



**The American
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Academy of
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Transformation of Hospital Design after a 'disaster' or 'unforeseen event'



September 8, 2020

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September 8, 2020

Moderated by:

Cindy Beckham



Case Study

As part of the Academy's multi-channel, on-line approach, these sessions are intended to introduce members of healthcare-centric practices, in all stages of professional development, to case studies of relevant content, providing access to data and critical analysis of elements key to the project's success.



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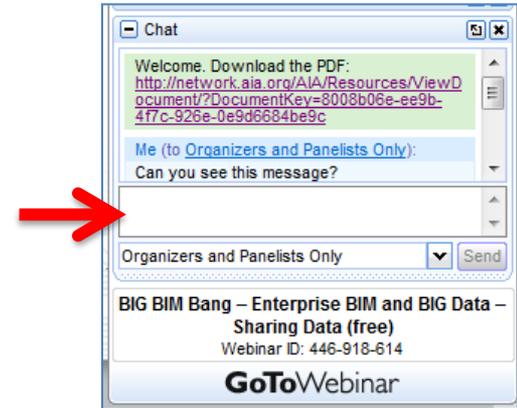
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Transformation of
Hospital Design
after a 'disaster' or
'unforeseen event'



Content

- Background & Methods
- Timeline & Major Events
- Event One: Crimean War
- Event Two: World War II & Rise of Modernism
- Event Three: Rejection of Modernism
- Event Four: Hurricane Katrina & Other Storms
- Current Event: Covid-19
- Takeaways / Summary
- Q&A

Background & Methods

Definition of Disaster: A sudden and unexpected event causing interruption in operation.

Disasters can be classified into three types:

- (1) natural;
- (2) man-made; and
- (3) hybrid

Healthcare delivery should do business as usual considering all the standards of healthcare delivery.



Disaster & Health System

Problem Statement

- Sophisticated Building Technologies
- Advanced Information Systems
- Developing Medical Technologies
- Benchmarking Clinical Pathways
- Research Informed Design
- Life-Enhancing Healing Environments

- For **centuries little** except shelter, comfort and prayer could be done to help the sick,
- Only for the last 100 years have we been able to create a **modern healthcare setting** that paces exploding medical advances, building technologies and the skills of compassionate designers,
- Life-enhancing environment where caring professionals are effectively supported as they work to heal the body, mind and spirit.

Pre-historic Hospital



Lithograph showing Nightingale talking with an army officer at Barracks Hospital in Scutari, 1856

Photograph: Corbis

<https://www.theguardian.com/science/gallery/2009/apr/27/nhs-design>

Changes Throughout the History

Hospitals of Early Era (BC-500 AD)

- Mesopotamian
- Arabic era
- Greek
- Romans
- Indians
- Egyptians
- Persian

Hospitals of Middle ages (500-1500 AD)

Renaissance Age (1500-1750 AD)

Florence Nightingale: 1820 – 1910



<https://www.natgeokids.com/za/discover/history/general-history/florence-nightingale/>

<https://www.slideshare.net/zulfiquer732/history-of-hospital>

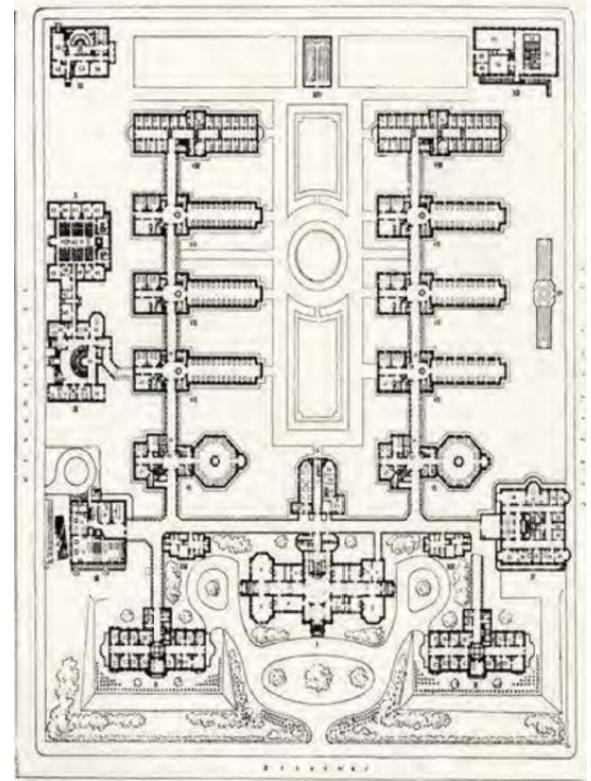
Modern and Classic Healthcare Delivery

Era of the new hospitals in the US

Era of scientific Medicine

1880s—John Hopkins Hospital

- Proposed by a surgeon from civil war and Architects John Rudolf Niernsee and Edward Clark Cabot.
- Influenced by European Pavilion Planning.
 - Pavilion Plans
 - Beds in Wards
 - Natural ventilation
 - Nightingale concepts



