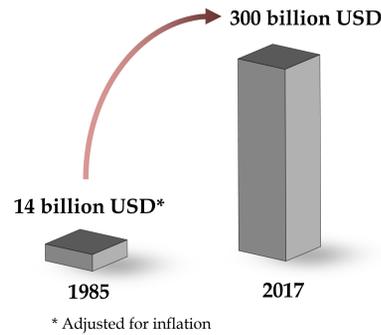


## INTRODUCTION

### Escalating threats from natural and man-made disasters

Growing global economic losses due to natural disasters (UNDRR, 2019)



Economic impacts in the US due to natural disasters (NOAA, 2019)

- 250 Incidents that cost over billion dollars between 1980 and 2019
- A total loss of 265 billion USD in 2017
  - Due to Hurricanes Harvey, Irma, and Maria
  - Equivalent to 1.4% of the annual US GDP (UNDRR, 2019)



Deepwater Horizon disaster (NOAA, 2011; Lee, Garza-Gomez, & Lee, 2018)



- Oil well blowout and resultant explosion in a drilling rig in 2010
- Tremendous oil spill that lasted for 87 days
- A total cost of 145 billion USD accounted for oil spill recovery, settlement, and liabilities

Coronavirus Disease 2019 (COVID-19)

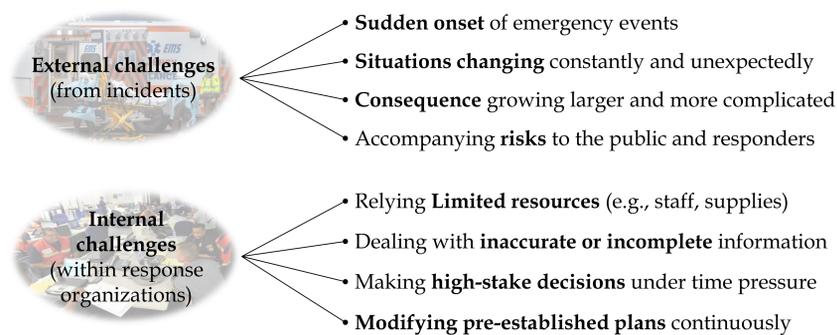


- Global impacts† (as of May 6, 2020)
  - Total confirmed cases: 3,688,635
  - Total deaths: 258,085
- Increasing impacts in the US ‡ (as of April 6, 2020)
  - Total confirmed cases: 1,239,848
  - Total deaths: 72,381
  - Expected maximum deaths: 100,000 to 240,000\*

† Johns Hopkins University Coronavirus Research Center (<https://coronavirus.jhu.edu/map.html>)  
 ‡ Worldometers (<https://www.worldometers.info/coronavirus/country/us/>)  
 \* New York Times (<https://www.nytimes.com/2020/03/31/us/politics/coronavirus-death-toll-united-states.html>)

## BACKGROUND

### Persistent Challenges to Disaster Management (Perry & Lindell, 2003; Perry, 2007)



### Rise of Resilience in Disaster Management

- **Definition of resilience:** 'A system's ability to adjust its performance to expected and unexpected situations (Boin, Comfert, & Demchak, 2010; Hollnagel, 2011).'
- Two safety views to capture opportunities and challenges of resilience of a system (Hollnagel, 2014)

	Safety-I	Safety-II
Definition of safety	Absence of undesired events	Presence of desired events
Focus	What went wrong	What went right
Attitude towards rules and procedures	Compliance	Adaptation, improvisation
Approach	Find-and-fix	Find-and-foster

➔ Knowledge of resilient performance in hospital incident management is markedly limited despite its importance during disasters.

## STUDY AIM

- To identify opportunities and challenges of resilient performance in a hospital's response to Hurricane Harvey by adopting Safety-I and Safety-II viewpoints.

## METHOD

### Semi-structured Interview

Questions asked to interviewees

Aspect	Related questions
Personal & organizational context	<ul style="list-style-type: none"> <li>• What was your role in responding to Harvey?</li> <li>• Can you describe organizational structure and composition of the IMT you worked at?</li> </ul>
Challenges & successes	<ul style="list-style-type: none"> <li>• What were the major challenges of Harvey?</li> <li>• How did you overcome the challenges?</li> </ul>
Goals of IMTs	<ul style="list-style-type: none"> <li>• What were the major goals that you tried to achieve during Harvey and how did you accomplish the goals?</li> </ul>
Functions of IMTs	<ul style="list-style-type: none"> <li>• How did you make sense of evolving situations during Harvey?</li> <li>• What key decisions did you make to solve problems in Harvey and how?</li> <li>• Can you tell us about procedures, plans, or guidelines you used in response to Harvey?</li> <li>• How did you utilize resources to perform response actions?</li> </ul>

