Healthcare System Recovery Timeline: A White Paper for Texas

October 11, 2017
Updated March 2022

Following a number of related technical assistance requests and in anticipation of future information needs from healthcare systems impacted by current and future disasters, ASPR TRACIE developed this white paper to answer the question, "How long does it take the healthcare system to recover from a major hurricane?"

We conducted an extensive literature review of published and grey literature and open-source media accounts of past disaster recovery reports. The results are presented below with findings and considerations listed first, followed by links to additional placed in an appendix. Links to related resources can also be found on the ASPR TRACIE Hurricane Resources Page.

We specifically reviewed factors that affect the healthcare system's ability to "recover" and return to baseline (or the "new normal") following a disaster and the scope was bounded by the following questions and assumptions:

- Is it possible to return to "baseline" or are the healthcare system and population health permanently altered?
- What factors positively or negatively impact recovery?
- How is healthcare defined? Does it include hospitals, nursing homes, and primary care, or should we view it holistically, as it is all intertwined?
- Impact doesn't necessarily have to be hurricane related, but should address facilities that closed, evacuated, were impacted by surge of patients and/or lack of staff.
- Is granularity available on directly impacted facilities returning to normal, such as those that closed and evacuated or were affected by damage, versus those tangentially impacted due to increase in patients or lack of staff?
- What is the effect of flood water on population health?
- How does overall pre-disaster population health affect recovery of the healthcare system?
    - Baseline health
    - Chronic medical or behavioral health conditions
    - Percent of population covered by health insurance
    - Percent covered by Medicaid
    - Other socio-economic factors

The full breadth of analyses required to robustly answer this request is very complex and the results would vary significantly geographically. While beyond the resources available to ASPR

TRACIE, we have provided a cursory overview of some of the key factors that shape the answers to the above questions.

Findings

The answers to these questions are multifactorial in nature, with a number of interwoven components that affect the ability of the healthcare system to recover from a natural disaster, specifically one that involves widespread flooding. Disaster-related factors can include the size of the area affected, whether widespread flooding with long standing flood water is involved, and the direct impact to community infrastructure and healthcare facility infrastructure. Damage to the roads and transportation system can affect healthcare access as well. Other factors include the baseline health status of the community and the percent of the population covered by health insurance pre-disaster.

The following high-level responses are provided for the specific questions posed in the request to ASPR TRACIE, but readers should review this document in its entirety. The responses to the questions are based on the totality of information ASPR TRACIE staff were able to access and should not be construed as absolute fact. Additional information, if uncovered, could alter this high-level assessment.

- Is it possible to return to "baseline" or is the healthcare system and population health permanently altered?
    - In some situations the return to baseline is possible. After tornadoes struck in MO and MS, temporary healthcare infrastructure was put in place relatively quickly and the facilities were able to rebuild without apparent or reported significant adverse health effects on the community.
    - In New Orleans, following Hurricane Katrina, it does appear that there has been a shift in the overall health of the community and a wholesale change to the healthcare system (ASPR TRACIE is not implying a negative or positive – it is just completely different and therefore not at baseline).
    - In New York City, following Hurricane Sandy, there does not appear to have been a shift in the overall health status, but healthcare facilities have not necessarily regained patient or provider populations that were lost and resources that were shifted.
    - Hurricane Maria temporarily devastated Puerto Rico's infrastructure, with many living without electricity for months after the storm. In addition to physical health challenges caused partially by a lack of access to healthcare for a period of time, the mental health effects of this devastating disaster remain a challenge for residents, disaster responders, and healthcare workers.
- What factors positively or negatively impact recovery?
    - Community infrastructure such as power, water, and transportation significantly impact the speed with which the healthcare system can recover. Other factors include the size of the impact and the speed and nature of post-disaster

decision-making by emergency managers and healthcare facility leadership.

- How is healthcare defined? Does it include hospitals, nursing homes, and primary care, or should we view it holistically, as it is all intertwined?
    - For the purposes of this response, we took a holistic approach and searched for information related to any and all healthcare facilities or healthcare impacts.
- Impact doesn't necessarily have to be hurricane related, but should address facilities that closed, evacuated, were impacted by surge of patients and/or lack of staff.
    - We reviewed literature on hurricanes, floods, tornadoes, and earthquakes, along with several environmental emergencies that we felt had results we could extrapolate.
    - The section on Post Disaster Healthcare Demand addresses the types of surge patients and the level of healthcare demand expected following a storm or event and in relation to loss of other facilities.
- Is granularity available on directly impacted facilities returning to normal, such as those that closed and evacuated or were affected by damage versus those tangentially impacted due to increase in patients or lack of staff?
    - We dedicated a section of this TA response on recovery timelines from past disasters which includes as much granularity as possible on facility closure and opening times and issues.
- What is the effect of flood water on population health?
    - There was little published material on the effect of flood water specifically on healthcare system response.
    - This document does include information on the short-, medium-, and long-term health impacts of flooding.
- How does overall pre-disaster population health affect recovery of the healthcare system?
    - Baseline health
    - Chronic medical or behavioral health conditions
    - Percent of population covered by health insurance
    - Percent covered by Medicaid
    - Other socio-economic factors
        - We addressed this extensively in the section on Baseline Health Status Resources for Texas

Evaluating/Assessing Recovery Factors

Exhibit 1 visually displays example factors that influence or impact recovery. There is no formula output from this chart; this is more of a "dashboard" that could be used as a quick look to determine vulnerabilities and areas of focus for maximizing the recovery timeline. The "Status" scale could be described as Intact, Intact with a small qualifier, Minimally Disrupted with a small qualifier, Disrupted, Destroyed.