Methods

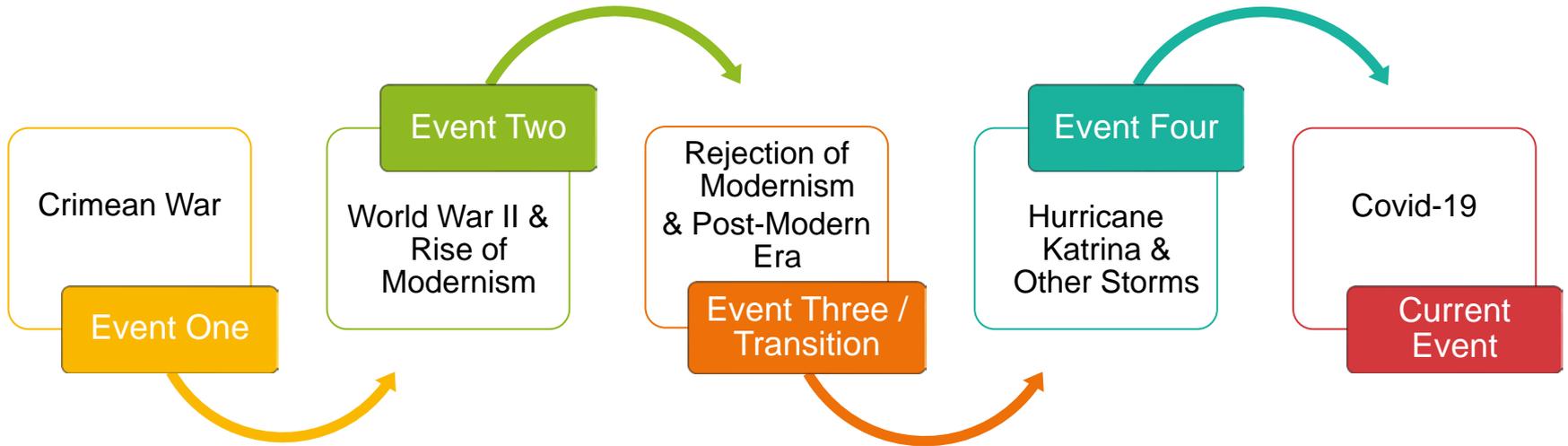
Literature Review

- Google Search
- Data Bases Search
- Google Scholar Search
- Other Data Bases: AIA Website

MS Thesis of Kader (2008)

Previous Research

Timeline & Events



Timeline & Events

Event One
Crimean War

Dates: Oct 5, 1853 – Mar 30, 1856



- Influence of Florence Nightingale
- A team of 38 volunteer nurses to care for the British soldiers fighting in the war.
- A golden period with respect to nursing, and
- A great example of modern nursing.
- Changing the nursing career by being more professional and dedicated to patients and played a significant role on soldiers treatment process (Fee & Garofalo, 2010).

Nightingale Ward

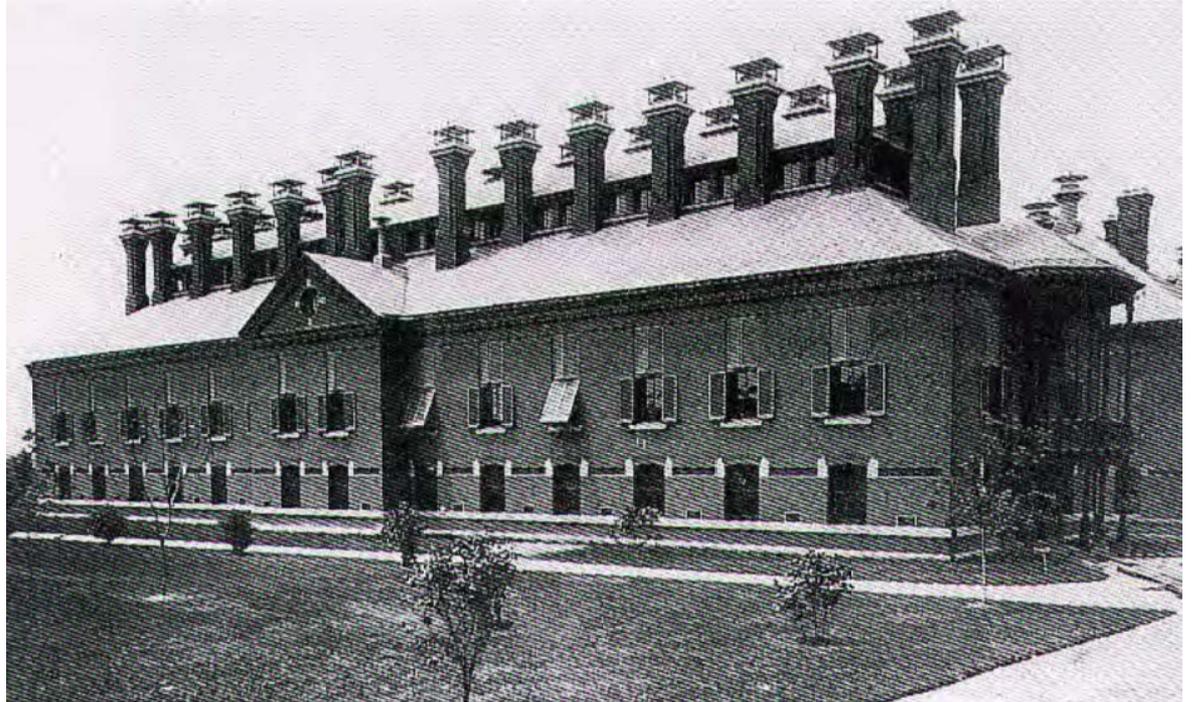


<https://kingscollections.org/exhibitions/specialcollections/nightingale-and-hospital-design/florence-nightingale-and-hospital-design>

Event Two
World War II
& Rise of Modernism

Changes in the New Century

- Steel Skeleton
- Elevator
- Electrical Lights
- Ventilation



Changes in care

- Cleanliness
- Trench Warfare
- Blood Transfusions
- Triage
- Anesthetic
- Thomas Splint