### Participants

6 hospital incident personnel of a large regional hospital that responded to Harvey

- Major roles of the incident management function ranging from incident commander to safety supervisor
- Five of them were certified of ICS-300 (advanced incident command training)
- Years of incident management experience: 1 year – 27 years

### Data Analysis

A thematic analysis (Braun & Clarke, 2006)

- Inductive (bottom-up) and deductive (top-down) coding of data
- An iterative analysis to refine emerging themes of opportunities and challenges of hospital incident management

## FINDINGS

### Situations and Goals of the hospital during Harvey

Noticeable events during Harvey	Goals of the hospital
<ul style="list-style-type: none"> <li>• Massive rainfall and flooding</li> <li>• Severely limited access to hospital</li> <li>• Shutdown of local clinics for a longer period</li> <li>• Patient surge (e.g., dialysis) in the ED</li> <li>• Loss of electric power in some areas</li> <li>• Contamination of sterile supplies and patient lab samples</li> <li>• Inundation of the basement</li> </ul>	<ul style="list-style-type: none"> <li>• Patient health and safety</li> <li>• Stabilization of hospital operations</li> <li>• Maintaining hospital structural integrity</li> </ul>

### Opportunities and Challenges of resilient performance of the hospital

Aspect	Opportunities	Challenges
Organizational structure and functions, and individual roles	<ul style="list-style-type: none"> <li>• Establishing multiple incident command centers</li> <li>• Turning into an outpatient-centered operations</li> <li>• A smooth role transition from normal to emergency duties</li> </ul>	<ul style="list-style-type: none"> <li>• Excess endeavors to coordinate multiple centers</li> <li>• Concentration of resources on specific areas of care (e.g., dialysis)</li> </ul>
Communication and situational awareness	<ul style="list-style-type: none"> <li>• Availability of various formal and informal communication channels</li> <li>• Regular conference calls and briefings to transfer knowledge across shifts</li> </ul>	<ul style="list-style-type: none"> <li>• Needs for a hospital-wide notification system</li> <li>• Lack of direct communication between medical facilities</li> <li>• Incompatibility between different hospital information management systems</li> </ul>
Operating plans and protocols	<ul style="list-style-type: none"> <li>• Skipping administrative procedures for urgent requests (e.g., paperwork)</li> <li>• Accepting food donation from private and non-government organizations</li> <li>• Maintaining the CMS patient reporting protocol</li> </ul>	<ul style="list-style-type: none"> <li>• Difficulty of following a formal planning process (e.g., the NIMS)</li> <li>• Too specific requirements for reimbursement form federal funding</li> </ul>
Human and physical resources (staff, space, and supplies)	<ul style="list-style-type: none"> <li>• Sufficient staffing capacity</li> <li>• Flexible utilization of spatial resources for patient care and staff welfare (e.g., sleeping area)</li> <li>• Mobilizing back-up supplies and equipment to sustain hospital operations</li> </ul>	<ul style="list-style-type: none"> <li>• Increased fatigue and anxiety of hospital staff</li> <li>• Issues with the ad-hoc use of spatial resources (e.g. helipad, sleeping space)</li> <li>• Hazards from back-up equipment (e.g., emergency generator) and limited stock of supplies (e.g., fuel)</li> </ul>
Lessons learned from incidents	<ul style="list-style-type: none"> <li>• Reflecting lessons into current preventative and protective measures (e.g., flood gates)</li> <li>• Regular inspections and drills for disaster preparedness</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of a community-wide effort to incorporate lessons into the community infrastructure</li> </ul>
Leadership and high-level decision making	<ul style="list-style-type: none"> <li>• Walk-arounds and hands-on interaction with front-line staff to get more accurate operational needs and to make relevant decisions</li> </ul>	<ul style="list-style-type: none"> <li>• Delayed emergency declaration in the hospital.</li> <li>• Lack of incident command leadership among neighboring hospitals</li> </ul>

## DISCUSSION & CONCLUSION

- Recurrent issues with hospitals' coping with disasters
  - Major issues: Surge capacity, loss of electricity, and staff shortage
  - Reactive attitude: lack of proactive and coordinative efforts for possible disaster scenarios
- Safety-I and Safety-II viewpoints were employed to identify challenges and opportunities for resilient performance of hospital incident management.
  - Advantages and disadvantages of adaptations and improvisations (e.g., two incident command centers)
- Technical incompatibility to be resolved
  - Future studies for interoperability between emergency management computer software and electronic health record (EHR) systems.
- ✓ We confirmed that chronic challenges to hospital disaster planning and management should be addressed.
- ✓ The opportunities identified in our case study need to be incorporated into hospital disaster preparedness programs in order to make hospitals and healthcare systems more resilient in large-scale disaster events.