Exhibit 1: Factors Impacting Recovery for the Healthcare System and the Community

Healthcare System			Population/Community		
Factor	**Description**	**Status**	**Factor**	**Description**	**Status**
Leadership and Governance	Healthcare leadership in place and functioning. Healthcare coalition in place and functioning		Leadership and Governance	State and local government leadership in place and coordinating response	
Healthcare Workforce	Any loss of staff from injuries, inability or unwillingness to come to work		Education	Are schools back in session and is attendance near baseline	
Infrastructure	Any damage to healthcare facilities, any closures – use this broadly to include acute care hospitals, long term care facilities, primary care and clinics, other ancillary services Disruptions to one aspect of the healthcare system will overflow onto the other components		Health Status	Pre-event health status of the population, percent uninsured, percent with chronic disease, percent on Medicaid, etc – Any changes this baseline?	
Medical Supplies, Equipment, Technology	Enough supplies to meet need, damage to major systems, supply chain disruptions		Affordability	Any change to the affordability of healthcare – income loss, loss of insurance, price gouging	
Health Information	Electronic medical records, health IT systems, communication systems within the healthcare community		Income	Related to affordability, but is there a large loss of income in the community – has there been a major loss of employment due to the event or drop in income due to lack of work.	
Health Financing	Concerns with facility cash flow and solvency, concerns with uninsured		Infrastructure/ Transportation Access	Infrastructure (power, water, gas, communications), Transportation (access due to damage, are busses, trains, cabs, etc operating, so people can access healthcare)	
Service Delivery	Can healthcare services continue to be provided without disruption? Can patients continue to be seen at their pre-disaster medical homes?				

ASPR TRACIE has developed a companion document titled Major Hurricanes: Potential Public Health and Medical Implications. Many resources and information on recovery are included in that document.

ASPR TRACIE also has relevant Topic Collections on Disaster Recovery Planning, Continuity of Operations/Failure Plans, and Natural Disasters and an additional document: Hurricane Resources at Your Fingertips. Access links to these and other resources, including the Emergency Prescription Assistance Program on the Hurricane Resources Page.

Baseline Health Status Resources for Texas

Please note that this information on Texas is included below, as the impetus for this White Paper was healthcare recovery from Hurricane Harvey's impact on Texas. We have left the information for review as an example of the types of data available on any jurisdiction's health status, which is critical information for all public health and healthcare system preparedness professionals to have on their population.

Understanding the baseline health status for the effected population is critical to understanding its resiliency and ability to recover. There are several tools that support this data gathering. One program that supports this data gathering is the HHS emPOWER Program. The HHS emPOWER Program is mission-critical partnership between the Office of the Assistant Secretary for Preparedness and Response (ASPR) and the Centers for Medicare and Medicaid Services (CMS). The HHS emPOWER Program provides federal data, mapping, and artificial intelligence tools, as well as training and resources, to help communities nationwide protect the health of at-risk Medicare beneficiaries, including 4.2 million individuals who live independently and rely on electricity-dependent durable medical and assistive equipment and devices, and or essential health care services.

According to the publicly available data for Texas, as of December 2020, there are 4,251,627 Medicare beneficiaries in Texas and 172,910 of them are using electrically dependent medical equipment. In Harris County alone there are 563,795 Medicare beneficiaries and 18,512 use electricity dependent medical equipment. Disaster declarations for Hurricane Harvey were made for Aransas, Austin, Bastrop, Bee, Brazoria, Calhoun, Chambers, Colorado, DeWitt, Fayette, Fort Bend, Galveston, Goliad, Gonzales, Hardin, Harris, Jackson, Jasper, Jefferson, Karnes, Kleberg, Lavaca, Lee, Liberty, Matagorda, Montgomery, Newton, Nueces, Orange, Polk, Refugio, Sabine, San Jacinto, San Patricio, Tyler, Victoria, Walker, Waller, and Wharton counties in Texas. These counties have 1,207,909Medicare beneficiaries and 43,695 of those beneficiaries are prescribed electricity-dependent medical equipment.

According to reports published by Texas Health and Human Services, as of June 2017, there were approximately 3,155,092 Medicaid clients under the age of 21 and 886,391over the age of 21, State-wide (there is no breakdown by county after November 2016). Texas Health and Human Services also has additional information available on numbers of enrollees in SNAP and TANF as an indication of socio-economic status.

According to the Texas Medical Association, 4.3 million Texans, including 623,000 children do not have health insurance coverage. The Texas uninsured rate is 1.75 times higher than the national average.

Finally, a review of materials related to chronic medical conditions in Texas revealed that chronic disease accounts for 3 out of every 4 deaths in Texas. Texas reports data on the following chronic diseases specifically; ischemic heart disease, stroke, lung cancer, breast cancer, cervical cancer, colorectal cancer, asthma, arthritis, and diabetes mellitus. In Texas, the leading causes of death are the following diseases in order of prevalence; heart disease, cancer, chronic lower respiratory disease, stroke, diabetes, and kidney disease. A report from Harris County Public Health and Environmental Services states, "Among adults in Texas, 18% are smokers; 83% are not meeting recommendations for a healthy diet; and 27% are physically inactive. Moreover, almost 1/3 of adult Texans are obese, and almost 1/3 have hypertension."

The baseline health status of the affected population will be a factor in post disaster medical needs and potential surge to healthcare facilities and must be factored into any assessment of recovery timelines or overall healthcare resilience.

Primary Sources

Texas Department of State Health Services. (2008). Chronic Disease in Texas: A Surveillance Report of Disease Indicators.

> This report provides an overview of the chronic conditions and risk factors that influence health disparity in Harris County, Texas.