Besides the unfamiliar medical needs the war presented

Changes in Healthcare Delivery

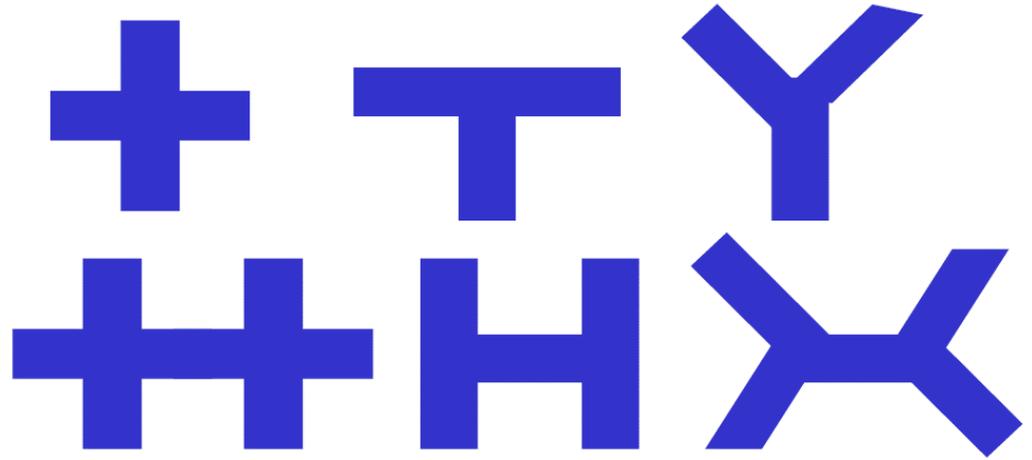


<https://ceufast.com/blog/nursing-and-medicine-during-world-war-i>

Event Three / Transition
Rejection of Modernism &
Emergence of
Post-modernism ...

Double Loaded Corridors

One Room Deep
On Each Side  No Mechanical
Ventilation



Typical
Prototypes of
Hospitals

Efficiency concerns

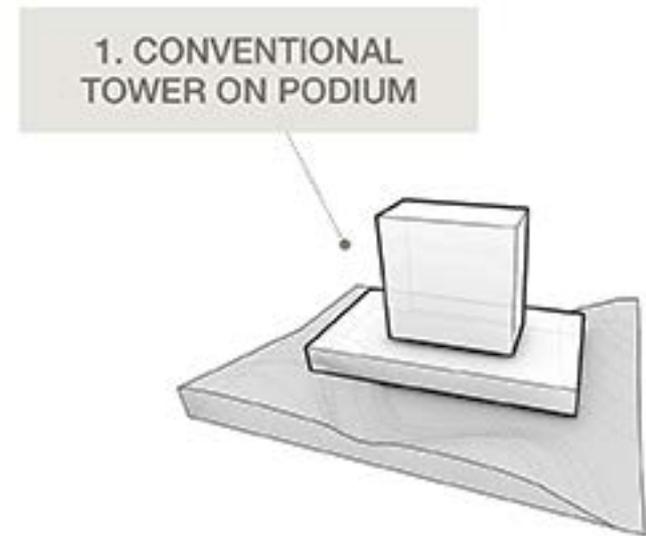
- No nurse's station concept of decentralized nursing unit staffing
- Each patient's room should become its own nursing station

First Intensive Care Units

- In 1950, anesthesiologist in Europe, Peter Safar established the concept of "Advanced life support", keeping patients sedated and ventilated in an intensive care environment.

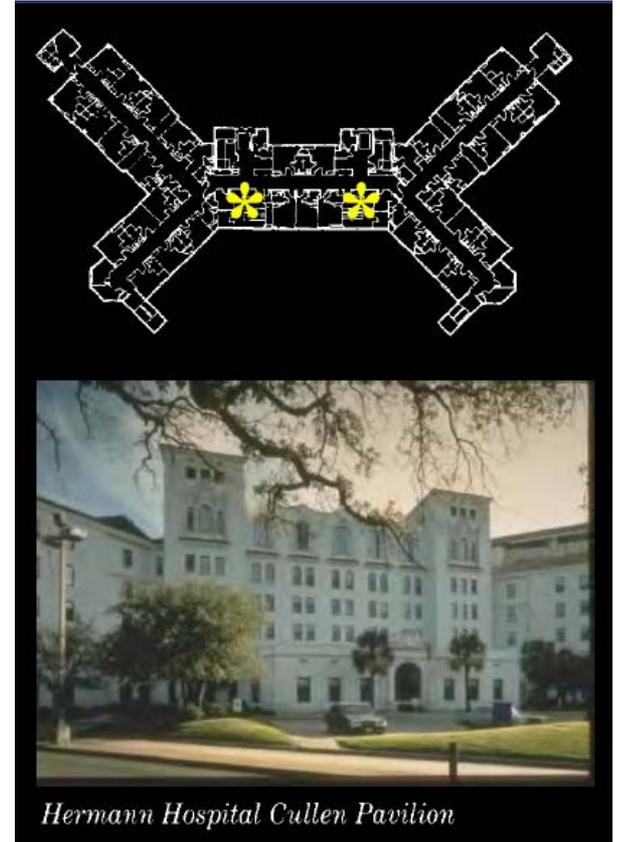
Air Conditioning became widespread

Period of Podium Design



Changes in Design

- Central nurse stations
- Double loaded corridors
- T shape units



Event Four
Hurricane Katrina &
Other Storms

'Natural and Man-made Disasters'

