Towards More Resilient Performance of Emergency Departments

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1. BACKGROUND

Crisis in Emergency Departments (EDs)
The ED is a complex, dynamic system that copes with:
- Limited time and resources.
- Uncertain demands.
- Risks of causing high-consequence of medical errors, and
- Economic pressure due to competitive market and federal mandate.
(e.g., Emergency Medical Treatment and Labor Act or EMTLA)

EDs are at a Brittle Point

- Growth of influx of ER patients.
- ED shutdowns are increasing.
- Crowding/dumping patients become common.
- Chronic shortage of physicians and nurses.


Resilience Engineering as a Remedy

Resilience engineering is defined as “a paradigm for safety management that focuses on how to help systems cope with complexity under pressure to achieve success” (Woods & Hollnagel, 2006).³

Safety-I Perspective⁴
- See what things go wrong
  - Errors, mistakes, accidents
  - Finding failure
- Emphasis on the reduction of human intervention
  (e.g., “To Err is Human”)

Safety-II Perspective⁵
- See what things go right
  - Adaptation, variability
  - Finding success
- Stress the need to support human adaptation

2. RESILIENT ED RESPONSES

Four Types of Resilient ED Responses³
Responsive capacity of EDs is finite and limited in time and quality of staff, availability of technology, processes, equipment and facility.

<table>
<thead>
<tr>
<th>Type</th>
<th>Demand Level</th>
<th>Response Pattern</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matched</td>
<td>Below max. capacity</td>
<td>'Eat up' existing resources</td>
<td>Routine emergency cases, e.g., single car crash</td>
</tr>
<tr>
<td>Extended</td>
<td>Slightly over max. capacity</td>
<td>Consume additional resources</td>
<td>Unusual but expectable cases, e.g., multiple car accidents</td>
</tr>
<tr>
<td>Sustained</td>
<td>Moderately over max. capacity</td>
<td>Stay 'extended' for a longer period or ‘free fall’</td>
<td>Rare and unexpected instances, e.g., train derailment</td>
</tr>
<tr>
<td>Transformed</td>
<td>Largely over max. capacity</td>
<td>Change its behavior in a radical way</td>
<td>Mass casualty incident, e.g., suicide bombing</td>
</tr>
</tbody>
</table>

3. REPRESENTATION OF RESILIENCE

Representation of Resilience of EDs
Resilience is a tacit, covert property of a system. Hence, visualization efforts help understand some of dimensions it possesses.

1. State-Space Model (adapted from Hollnagel & Sandström (2006))
- The ED possesses a set of discrete states.
- Normal state
- Regular Reduced Functioning
- Irregular Reduced Functioning
- Suspended Functioning
- Conns: - Limited in explaining temporal changes.
- State transition occurs between adjacent states.

2. Stress-Strain Curve (adapted from Sheridan (2008); Woods, Wraith & Anders (2006))
- Resilience is a physical property of a material.
- A system can be viewed resilient or brittle.
- A system reaches a failure when it uses up all the adaptive capacity.
- Cons: - Same as for Space-State Model.

3. Discrete Temporal Model (adapted from Cook (2006))
- Illustrate how system’s performance elongates or shrinks against varying demands.

4. Variety Space Diagram (adapted from Rankin et al. (2013))
- A system can function in various states and is controlled by two ends.
  - Sharp end (e.g. nurses)
  - Blunt end (e.g., hospital management).
- Interaction between two ends comes along as the system sustains.
- In extreme events, e.g., MCI neither sharp or blunt end has control actions available to them.

5. Stretched Dynamics Model (adapted from Cook & Rasmussen (2005))
- A system’s operating capacity expands with dynamic interplay among opposing forces.
  - Economic pressure
  - Workload release
  - Safety effort
- As these forces push the system near and over the operating boundary, accidents, mishaps and near-misses take place.
- This model can display multiplicity of disruption – response patterns.

4. STRATEGIES FOR RESILIENCE

4 ‘S’s: Staff, Supplies, Structure and Sequence
1) Defensive
   - Staffing: human resources such as physicians, nurses and other practitioners.
2) Autonomous
   - Supplies: medical apparatus, equipment and pharmaceuticals
     - Stockpile a cache of essential commodities
     - Substituting between functionally compatible tools
   - Structure: restriction on a certain therapy
   - Sequence: proper cleaning and sterilization
   - Adopt for purposes for they are not intended
   - Sequence: those in the largest needs
3) Cooperative
   - Sharing among similar units (ED-OR-ICU)
   - Borrowing from dissimilar units

5. PATH FORWARD

1. Observation studies: some of theoretical and hypothetical arguments need to validated in the real hospital settings.
2. Measuring resilience: patterns of resilient performance must be defined in operational terms for future improvement in e.g., process and interface design.
3. Develop and test resilience-based design principles for healthcare applications

REFERENCES

4. Science and Medicine, 8, 78-87.
5. Stretched Dynamics Model (adapted from Cook & Rasmussen (2005))

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