Texas Department of State Health Services. (2016). Texas Chronic Disease Health Disparities.

> This infographic visually displays information related to chronic disease in Texas. Graphics specifically cover leading cause of death, health care costs, heart disease deaths, stroke deaths, diabetes-related deaths, total cancer deaths, and obesity.

U.S. Department of Health and Human Services. (2017). HHS emPOWER Map.

> The HHS emPOWER Map provides monthly de-identified totals of Medicare claims submitted for one or more of the fourteen types of life-maintaining or saving electricity-dependent durable medical and assistive equipment (DME) and certain implanted electricity-dependent cardiac devices, at the national, state, territory, county, and ZIP Code levels. Users have the ability to create unique aggregations by geography and export the data, as well as the ability to access historical HHS emPOWER Map datasets for further analysis. When combined with real-time severe weather and hazard maps, the HHS emPOWER Map gives communities the power to anticipate, plan for, and address the needs of this population prior to, during, and after an incident, emergency, or disaster.

Recovery Timeline from Past Disasters

The ASPR TRACIE team reviewed news articles and other published data for reports of health facility closures and openings in past flooding related disasters. A more detailed review of past disaster Situation Reports might provide more clarity, but those reports were not available to ASPR TRACIE for this review.

We provide these examples and this information, as past disasters are the best indicators of future performance, but every disaster is unique with its own nuances and considerations.

Hurricane Katrina

Katrina by the numbers:

- During the storm 1749 patients occupied the 11 hospitals surrounded by flood waters. These hospitals also house up to 7600 additional people including staff and patient family members, as well as others seeking shelter.
- Before Katrina, the New Orleans metropolitan area had 4,083 hospital beds. A year later, it had 1,971.
- About 4,500 doctors serving three of the city's parishes were forced to relocate because of Katrina, and a year later, only 1,200 had returned to practice.
- The number of nursing homes fell from 51 to 29, leaving the city with 2,200 fewer nursing home beds.
- As of July 2007, only one of New Orleans' seven hospitals was operating at full capacity, 2 were partially open, and four remained closed. There are 16,800 fewer medical jobs down 27% due to facility closures.
- This article quotes local officials as saying "… [New Orleans] cannot recover unless medical care becomes available there, officials say, and neither can large sections of the economy. Doctors and hospitals, though, are reluctant to return unless the population does."
- In 2006, 85 percent of people said they were worried that health care services wouldn't be available if they needed them. By 2015, that share had fallen to 54 percent.
- Only 1 percent thought in 2006 that the city had enough health care services available for the uninsured and poor. That had increased to 28 percent in 2015 — still low, but a substantial improvement.
- 74 percent of the city's residents said the Katrina disaster had made them better able to cope with stress.

Primary Sources

Adams, V., Kaufman, S., Van Hattum, T. Moody, S. (2011). Aging Disaster: Mortality, Vulnerability, and Long-Term Recovery Among Katrina Survivors. Med Anthropol. 30(3): 247–270.

This multi-year qualitative study discussed differences in how the elderly cope with disasters using data from Hurricane Katrina and flooding in New Orleans. At the time of the disaster, the elderly of New Orleans were at greater risk than other groups, and more elderly died than any other group during the storm and in the first year after. Those who did survive beyond the first year report coping with the long term disaster aftermath better than the generation below them, experiencing heightened stresses, and feeling as if they are "aging" faster than they should.

Berggren, R. (2006). After the Storm – Health Care Infrastructure in Post-Katrina New Orleans.

This article provides an overview of the healthcare infrastructure in place one year following the impact of the storm. It also provides information on the current health status of the population and current attitudes towards healthcare in the affected area.

Coombs, B. (2015). Ochsner: Hospital powerhouse forged in the wake of Katrina. CNBC.

This article shares the story of Ochsner Baptist Hospital (previously Memorial Medical Center) in New Orleans now owning its own fleet of rescue boats and staffers who undergo water rescue training due to their experience during Katrina. Over the last 10 years since Katrina, they've invested over $100 million in resources and reopened 8 years after Katrina.

Goodnough, A. (2015). New Orleans Hospital is Replaced with Hope of Preserving its Mission. The New York Times.

Nearly a decade after Hurricane Katrina, the replacement for Charity Hospital (now called University Medical Center New Orleans) opened. Built largely with federal disaster funds, and run by a private operator under contract with the state, UMC will continue to serve as the main trauma hospital for the area. The new hospital is part of an expanded medical district to also include a new VA hospital and rehab hospital. Additional similar article includes:

- Associated Press. (2015). New Orleans Public Hospital Re-Opens 10 Years After Katrina. Modern Healthcare.

Gray, B. After Katrina: Hospitals in Hurricane Katrina; Challenges Facing Custodial Institutions in a Disaster. The Urban Institute.

This document discusses the challenges facing hospitals before, during, and after Hurricane Katrina.

Hamel, L. (2015). New Orleans Ten Years After the Storm: The Kaiser Family Foundation Katrina Survey Report. Kaiser Family Foundation.

This report describes the results of a series of surveys conducted by the Kaiser Family Foundation looking into how New Orleans residents feel about the recovery and the status of their community following Katrina.

Kaiser Family Foundation. (2013). Addressing the Health Care Impact of Hurricane Katrina. Kaiser Commission on Medicaid and the Uninsured.

This paper addresses the overarching healthcare status of the areas affected by Hurricane Katrina and their potential impact to other locations across the nation. It describes issues related to public health, emergency/trauma care, primary care, medication access, acute hospital care, long term care, and mental health care.