NAME	Name of Disaster	Year
General Hospital of Everett, Washington	Fire	1987
12 hospital, Northridge, California	Earthquake	1994
Rural Community Hospital	Bomb Threat	1999
Memorial Hermann, Houston, Texas	Tropical Storm	2001
Hospitals in New Orleans	Hurricane -Katrina	2005

The Deadly Choices at Memorial

by Sheri Fink, Aug. 27, 2009, 3 p.m. EDT



The New York Times Magazine

The Deadly Choices at Memorial



AUG. 1, 2009 Four years after Katrina, wheelchairs and equipment litter a walkway to the helipad at the former Memorial Medical Center, parts of which have not reopened. Photo: Paolo Pellegrin/Magnum, for The Times

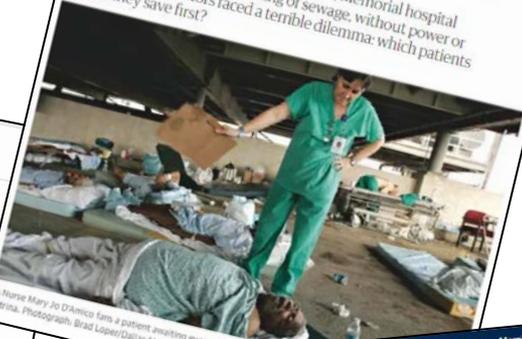
By SHERI FINK

Aug. 25, 2009

f t e

Hurricane Katrina: after the flood

When hurricane Katrina hit New Orleans, Memorial hospital was left in chaos: stifling, stinking of sewage, without power or running water. Doctors faced a terrible dilemma: which patients should they save first?



▲ Nurse Mary Jo D'Amico fans a patient awaiting evacuation from Memorial hospital after Hurricane Katrina. Photograph: Brad Losen/Dallas Morning News

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Katrina: The Long Road Back

Doctor, 2 nurses held in Katrina deaths

Arrest order: patients given morphine; 2nd-degree murder charges filed

NBC NEWS.com

Katrina Deadly Choices

MS Thesis
Kader (2008)

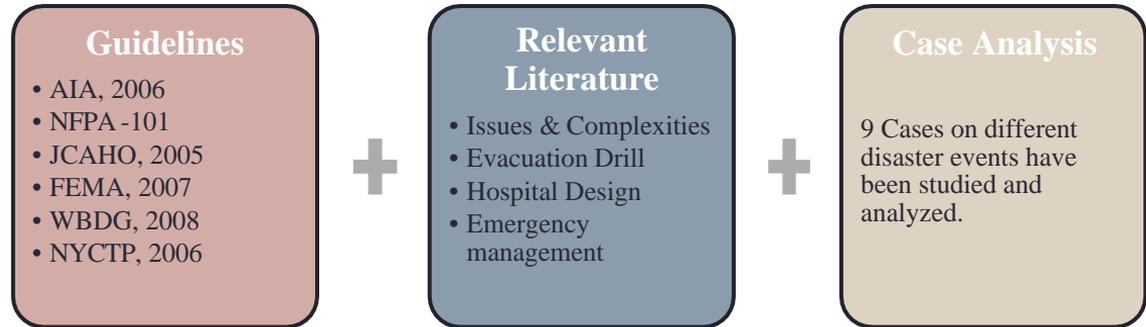
Title	DEVELOPMENT OF DESIGN STRATEGIES TO SUPPORT EVACUATION PROCESS OF HOSPITAL BUILDINGS IN UNITED STATES
Objective	To develop to develop design strategies for hospital facilities to support the complete evacuation process during any kind of disaster.

METHODS



Threat Analysis

Disaster threats for patients' evacuation (types of disaster), Warning period for evacuation (rapid or regular), Evacuate-location (outside building or town), Pattern (full or partial)



DESIGN PARAMETERS CONSIDERED

The following parameters have been considered in this [study](#):

- a) Evacuation Exit Route (EER)
- b) Site Access (ambulance and helicopter)
- c) Vertical Transportation (elevator, ramp and staircase)
- d) Emergency Assembly Area (Inside and outside)
- e) Emergency Operation System (EOS)

'Lessons Learned'

	NAME	CAUSE	
Case -1	Children Hospital, New Orleans	Hurricane -Katrina	2005
Case -2	Texas Children's Hospital, New Orleans	Hurricane -Katrina	2005
Case -3	Tulane University Hospital, New Orleans	Hurricane -Katrina	2005
Case -4	Charity Hospital, New Orleans	Hurricane -Katrina	2005
Case -5	Rural Community Hospital	Bomb Threat	1999
Case -6	12 hospital, Northridge, California	Earthquake	1994
Case -7	12 hospital, Northridge, California	Earthquake	1994
Case -8	A 28-bed intensive care unit, Memorial Hermann	Tropical Storm	2001
Case -9	General Hospital of Everett, Washington	Fire	1987

