**Towards More Resilient Performance of Emergency Department**

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The vulnerability of Emergency Departments (EDs) in the U.S. becomes a major threat to various stakeholders including the public, healthcare service providers and policy makers (Institute of Medicine Committee, 2006). EDs are constantly encountered with economic pressure and fluctuating, excess demands. This crisis is aggravated by the federal mandate. For example, the Emergency Medical Treatment and Labor Act in 1986 gives rise to uncompensated care, which then shoves healthcare providers on the verge of shutdowns and patients overcrowding. In addition, EDs’ taxing work environment makes it difficult to resolve the chronic shortage of physicians and nurses (Kellermann, 2006). In order to cope with worsening problems in EDs, this work suggests resilience engineering as an effective approach by examining its concept, visual representations and coping strategies. Resilience is defined as a system’s capability to flexibly maintain, and quickly recover from perturbations to its normal operating conditions with minimum losses (Cook & Nemeth, 2006). In contrast with linear cause-effect views or Safety-I approach that emphasize finding and fixing things that go wrong such as human errors, resilience engineering (RE) places due weight on things that go right, the basis of Safety-II approach (Hollnagel, 2014). This alternative safety paradigm therefore focuses on ways to support human-machine systems to achieve success by helping cope with complexity under pressure.

Four types of resilient responses in EDs are presented: matched, extended, sustained and transformed. When demands are below the system’s normal operating capacity, the responses ‘eat up’ existing resources. As it elevates to higher demands, different patterns of such responses begin to emerge. For instance, extended responses require to recruit additional, readily available resources. If these escalated demands persist, sustained responses may occur, so called ‘free-fall’ (Wears & Perry, 2006). In case of the mass casualty incident (MCI) such as suicide bomb attack, the system necessitates a radical, transformative change in its performance. Since resilience is a tacit, covert property of a system, representational models offer benefits of understanding how these response patterns are manifested. Overall, five representations are provided. State-Space Model shows transitions among different states of system functioning. Stress-Strain Curve exhibits both elastic and brittle behaviors of a system by employing the law that governs material. While preceding two models are limited in terms of temporal description, Discrete Temporal Model presents how resilience is manifested over the time horizon. On the other hand, Variety Space Diagram shows more complex nature of a system’s resilient performance by modeling three system variables (Disturbance Variables, Sensemaking Variables and Control Variables) and two ends of a system (a sharp end and a blunt end). Lastly, Stretched Dynamics Model is predicated on the Law of Stretched Systems (Hirschhorn, 1997). It depicts how a system’s operations migrate towards unacceptable performance boundary due to pushes from management and workforce. Additionally, this model is able to illustrate different instances such as accidents, near-misses at multiple ends of the system.

Finally, this work provides strategies to make EDs more resilient. This is summarized as 4 S’s: staff, supply, space and sequence. To perform in more resilient ways, EDs recruit and utilize workforce strategically. They often defend their own resources by blocking the flow. In other cases, physicians and nurses are borrowed from other units, assigned to temporary roles and shared among similar units. Strategies for supply are basically associated with its quantity and usage. Stockpile, substitute, conserve, adapt, reuse and reallocate are presented as examples of tactics for supplies. Spatial arrangement is another consideration that affects the resilience of EDs. In overall, intra-departmental tactics employed within ED and inter-departmental tactics that occur among functionally-adjacent care units are introduced. With similar staffing, supply and space given, resilient performance may change depending on how works are sequence and processed. Skipping, expediting, reordering and sacrificing are discussed to show different sequencing strategies.

The efforts for providing concept, representations and strategies for more resilient EDs are worth helping understanding why it is necessary. However, one crucial question is how to engineer resilience in complex systems like EDs. Some progress is now visible as seen in the development of healthcare ICT solutions (Nemeth, Wears, Patel, Rosen, & Cook, 2011) and medical devices such as infusion pump (Nemeth, Wears, Woods, Hollnagel, & Cook, 2008). Yet there must be more questions to be answered than those that have been answered. One example of those questions is a question for more quantitative measurement of resilience provided that the instances and models for conceptual framework of RE are abundant. The progress towards designing more resilient ED systems is still in the nascent stage. The summary of patterns and representations of, and strategies for resilience presented in this work can offer basic understanding for addressing the chronic challenges experienced in EDs.

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