Morial, J. (2007). Katrina: Health Care System Recovery, Reform, and Renaissance. The Permanente Journal.

This article describes the origin of, impact to, and recovery of the Louisiana State Health Care system and how its unique design impacted healthcare delivery.

Potash, M. (2008). The Struggle for Mental Healthcare in New Orleans- One Case at a Time. Psychiatry. 5(7): 32-41.

The author of this article uses cases publicized in the media to demonstrate the plight of chronically mentally ill individuals returning to New Orleans and the emotional dresses faced by residents. It also provides recommendations for changes to mental health services after a disaster.

Rudowitz, R. (2006). Health Care in New Orleans Before And After Hurricane Katrina. Health Affairs.

This article describes the healthcare system in place before the storm, including how the healthcare structure affected the ability to respond to the storm and describes the post-storm rebuilding of a different healthcare model.

Scott, D. (2017). What Katrina can teach us about health care after Hurricane Harvey. Vox.

This article briefing highlights impacts to the healthcare system following Katrina as a description of what Texas may face following Hurricane Harvey. The author provides a number of statistics on healthcare availability prior to Hurricane Katrina and availability one year after Katrina in New Orleans and the surrounding areas.

US Department of Veterans Affairs. (n.d.). Project Legacy: Frequently Asked Questions.

> These FAQs focus on Project Legacy, the project to design and build a new medical center to replace the one damaged from Hurricane Katrina. After Hurricane Katrina, VA re-established services in New Orleans within 100 days, returned over 800 staff from temporary details to permanent assignments and assisted with relocating over 800 employees throughout the nation. Administrative functions started in 2014, with first patients to begin receiving care December 2016 and then the rest of the medical center to open in phases throughout 2017.

US Government Accountability Office. (2009). Hurricane Katrina: Federal Grants Have Helped Health Care Organizations Provide Primary Care, but Sustaining Services will be a Challenge.

> In 2007, HHS awarded the $100 million Primary Care Access and Stabilization Grant (PCASG) to Louisiana to help restore primary care services to the low-income population. This report provides GAOs findings on how PCASG fund recipients used the PCASG funds, how recipients used and benefited from other federal hurricane relief funds, and the challenges recipients faced and recipients' plans for sustaining services after PCASG funds are no longer available.

Superstorm Sandy

Open-source media has a number of articles one month following Superstorm Sandy that detail what was open and what wasn't and the impact. In addition, the report, A Stronger, More Resilient New York: Chapter 8 – Healthcare released in June 2013, provides an overview of the healthcare impacts following Sandy and provides an overview of recovery and resilience efforts in place for healthcare.

Five hospitals and one psychiatric facility closed due to the storm, resulting in 2000 patients being evacuated. Hospital bed availability was down 8% following the storm. Power outages affected some community providers for up to a week and a limited number remained closed longer due to flood damage. Ten hospitals remained opened despite power outages or other limitations and saw an increase of 13% in emergency department usage. The New York City report estimated that hospital closures resulted in roughly $70 million per week in the immediate aftermath of the storm.

Sandy by the numbers:

- 5 hospitals and 1 psychiatric hospital closed and took between one to 6 months to reopen
- 61 nursing homes were in storm affected areas
    - 50% continued to operate, but within a week of the storm 26 facilities had to shut down, another 5 partially evacuated, reducing nursing home bed capacity by 4,600 beds
    - Power loss was the leading cause of nursing home closures
- Community-based providers in over 500 buildings (5% of total community provider buildings) were in flooded areas, including doctor's offices, pharmacies, and outpatient and ambulatory care facilities.
    - 12% were in areas with power outages, so those facilities were closed until the power was restored
- Home care providers were impacted by transportation, gasoline shortages, elevator outages in high rises. Power, heat, and water outages in patient's homes increased the likelihood of worsening health status

Facility-specific information and impact

Bellevue Hospital closed during the storm, due to flooding in the basement and did not open again until February 2013, 99 days after closing. Beth Israel Medical Center, nearby Bellevue, reported visits to their emergency room increased by 24%. Hospital admissions have risen 12% compared to the same time frame the year before. Another nearby hospital, New York – Presbyterian/Weill Cornell claimed emergency room visits were up 25%.

Coney Island Hospital closed during the storm and patient surge from this closure led to 2-3 day waits for admission in the emergency department of nearby Maimonides Medical Center, which translated to roughly 1100 additional emergency room visits. Maimonides Medical Center psychiatric emergency room reported psychiatric visits tripled starting 3-days before the storm. They purchased 5 additional beds to manage suicidal admissions. The main emergency department purchased 27 additional stretchers.

Lenox Hill Hospital converted office space into new patient care wards and reported emergency room visits were up 10% and surgery had been expanded from five days a week to seven. Hospital staff reported they usually operate 300 beds, but were currently operating over 550 beds.

As of one month following the storm, four hospitals remained closed; Bellevue, Coney Island, NYU Langone Medical Center, and the VA New York Harbor Healthcare System.

Doctors and nurses at the closed hospitals have sought privileges and new positions with open hospitals and some closed hospitals have attempted to retain staff by paying them salary while closed or facilitating sharing staff to ensure staff are there when the hospital reopens.

New York State requested $3.1 billion in federal aid for hospitals and other healthcare providers to rebuild and repair.

The five hospitals closed, reopened according to the following schedule:

- Bellevue Hospital – freestanding ER opened on November 19, 2012, full reopening 99 days after closing
- Coney Island Medical Center – "early 2013"
- NYU Langone Medical Center – December 2012
- VA New York Harbor Healthcare System – May 2013
- Long Beach Medical Center – reopened a stand-alone emergency department in August 2015 – it appears the hospital reopened at the end of 2013, but had solvency issues that preceded the storm

Exhibit 2: FEMA Storm Surge Impact Analysis: Lower Manhattan Hospitals Affected by Hurricane Sandy

Primary Sources

5WPR. (2013). Shore View Health Care Facility Reopens After Repairing Sandy. YouTube.