'Issues and complexities' of hospital evacuation

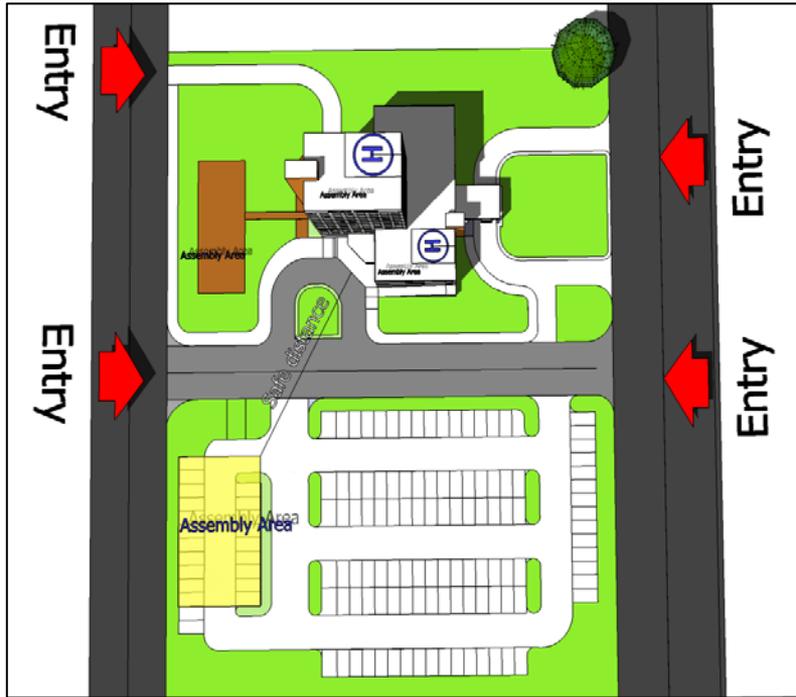
Nature of Threats: Evacuation process depends on the threat's severity, urgency of evacuation required, and ability to function during the evacuation. Among them, the evacuation warning time is the most important factor. For example, hurricanes and floods present threats that may allow some time for evacuation, but tsunamis allowing less time and earthquakes, tornados, and building fires almost none at all.

Risk to ICU Patients: ICU patients may have severe condition for evacuation, tend to be shelter-in-place. Also, staff injury and fatigue due to patients' transfer during disaster.

Threat Probabilities and Timing: Evacuation timing depends on threat probabilities. The amount of notice before evacuation is an important factor in the evacuation's success.

Continuing Care: Hospital should provide continuous care for patients', whom they cannot discharge during evacuation.

Resource Demand: Evacuation requires resources, such as, 3 to 5 person to transfer one ICU patients, transportation, medical professionals, emergency supplies. But hospital does not possess these amounts of resources for routine operations. So, during evacuation the crisis of resources is an important issue.



Recommendations

Mass Evacuation

Mass evacuation is mainly required for hurricane, earthquake, wildfire, volcanic eruption, extreme heat, winter storm, landslide, and terrorism.



The University of Texas Medical Branch, UTMB Hurricane IKE, 2008

Multiple accesses to the site will be beneficiary to accommodate lots of transportation, and it also increases safe entry and exit. Since, it depends on hospital location and site, for dense urban areas the accesses can be limited. During mass evacuation hospital may have external visitors, staff or patients' family, so that hospital facilities should have flexibility to accommodate extensive services. Patients' safety is one of the major criteria.



The sketch is showing a hospital with recommended design considerations in a mass evacuation scenario.



Multiple Accesses Require

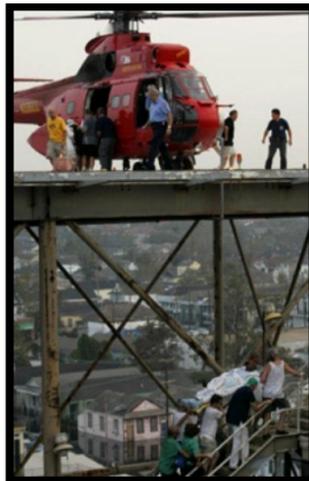
In flood affected area, hospital could be surrounded by water, which may impair the ground evacuation. Hospitals should have multiple exit routes distributing in different levels.

Mercy Medical Center in Cedar Rapids, Iowa.

Ground Evacuation

The facility should have provisions to access the boats to transfer patients. A ramp connecting upper level with ground could be an alternative solution.

Memorial Hospital, New Orleans (Hurricane Katrina, 2005)



Air Evacuation

Location of helipad should be specific. Ground helipad should be avoided for flood. For earthquake, ground helipad with a safe distance from the building is better. Sometimes the hospital roof top is the only choice, but if possible the garage top can be a better option which can be connected with the hospital building in upper level.

Workers move patients up the stairs from the parking garage to the helipad to be evacuated from Memorial Medical Center in New Orleans on Sept. 1, 2005



Recommendations

Vertical Evacuation: Elevator

The elevator is the practical way to transfer patients vertically. Elevator use is restricted only for fire. The fire fighter can examine and use the elevator for evacuation. It requires alternative solution. The operation of elevator should be protected from any kind of hazards.



The last stoppage should be above the flood level. The number of elevator (big one) should be more than the minimum number mentioned in standard.



The Sketches are showing two scenarios; during fire hazard, elevator cannot be use for vertical evacuation and during hurricane Katrina a New Orleans hospital faced the elevator in water problem.

Vertical Evacuation: Stair

Stairwell is the practically alternative solution of elevators. Stairwell design should consider the turning radius of various specialized devices, such as Backboard, Stretcher, or Scoop Stretchers.

Charity Hospital, Hurricane Katrina, 2005.



- Stairwell design should consider the turning radius of various specialized devices, such as Backboard, Stretcher, or Scoop Stretchers.
- Flashlights should be in all units and stairwells with proper hanging system.

