Rapid Holistic Assessment and Rating of Post-Earthquake Hospital Functionality

Megan Boston, PhD, University of Waikato

Motivation

It is essential that critical care facilities remain functional and operational following a major disruptive event. These facilities provide continued and ongoing care of existing patients and provide rapid and emergency treatment to the potential surge of injuries caused by the disaster.

The World Health Organization states:

1. **Protect the lives of patients and health workers** by ensuring the structural resilience of health facilities.
2. Ensure that health facilities and health services are **able to function in the aftermath of emergencies and disasters**, when they are most needed.
3. Improve the emergency management capacity of health workers and institutions

Existing Resilience Rating Systems

- Assess building performance
  - Safety (occupant safety during the event)
  - Damage (financial cost to repair the building)
  - Recovery (time required to make necessary repairs to the building)
- Variations in rating systems in their assessment of post-disaster functionality
- Outputs, which are intended to be informative to the public and stakeholders, differ between the rating schemes.

Rating Systems and Hospitals

- Resilience of the physical building **not** the resilience of the internal organizations
- Resourcefulness and adaptive capacity of the internal organizations are omitted
- Results have limited application to critical facilities such as a hospitals

oshpd
Office of Statewide Health Planning & Development

Structural Performance Categories		Non-structural Performance Categories	
SPC 1	Building poses significant risk of collapse, danger to the public	NPC 1	Equipment does not meet anchoring or bracing requirements
SPC 2	Compliance with pre 1973 building code. Meets life safety requirements but unlikely to be repairable or functional.	NPC 2	Bracing and anchoring of key systems such as: communication, emergency power, medical gases
SPC 3	Compliance with HSSA prior to 1994. Meets life safety requirements but unlikely to be repairable or functional.	NPC 3	NPC 2 and bracing and anchoring of nonstructural elements in critical care, clinical labs, pharmaceutical, radiology, and sterilization areas
SPC 4	Compliance with HSSA after 1994, may have structural damage that will hinder hospital services	NPC 4	NPC 3 plus proper anchoring and bracing of all architectural, mechanical, electrical, and medical equipment
SPC 5	Compliance with HSSA after 1994, reasonably capable of providing services after a major event	NPC 5	NCP 4 plus 72 hours of onsite water and holding tanks.

OSHPD — SPC: 5 — NPC: 4

REDi

SILVER
Downtime-Reoccupancy: 0 days
Downtime-Functional: 114 days for repairs
Direct Financial Loss: 0.4%
Occupant Safety: No expected injuries

United States Resiliency Council

SAFETY ★★★★★
DAMAGE ★★★★★
RECOVERY ★★★★☆

Hospital Safety Index

A
0.91
Structural: 0.98
Nonstructural: 0.86
Functional: 0.81

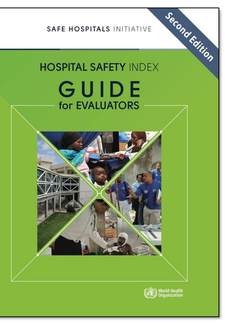
REDi Framework

- Resilient Design and Planning
  - Organizational Resilience
  - Building Resilience
  - Ambient Resilience
- Evaluation
  - Loss Assessment

	Downtime: Re-occupancy	Downtime: Functional Recovery	Direct Financial Loss	Occupant Safety
Platinum	Immediate (green tag)	< 72 hours	< 2.5%	Injury unlikely
Gold	Immediate (green tag)	< 1 month	< 5%	Injury unlikely
Silver	< 6 months (yellow tag)	< 6 months	< 10%	Injury possible but structural collapse unlikely