This news clip shows the reopening of the Shore View Nursing Home six months after being evacuated due to damage from superstorm Sandy. It describes some of the repairs and reinforcements done to the building.

City of New York. (2013). A Stronger, More Resilient New York: Chapter 8, Healthcare. Full report is available here.

Part of a larger report focused on improving the overall infrastructure of New York City after superstorm Sandy, chapter 8 focuses on healthcare improvements and sustainability. This chapter provides an overview of the healthcare system in NYC, case studies of hospitals and other healthcare facilities during Sandy, risk assessment summary, and initiatives for increasing resiliency. Twelve initiatives are listed and range from improving construction, hardening, retrofitting, to improving power resiliency and electronic health records.

Evans, M. (2012). Recovery Mode: More than a month after Sandy, five hospitals are still scrambling to repair damage and begin admitting patients again. Modern Healthcare.

This article outlines challenges that hospitals in New Jersey and New York face after superstorm Sandy such as damaged electrical systems, rooms, and elevators. It also discusses some of the plans they have to meet possible new regulations/standards to withstand similar/ more powerful storms in the future.

Evans, M. (2013). VA reopens hospital damaged by superstorm Sandy. Modern Healthcare.

Article notes that the Veterans Affairs Department fully reopened its Manhattan hospital after superstorm Sandy destroyed critical equipment. The article notes that Long Beach Medical Center, one of the five NY hospitals that closed due to the storm, has yet to reopen.

Gold, J. (2013). Post-Sandy, NYU Langone has reopened, but can it regain market share? Kaiser Health News.

This article outlines the possible challenges with retaining lost business and staff after a hospital closing due to a disaster. NYU Langone Medical Center reopened most of its services three months after the storm, but some of their doctors have applied for permanent positions at competitor hospitals and many of their patients may also continue to go to other hospitals in the future. The article notes that competitor hospitals saw large spikes in their monthly birth rates the months that NYU was closed. It also notes that the positive outcome was that they saw that the closing of two large hospitals in NY (approx. 900 beds each) were able to be absorbed by other hospitals in the area.

Hartocollis, A. (2012). With Some Hospitals Closed After Hurricane, E.R.'s at Others Overflow. New York Times.

This article describes the effect of hospital closures on emergency department visit and hospital admission statistics for surrounding hospitals following the impact of Hurricane Sandy on New York City.

He, F.T., De La Cruz, N.L., Olson, D., et al. (2016). Temporal and Spatial Patterns in Utilization of Mental Health Services During and After Hurricane Sandy: Emergency Department and

Inpatient Hospitalizations in New York City. (See attached.) Disaster Med Public Health Preparedness. 10:512-517.

The authors of this study assessed the impact on mental health–related emergency department (ED) and inpatient hospital service utilization after Hurricane Sandy. Results indicated that open hospitals experienced a substantial increase in psychiatric ED visits from patients living in the service areas of closed hospitals. This surge in psychiatric ED visits persisted for 4 to 6 months after Hurricane Sandy. However, the increase in psychiatric hospitalizations was observed for 1 to 3 months.

Jacobson, J. (2013). A Long, for Some Too Slow, Health Care Recovery after Sandy. AJN, Vol 113, Issue 2, p. 19-21.

This article outlines the Build Back Better campaign, a collaborative effort between a group of healthcare providers, NY State Nurses Association, Physicians for a National Health Program, and Occupy Sandy. The authors addressed four areas they suggested the city should focus on: fill the gap in care created after the closures of four hospitals, restore services at those four hospitals, oversee medical relief work in the city, and correct the faults in the system that the storm exposed.

Lee, D., Smith, S., McStay, C.M., et al. (2014). Rebuilding Emergency Care After Hurricane Sandy. (See attached.) Disaster Med Public Health Prep, 0: 1-4.

This article provides an overview of the freestanding emergency department that was opened after superstorm Sandy, in collaboration with NY State Department of Health, Health and Hospitals Corporation, and Bellevue Hospital Center. An emergency critical care ward and system to monitor ED utilization at affected hospitals was also established. Results of this study indicated that a model for future efforts to rebuild emergency care capacity after a natural disaster, such as Hurricane Sandy, can be accomplished.

Mogul, F. (2012). Four NYC Hospitals Still Closed by Hurricane Sandy. Kaiser Health News.

This article describes the four hospitals in NYC still closed three weeks after Hurricane Sandy. Initial challenges for finding places for displaced patients are noted and initial loss of revenue for both closed hospitals and those taking in patients.

Ofri, D. (2012). A return to Bellevue after the storm. The New York Times.

This article notes the repairs done and challenges that continue after Bellevue Hospital reopened a month after superstorm Sandy caused the hospital to evacuate and relocate patients and staff. More than 500 staff and 500 patients were relocated, and 275 patients discharged during the storm.

Sharp, M.J., Sun, M., Ledneva, T., et al. (2016). Effect of Hurricane Sandy on Health Care Services Utilization Under Medicaid. (See attached.) Disaster Med Public Health Prep. 10(3):472-84.

This article provides results from an assessment of Medicaid data for enrollees residing in eight counties in NY affected by the storm to determine claims for four service types over immediate, three month, and one year periods. Changes in service utilization within areas inside or outside the storm zone were most pronounced over the one-year effect period. Results are consistent with previous investigations demonstrating that some of the greatest effects of a disaster on health services utilization occur well beyond the initial event. One-year effects, combined with some three-month effects, suggests that storm recovery, with its effect on health care services utilization, may have followed different paths in areas designated as inside or outside the storm zone.