Recommendations

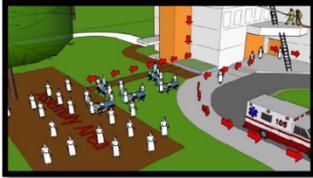
A hospital facility requires two types of assembly areas; inside and outside. Hospital should have outside assembly areas for any kind of internal hazards to gather patients. It can be parking lot, terrace top, roof top or any elevated platform; need to be threat specific. For fire, explosion or earthquake, it can be at a safe distance from the building. It can be designed with shading device to protect them from sun or rain.

Outside Assembly Area



The sketch is showing that how an outside assemble area can works during fire hazard.

Inside Assembly Area



Any function can be considered as an assembly area during disaster. It should have adequate outlets and supply to provide continuous care. Emergency department can be a good choice, it should have the provision separating the contagious patients. Also it should be located near to the exit point, to transfer patients quickly.



Charity Hospital, Hurricane Katrina, 2005.



Emergency Power Supply

Emergency power supply should be protected from any kind of hazards to provide continuous support for evacuation, especially for elevator. This system should be located in a secure place, such as; the switch gear or generators should be located above the flood level.

Connections between Buildings

In hospital complex design, it is wise to connect one building with others in different levels, specifically, where the critical patients are located to avoid the vertical evacuation.



Memorial Hospital, New Orleans (Hurricane Katrina, 2005)



Recommendations

Recent Disaster Events

- **Hurricane Florence in Fall 2018** - has led to the closure of numerous care facilities across the Carolinas. The City of Wilmington was even completely cut off from outside access for days due to flooding.
- **Hurricane Irma in Fall 2017:** 12 residents of a Florida nursing home died during this hurricane, when the building's central air conditioner failed and led to extreme overheating.
- **Hurricane Harvey in 2017:** 60 inches of rain and strong wind to the Houston, around 20 hospitals in the area had to close or evacuate - estimated disaster-related costs totaled \$460 million.

Design Strategies

scenarios	strategies
Hurricanes and Tropical Storms	<ul style="list-style-type: none">• Impact-resistant glass• Water storage tanks• Extra on-site backup power
Storm Surge, Sea Level Rise, and Flooding	<ul style="list-style-type: none">• Locating power center and HVAC equipment above the storm surge elevation or floodplain levels• Landscape elements such as berms, swales and/or natural wetlands
Extreme Heat and Cold	<ul style="list-style-type: none">• Strategic siting and shading of the building to reduce heat gain• Super-insulated building envelopes• Operable windows
Drought	<ul style="list-style-type: none">• Graywater recycling features• Rainwater cisterns• Xeriscapes with native trees and shrubs

<https://www.aia.org/resources/71636-disaster-assistance-handbook>



The image shows a screenshot of the AIA website. At the top, there is a red header with the AIA logo and the text "AIA". Below the header is a navigation bar with the following categories: Architects, Career, Advocacy, Events, Topics, and Practice. The main content area features the title "Disaster Assistance Handbook" in a large, black, sans-serif font. Below the title is a paragraph of text: "Architects are adept and skilled in anticipating the impacts of disruptions in the built environment". Underneath the text is a row of social media sharing icons: Twitter, Facebook, LinkedIn, Email, and Print. At the bottom of the page, there is a large red graphic that is a stylized representation of the book cover. The cover is red with the title "Disaster Assistance Handbook" and "Third Edition, March 2017" written on it in white text. The book is shown at an angle, suggesting it is a spiral-bound notebook.

Current Event
Covid-19

Isolation Center
Pandemic Surge Facility
Quarantine Camp
Covid-19 Testing Booth



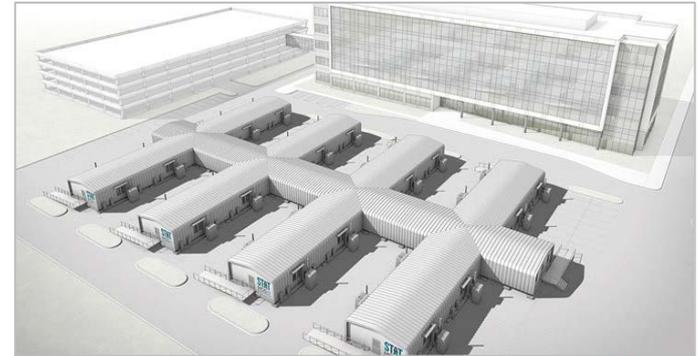
<https://www.csemag.com/articles/modular-walk-in-booth-design-for-covid-19-testing/>



<https://consultqd.clevelandclinic.org/how-we-created-a-hospital-for-covid-19-patients-in-less-than-a-month/>