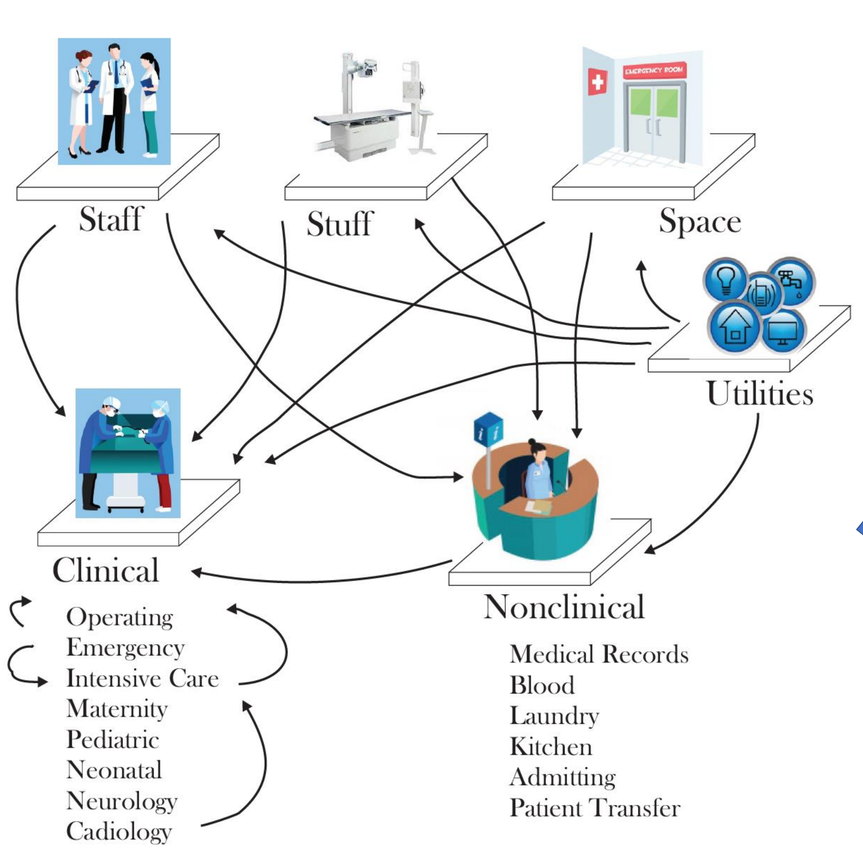
U.S. RESILIENCY COUNCIL
Rating Building Performance in Natural Disasters

STARS	SAFETY	DAMAGE	RECOVERY
★★★★★	**Injuries and blocking of exits unlikely** Fatality < $3x10^{-5}$	**Minimal Damage** Repair cost < 5%	**Hours to days** Recovery < 5 days
★★★★	**Serious injuries unlikely** Fatalities < $1x10^{-4}$	**Moderate Damage** Repair cost < 10%	**Days to weeks** Recovery < 4 weeks
★★★	**Loss of life unlikely** Fatalities < $4x10^{-4}$	**Significant Damage** Repair cost < 20%	**Weeks to months** Recovery < 6 months
★★	**Loss of life possible in isolated locations** Fatalities < $4x10^{-3}$	**Substantial Damage** Repair cost < 40%	**Months to 1 year** Recovery < 1 year
★	**Loss of life likely** Fatalities > $4x10^{-3}$	**Severe Damage** Repair cost > 40%	**More than 1 year** Recovery > 1 year



Safety Index	Classification	Predicated Outcomes	Recommendation
0.66-1.0	A	Hospital is likely to function	Continue to improve emergency and disaster management
0.36-0.65	B	Ability of the hospital to function after a disaster is at risk	Short term intervention is needed
0.0-0.35	C	Hospital is unable to function following a disaster	Urgent intervention is needed

Holistic Rating System Framework



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Results from Existing Rating Systems

REDi, USRC

- Detailed comprehensive assessments that consider building performance and recovery levels
  - Inconsistency of criteria for rating systems
- OSHPD
  - Generalized performance categories
- Hospital Safety Index
  - Quick assessment that requires limited calculations and only considers immediate impact
- Overall
  - Rating Systems focus on the performance of the physical building
  - Largely neglect business continuity
  - None of the rating systems provide enough detail in the immediate recovery time frame to provide emergency managers enough information to predict the immediate and short-term operability of hospital after an earthquake

Holistic Hospital Rating System

- System that considers all aspects contributing to a hospital's ability to function
  - Staff, supplies, utilities, space …
- Measurement of partial functionality over time
- Need to consider ability to provide clinical and non-clinical service

Functionality
- Full
- Partial
- Limited
- None

Conclusions

Each of the existing rating systems provide valuable information, however the way the results are currently presented to stakeholders and the public are misleading to the actual resilience and functionality of a hospital after a disaster.

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