Toner, E.S., McGinty, M., Schoch-Spana, M., et al. (2017). A Community Checklist for Health Sector Resilience Informed by Hurricane Sandy. Health Secur. 15(1): 53–69.

This document is a checklist of actions for healthcare, public health, nongovernmental organizations, and private entities to use to strengthen the resilience of their community's health sector to disasters. It is informed by the experience of Hurricane Sandy and analyzed in the context of findings from other recent natural disasters in the U.S.

US Department of Health and Human Services, Office of Inspector General. (2014). Hospital Emergency Preparedness and Response during Superstorm Sandy.

This report provides recommendations from HHS OIG based on a survey of 174 Medicare-certified hospitals in CT, NJ, and NY; 10 site visits; interviews of state hospital associations and healthcare coalitions; and examination of information from state survey agencies. Findings included 89% of hospitals in these areas experienced substantial challenges in responding to the storm such as infrastructure challenges and community collaboration issues over resources such as fuel and beds. Recommendations include ASPR to continue to promote community collaboration and CMS to examine existing policies and provide guidance regarding flexibility for reimbursement under disaster conditions.

Joplin (Tornado)

An EF-5 tornado passed through Joplin, Missouri on May 22, 2011, demolishing St. John Regional Medical Center. The hospital reopened 4 years later, with a temporary 60-bed facility in place during the rebuild. Rebuilding the hospital cost between $434 million and $1 million with somewhere between $33-50 million coming from federal aid. There were five medical buildings including three medical offices and a rehabilitation facility that were also on the same hospital campus and were a complete loss.

Ozark Center, the area's Department of Mental Health administrative agent, lost eight buildings, which were totally destroyed, and set up supplemental facilities to handle the surge of patients and community members needing support following the storm.

Primary Sources

Bernhard, B. (2011). Lost medical records complicate Joplin hospital's tornado recovery. St. Louis Post-Dispatch.

This article discusses how St. John's Regional Medical Center joined its parent company Mercy's electronic medical record system just three weeks prior to the tornado to back up the paper records. However, the tornado scattered the paper records for miles, with some being found up to 75 miles away. Privacy waivers are also discussed in the article, which were invoked after Hurricane Katrina.

Cage, J. (2013). Joplin Pays it Forward: Community Leaders Share Our Recovery Lessons.

This document compiles stories of those that were part of the response and recovery efforts after the Joplin tornado in 2011. The firsthand accounts include stories of how schools reopened, working together to open surge medical clinic and volunteer coordination points, coordination of thousands of volunteers, and others from first responders and residents.

Mercy Emergency Medical Services. (2014).The Story of Mercy and Joplin – Hospital Recovery – Sustainability.

This PowerPoint presentation provides an overview of the tornado impact, the rescue and response operations for the impacted hospital facility, the path to recovery, and lessons learned from the event from the healthcare system perspective.

Missouri Department of Mental Health. (2013). Supporting Joplin in Recovery: The Behavioral Health Response.

This report includes highlights and lessons learned from the two major federal initiatives to support Joplin: Crisis Counseling Program and the SAMHSA Emergency Response Grant. September 30, 2012 marked the end of the major federal funded Joplin mental health recovery initiatives administered by the Department of Mental Health. Attachment 1 provides an overview of the initiatives and Attachment 2 provides a summary of sustainability of mental health recovery efforts.

Morse, S. (2015). When disaster strikes: CFOs help hospitals recover after Joplin tornado, Hurricane Sandy. Healthcare Finance News.

Four years after the tornado hit St. John Regional Medical Center, it has rebuilt and reopened as Mercy Hospital Joplin. FEMA provided $33 million of the $434 million needed to rebuild the new hospital. The CFO noted a 20% drop in market share during

the transition/rebuilding. Also, the South Nassau Communities Hospital took two years to finalize their insurance claim, but only 6 months to rebuild ($4-$5 million). The hospital lost approx. $4 million in operations in 2012, which was the only year in its 8 year existence it lost money.

National Institute of Standards and Technology (NIST). (2011). Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri.

NIST conducted an investigation on the tornado and the impact to infrastructure in Joplin. The report details the findings of the investigation and provides descriptions of the impact and damage on the community.

Patterson, B. (2014). The story of Mercy and Joplin- Hospital Recovery- Sustainability. 19th Annual Chicago Infection Control Conference.

This slide deck provides an overview of the impact of the tornado on Joplin, with a focus on the destruction of the hospital. Slides outline evacuation, triage, emergency care, tracking, EMS operations, and challenges. It also includes the Missouri Hospital Association's response roles, public health response, ongoing challenges, and lessons learned.

Other Storms/Events

In April 2014 a tornado struck Louisville, MS, including the local hospital Winston Medical Center. The hospital was destroyed and the community established a mobile medical facility to be in place during the rebuild. The hospital reopened 3 years after the tornado.

Health Impacts of Flooding

Flood water can contribute to numerous health hazards including, but not limited to:

- Contaminated drinking water
- Infectious disease outbreaks
- Air quality issues
- Disease carrying mosquitoes
- Skin disease/wound infections from contact with contaminated flood waters
- Mold

Public health surveillance will be required to test the water and air, and monitor populations for infectious disease outbreaks. Public information and risk communication is necessary to let the public know what to do to mitigate the hazards.

Primary Sources

Du, W. (2010). Health impacts of floods. Prehospital Disaster Medicine.