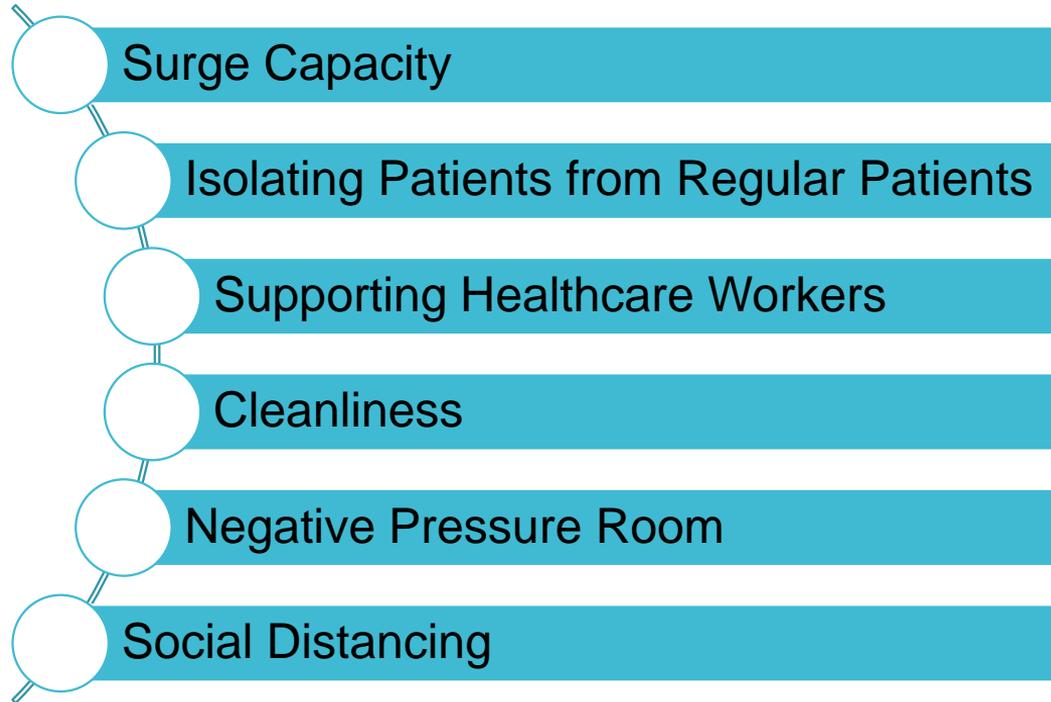


Healthcare
Facilities



<https://www.worldconstructionnetwork.com/news/hga-boldt-build-critical-care-units-to-address-hospital-bed-shortage-due-to-covid-19/>

Hospital Design Related Challenges



Post COVID-19 Hospital Design

10 Areas Where Change Coming

1. Improving infection prevention.
2. Increasing isolation room capacity.
3. Limiting shared staff spaces.
4. Triageing patients before they enter the ED.
5. Waiting rooms and public spaces.
6. Planning for inpatient surge capacity.
7. Increase surge capacity in outpatient centers.
8. More storage areas for supplies.
9. Facility Size: Breaking into small structures.
10. Isolation operating rooms and cath labs.

1. Improving infection prevention



- **Selection of materials:**
 - Nonporous materials
 - Easily cleanable
 - Withstand harsher chemicals
- Use of UV light or sterilizing mists in high and medium risk areas.
- Low risk areas, such as exam rooms, need thorough cleaning protocols and room turnover process – which will influence future planning and programming

2. Increasing isolation room capacity



- Allocate a groups of rooms / entire units / wings that can be negatively pressurized
- Have the scope to cut off or separate these isolation areas from the other parts of the hospital.
- Easily accessible entrance/exit from ED or outside triage.
- Design areas where staff can remove PPE without contaminating other areas outside isolation room.

3. Limiting shared staff spaces

- Number of occupancy rates need to be reconsidered for dedensification purpose.
- Rethinking size of staff areas and workstation.
- Staff Break Room – Large areas may be eliminated in favor of smaller and more discrete spaces.
- Administrative department may move to off-site.
- Design more recreational and private spaces for the staff, also outdoor separate areas only for staff.



4. Triageing patients before they enter the ED

- Design ways to triage people outside for they come to front door.
- May require multiple entries and waiting solutions.
- Design separate circulations (if possible).



5. Waiting rooms & public spaces



- Design self-check-in booth or self-rooming system - to reduce close contact among unknown people.
- Rethinking of waiting room: breaking it into small parts, more private, reducing size as patients may encouraged to wait outside, or in their car.
- Common spaces, waiting rooms, lobbies, and dining facilities will need to design with greater physical separation between people, with appropriate queuing.

6. Planning for inpatient surge capacity

- Med-gas, E-power, HVAC, and other equipment – need to design in such a way so that patient room and other spaces can accommodate more patients.
- Two beds in single-patient room.
- Surgical Prep and PACU to ICU.



7. Increase surge capacity in outpatient centers



- Ambulatory Care Facility can easily convert into facility to accommodate surge capacity, with fewer disruptions, than the field hospitals being erected in hotels and convention centers.
- While designing outpatient clinics, freestanding EDs, and ambulatory surgery centers, we need to consider this scenario or pandemic for future.

8. More storage areas for supplies

- Hospitals/health systems will seek greater control of their own supply chain and may stockpile key supplies, equipment, and medication to avoid future supply shortages.
- Design facilities to house these inventories



9. Facility Size: Breaking into small structures



- The desire to break apart some of the functionality of a large hospital and spread it out into other facilities-like oncology centers or ambulatory surgery centers will grow - to reduce the large population at one building.
- Designing facilities where you have people sitting further apart, you have smaller waiting areas, perhaps, instead of a big, large emergency room waiting area where everyone's sitting side by side.
- The future as telemedicine reduces the need for exam rooms, waiting rooms, and support spaces.

10. Isolation operating rooms and cath labs.



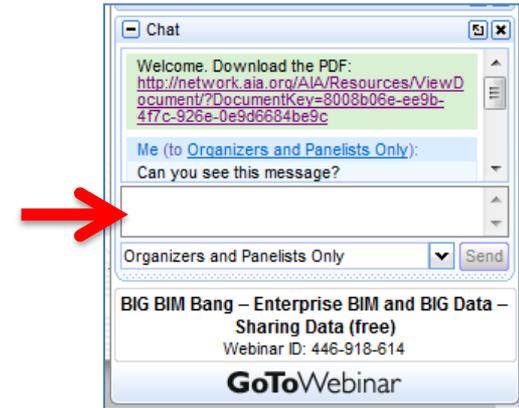
- The Centers for Disease Control and Prevention guidelines - an infectious patient require that the operating room remain positively pressurized throughout the surgery, and that no activity takes place within the room for an extended time after intubation and extubation.
- As it extends the length of surgical cases and limit staff mobility in and out of the room before, during, and after cases.
- More hospitals will want ORs and cath labs.
- More anterooms from OR to both the hallway and surgical core or control room.

