students from economically disadvantaged areas of New York City and Hudson County, New Jersey.

PRESENTATIONS

Scientific Meetings

McGinty, M.D., Rutkow, L., & Burke, T.A. (2015, November). *Hospital Evacuation and Shelter-in-Place During Hurricane Sandy – An Analysis of Influential Mid-Atlantic State Laws*. Poster presented at 143rd American Public Health Association Annual Meeting and Exposition, Chicago, IL.

McGinty, M.D. (2015, September). *Evacuation and Shelter-in-Place Decision-Making for Hospitals during Hurricane Sandy: Perceptions of Authority and Responsibility.* Presented at the 2015 Maryland Public Health Association Annual Conference, Baltimore, MD.

McGinty, M.D. (2015, April). *Mid-Atlantic Evacuation and Shelter-in-Place Legal Authorities during Hurricane Sandy.* Poster presented at the Green Research and Sustainability Symposium, Baltimore, MD.

McGinty, M.D., Truant, P., Burke, T.A., Resnick, B., Le, J., & Lam, J. (2014, November). *Educating Public Health Professionals for the Future: A Competency-based Approach to Public Health Practica*. Presented at 142nd American Public Health Association Annual Meeting and Exposition, New Orleans, LA.

McGinty, M.D., Kansagra, S.M., Morgenthau, B.M., Marquez, M., Frascilla-Roselli, A., Zucker, J. & Farley, T.A. (2010, November). *Cost of mass vaccination against H1N1 influenza: A comparison of two New York City campaigns*. Poster presented at 138th American Public Health Association Annual Meeting and Exposition, Denver, CO.

Kansagra, S.M., Papadouka, V., Geevarughese, A., Hansen, M.A., **McGinty, M.D**., & Zucker, J.R. (2010, November). *Where children receive Influenza vaccine: Importance of school-located vaccination*. Poster presented at 138th American Public Health Association Annual Meeting and Exposition, Denver, CO.

Kansagra, S.M., **McGinty, M.D.**, Morgenthau, B.M., Marquez, M.L., Roselli-Frascilla, A., Zucker, J.R. & Farley, T.A. (2010, March). *Cost Comparison of Two Mass Vaccination Campaigns Against H1N1 Influenza In New York City*. Presented at 45th National Immunization Conference, Washington, DC.

McGinty, M.D. (2007, May). *Assessing Preparedness Competency and Training Needs at the Maryland Department of Health and Mental Hygiene.* Presented at the PHASE Symposium, Baltimore, MD.

McGinty, M.D. (2006, May). *Fostering collaboration among first responders: A means to mitigate Public and Social Health Impacts of Methamphetamine Use.* Presented at the Society for Public Health Education Midyear Scientific Conference, Las Vegas, NV.

Invited Seminars

McGinty, M.D. (2015, October). "Hospital Decision-Making During Extreme Weather Events." Seminar presented for the Environment, Energy, Sustainability and Health Institute. The Johns Hopkins University.

CERTIFICATIONS

- New York State Emergency Medical Technician (EMT) Basic (Ex. 06/2013)
- National Incident Management System (NIMS) Incident Command Courses: IS 100, 200, 300, 400, 700 & 800
- COOP Awareness (IS-546)
- Introduction to COOP (IS-547)
- Continuity of Operations Manager (IS-548)
- COOP Manager (IS-548) Train-the-Trainer
- COOP Planner (IS-550) Train-the-Trainer
- Effective Communication (IS-242)
- Fundamentals of Emergency Management (IS-230.a)
- Determined Accord Pandemic Influenza Tabletop Exercise
- Geographic Information Systems (GIS) Boot Camp I
- OEM COOP Tabletop Exercise 101 Course
- Enhance Threat and Risk Assessment
- Hazardous Materials Response and Decontamination: Awareness and Operations
- Weapons of Mass Destruction (WMD): Awareness
- Department of Homeland Security (DHS) Enhanced Threat and Risk Assessment
- Recognition of Organophosphate (Nerve Agent) Poisoning and Administration of Antidote Kits
- EPA Clandestine Methamphetamine Laboratories: Awareness, Operations and Train-the-Trainer
- Coaching the Emergency Vehicle Operator (CEVO) II
- Emergency Vehicle Operations Course (EVOC)
- Psychological First Aid (PFA)

ADDITIONAL INFORMATION

Personal Statement of Research and Research Objectives

I am a public health emergency management researcher and practitioner. My doctoral thesis examines evacuation and shelter-in-place decision-making for acute care hospitals during Hurricane Sandy in 2012, a priority of the *Science Preparedness* agenda for Hurricane Sandy. In addition, I conduct mix-methods practice-based research on subjects including the allocation of scarce resources during disasters, risk management and communication, health sector collaboration, and resilience. It is essential to ensure that time-sensitive data and information needed to protect public health are identified, collected, and analyzed during disasters. I am committed to advancing post-disaster research to improve future emergency response. I am also interested in understanding how we can ensure a competent public health workforce. In particular, a main objective of my work is to ensure the ability of practitioners to communicate effectively and make difficult decisions.

Keywords

Public health preparedness, risk assessment, risk communications, organizational decision-making, occupational injury epidemiology