> The authors conducted an extensive literature review looking for health impacts of flooding. They determined that there are health risks associated with flooding that are consistent among all floods and risks that pertain to a specific flood.

Gray, S. (2008). Long-term health effects of flooding. Journal of Public Health.

> The author conducted interviews and a retrospective study to evaluate the health effects of the post Katrina flooding on the health of the population. The author reports lack of access to healthcare has increased adverse health outcomes such as lack of access to mental health care, exacerbation of chronic medical conditions, and new medical complaints such as dermatitis, asthma, musculoskeletal injuries, and chest infections.

Saulnier, D. (2017). No Calm After the Storm: A Systematic Review of Human Health Following Flood and Storm Disasters. Prehospital and Disaster Medicine.

> The authors conducted a literature review to examine health problems following flood and storm disasters. They found that illness mainly occurred within four weeks of these events. Poisonings, wounds, gastrointestinal infections, and skin or soft tissue infections increased after storms; gastrointestinal infections were more likely to occur after flood events.

Post-Disaster Healthcare Demand

In the article Effect of Hurricane Sandy on Health Care Services Utilization Under Medicaid, the authors determined the greatest effects on healthcare services utilization extended well past the immediate post storm period and was still evident up to a year after. The information provided above on Hurricane's Katrina and Sandy detailed the impact and increase in services experienced from the temporary loss of services in some areas of the city. Demand at existing facilities was still increased by sometimes 30% even 6 months to a year following the events.

The typical health-related impacts of hurricanes and floods include:

- Carbon monoxide poisoning due to poor ventilation of gas generators
- Gastro-intestinal illnesses from food sources and person-to-person spread
- Hypothermia from water immersion
- Orthopedic trauma from clean up injuries, crashes, and other incidents
- Respiratory illness
- Skin rashes and wound infections
- Soft tissue injuries from debris and clean up
- Exacerbation of chronic medical or behavioral health conditions

Hospitals and other healthcare providers should be prepared to handle an increase in patients with a wide range of chief complaints. There are typically three surges of patients related to the storm: those seeking care before the storm due to preparedness injuries, stress, support for chronic conditions, and/or fear of being alone; patients ill or injured during the storm; and the surge of patients who become ill or injured post-storm. Many patients seen in the days and weeks following the storm will display exacerbations of underlying disease due to disruptions in their care or their environment. This surge will be made more challenging if acute care and primary care facilities have been damaged and are off-line in post storm recovery.

Primary Sources

ASPR TRACIE. (2017). Major Hurricanes: Potential Public Health and Medical Implications

> This ASPR TRACIE resource was developed to provide a short overview of the potential significant public health and medical response and recovery needs facing hurricane- and severe storm-affected areas, based on past experience and lessons learned from Hurricanes Katrina, Sandy, Harvey, and others.

Bell, S.A., Abir, M., Choi, H., et al. (2017). All-Cause Hospital Admissions Among Older Adults After a Natural Disaster. (See attached.) Ann Emerg Med.1-9.

> The authors of this study conducted case study analysis after 218 tornadoes hit the U.S. across the Southeast and Midwest on April 27, 2011. The objective of this study was to characterize hospital admissions among older adults for any cause in the 30 days after a significant natural disaster. Separate analyses were conducted to examine all-cause hospital admissions excluding the 72 hours after the disaster, ICU admissions, all-cause in hospital mortality, and admissions by state.

Domino, M.E., Fried, B., Moon, Y., et al. (2003). Disasters and the Public Health Safety Net: Hurricane Floyd Hits the North Carolina Medicaid Program. 93:1122–1127.

> The authors of this study measured the effect of Hurricane Floyd on Medicaid enrollment and health services use in the most severely affected counties of North Carolina. Results showed that overall spending per enrollee showed little short-term effect but demonstrated a moderate increase one year after the storm.

Redwood-Campbell, L. (2011). Primary Health care and Disasters—The Current State of the Literature: What We Know, Gaps and Next Steps. (See attached.) Prehospital and Disaster Medicine.

> The authors conducted literature searches of fourteen major databases looking for articles or other resources that addressed primary health care and disasters. After reviewing the findings, the authors conclude that including and having primary health care is critical to an effective health emergency response to disasters.

Reifels, L., Bassilios, B., Spittal, M.J., et al. (2015). Patterns and Predictors of Primary Mental Health Service Use Following Bushfire and Flood Disasters. (See attached.) Disaster Med Public Health Preparedness.9:275-282.

The objective of this study was to examine patterns and predictors of primary mental health care service use following two major Australian natural disaster events, a bushfire and flood/cyclone disasters. The authors concluded that substantial demand for primary mental health care services following major natural disasters can vary in magnitude and trajectory with disaster type.

Runkle, J. (2013). Long-term Impact of Environmental Public Health Disaster on Health System Performance: Experiences from the Graniteville, South Carolina Chlorine Spill. Southern Medical Journal.

The article describes the impact of a chemical chlorine spill on the health needs and healthcare system demand of a South Carolina community.

Runkle, J.D., Brock-Martin, A., Karmaus, W., et al. (2012). Secondary Surge Capacity: A Framework for Understanding Long-Term Access to Primary Care for Medically Vulnerable Populations in Disaster Recovery. 102:e24–e32.

The authors of this article address the secondary surge in casualties caused by disasters due to the sudden increased need for long-term health care. They applied a health services use model to identify areas of vulnerability that perpetuate health disparities for at-risk populations seeking care after a disaster. They concluded that baseline assessments of existing needs and the anticipation of ballooning chronic health care needs following the acute response for at-risk populations are overlooked vulnerability gaps in national surge capacity plans.