Literature / Source

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- <http://hconews.com/2019/03/20/storms-and-climate-change-prompt-need-for-more-resilient-hospital-design/>
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- <https://www.healthcareradius.in/projects/26279-10-hospital-design-changes-post-covid>
- Carenzo, L., Costantini, E., Greco, M., Barra, F. L., Rendiniello, V., Mainetti, M., ... & Protti, A. (2020). Hospital surge capacity in a tertiary emergency referral centre during the COVID-19 outbreak in Italy. *Anaesthesia*.

Question Reminder

Submit your questions and comments
via the chat box.



SUMMARY

Resilient Design

Per the Resilient Design Institute:

“resilience is the capacity to adapt to changing conditions and to maintain or regain functionality and vitality in the face of stress or disturbance. It is the capacity to bounce back after a disturbance or interruption.”

<https://www.resilientdesign.org/what-is-resilience/>

Hospital Resilient Design



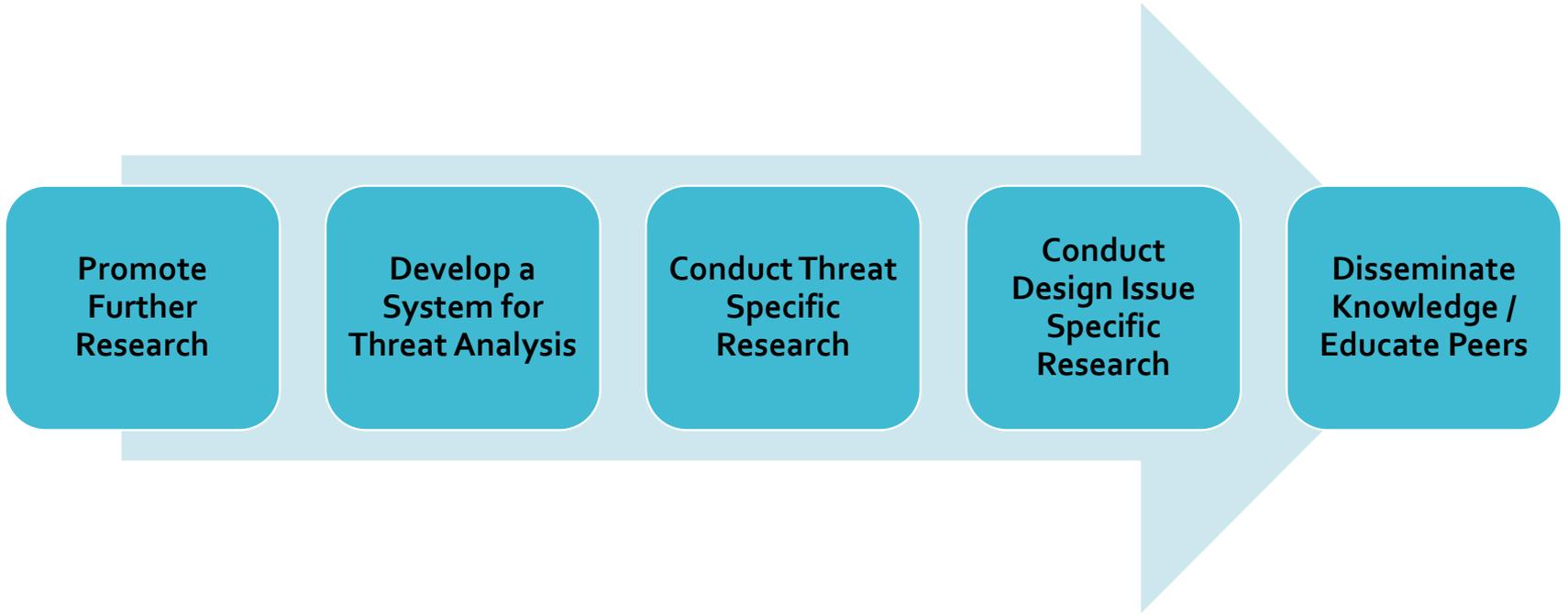
Natural Disaster

Infectious Disease

Emergency Surge Capacity

Hospital Patient Evacuation

Alternative Care Facility



Future Direction

THANKS

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Time for Questions and Comments



CES Reminder

The URL to the webinar survey <https://www.research.net/r/AAH2007> will be emailed to you or the individual who registered your site.

The survey closes **Friday, September 11th** at 12:30am ET.

For questions, please email knowledgecommunities@aia.org



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Announcements ADD

U40 List: Healthcare Design's Best Under 40  

The U40 List is nomination oriented recognition to celebrate individuals making a significant contribution to the advancement of health facilities design. Each year up to two individuals will be selected to have their names added to the distinguished U40 List. The recipients will receive a travel stipend to attend the Summer I Leadership

Upcoming Webinars

Date	Series	Topic
10/13	Master Studio	Recent Mental Health Projects: The newest lessons learned – Deep Dive
11/17	Beyond the Basics	This Session is a “Disaster”
12/8	Case Study Series	SSM Health Saint Louis University Hospital

Dates & topics are subject to change