Saulnier, D. (2017). No Calm After the Storm: A Systematic Review of Human Health Following Flood and Storm Disasters. Prehospital and Disaster Medicine.

The authors conducted a literature review to examine health problems following flood and storm disasters. They found that illness mainly occurred within four weeks of these events. Poisonings, wounds, gastrointestinal infections, and skin or soft tissue infections increased after storms; gastrointestinal infections were more likely to occur after flood events.

Stratton, S.J., and Tyler, R.D. (2006). Characteristics of Medical Surge Capacity Demand for Sudden-impact Disasters. Academic Emergency Medicine. 3:1193–1197.

The authors of this study address the characteristics of the demand for medical care during sudden-impact disasters, focusing on local U.S. communities and the initial phases of sudden-impact disasters. Results indicated that communities should be expected to sustain medical services for 24 hours, and up to 96, before arrival of external resources.

General Recovery and Resilience Resources

ASPR TRACIE identified a number of additional resources related to healthcare system recovery, mitigation, and resilience that could have value to communities planning for recovery. They are annotated below.

Centers for Disease Control and Prevention. (n.d.). Remediation and Infection Control Considerations for Reopening Healthcare Facilities Closed Due to Extensive Water and Wind Damage.

This site provides information to assist healthcare facilities with the tasks involved during clean-up and opening after a disaster. It includes information on worker health and safety, mold remediation and structural recovery, water and electrical utilities, ventilation system, clean up based on type of structural building materials, inspection of medical equipment, devices, and supplies, special considerations for designated activities (dialysis, laboratories, dental, radiology), and post reoccupation surveillance.

Centers for Medicare and Medicaid Services. (2013). Provider Survey and Certification FAQs- Declared Public Health Emergencies- All Hazards Health Standards and Quality Issues.

These FAQs provide information on CMS modifications and flexibilities during a declared emergency for all providers, clinical laboratory improvement amendment, community mental health center, critical access hospitals, drugs, emergency evacuations, enforcement activities, ESRD, home health, hospitals, and nursing homes. It includes information on 1135 waivers and EMTALA.

Committee on Post-Disaster Recovery of a Community's Public Health, Medical, and Social Services; Board on Health Sciences Policy; Institute of Medicine. (2015). Healthy, Resilient, and Sustainable Communities After Disasters: Strategies, Opportunities, and Planning for Recovery. National Academies Press.

This book includes the recommendations and guidance from an ad-hoc committee on strategies for mitigating disaster-related health impacts and optimizing the use of recovery resources. The committee found that many resources tend to focus on hardening critical infrastructure rather than strengthening the health and resiliency of individuals and the community. This book outlines the framework for integrating health considerations into recovery decision making.

Cormier, S., Wargo, M., and Winslow. W., (2015). Transforming Health Care Coalitions from Hospitals to Whole of Community: Lessons Learned From Two Large Health Care Organizations. (See attached.) Disaster Med Public Health Preparedness.9:712-716.

The authors of this study discuss two examples of healthcare coalition partners that use a more inclusive approach to planning, response, and recovery. One is a large health

care system spread across 23 states, and the other is a public safety agency in northeast PA that took the lead to address the preparedness and response toward a large influx of burn patients and grew to encompass all aspects of community health care.

FEMA. (2003). A Citizen's Guide to Disaster Assistance, Unit 3- Overview of Federal Disaster Assistance.

This document is part of the FEMA Independent Study Course IS-7 focused on pre-disaster preparedness. Unit 3 describes the role of the Federal government in disaster assistance and provide a brief history of federal disaster relief. It also discusses different federal assistance programs, response and recovery cycles, eligibility criteria for major types of assistance, how the President declares disasters, and purpose and function of the Emergency Response Team. A full version of the course study guide can be found here.

Lawlor, J., Franklin, R.C., Aitken, P., et al. (2014). Perceptions of the Utility and Acceptability of an Emergency Child Minding Service for Health Staff. (See attached.) Disaster Med Public Health Preparedness.8:485-488.

This article addresses how the provision of emergency child daycare services provided after Tropical Cyclone Yasi hit North Queensland, Australia, helped The Townsville Hospital health care staff return to work immediately after the disaster.

Patterson, O. (2010). The Role of Community in Disaster Response: Conceptual Models.

This article describes two conflicting definitions in community as it relates to disaster response. One definition is that a community is simply a grouping of individuals acting autonomously and the opposing definition is that community is in itself a "thing" that acts independently with its own interests.

Platt, S. (2017). Factors affecting the speed and quality of post disaster recovery and resilience. Cambridge Architectural Research Ltd.

Comparing ten earthquake disasters, the authors identify factors that impact the speed of community recovery. The researchers looked into three exogenous factors such as size of the impact, population demographics, and economic factors and five endogenous factors within control of decision makers – authority, decision-making, planning, finance, and science. The results showed that regardless of the exogenous factors, the clear connection to speed and quality of recovery is post-disaster decision making.

Shultz, J.M., McLean, A., Herberman Mash, H.B., et al. (2013). Mitigating Flood Exposure: Reducing Disaster Risk and Trauma Signature. Disaster Health 1:1, 30–44.

The authors of this study reviewed the data following the 2011 heavy winter snowfall that impacted two cities in North Dakota differently. Fargo was able to successfully mitigate and prevent flooding, while Minot was flooded. The authors studied the

respective hazards, vulnerabilities, stressors, psychological risk factors, psychosocial consequences, and disaster risk reduction strategies under conditions where flood prevention was, and was not, possible. The authors found that across a range of indicators, it is clear that successful mitigation diminishes both physical and psychological impact, thereby reducing the trauma effects of the event.