

# Situation Awareness: A New Model for Predicting and Preventing Patient Deterioration



Health care systems, including acute care hospitals, have historically been designed to respond to, rather than predict and prevent, events. The move to a prevention-based health care system continues to mature in outpatient care, particularly around screening and chronic care management. The use of prediction and prevention is more limited in the acute care environment. This is the case despite growing evidence that failure to rescue from preventable deterioration and complications is associated with devastating outcomes.<sup>1,2</sup> Clinical antecedents occur before most in-hospital cardiorespiratory arrests but may not be fully recognized or acted on.<sup>3</sup> Interventions such as rapid response teams, early warning scores, and virtual monitoring target the quality of monitoring and the response taken when abnormalities are identified.

We believe that rapid response systems work to improve the situation awareness of the clinical teams and that situation awareness, with its focus on projection and prediction, provides a model for their further improvement. Situation awareness is achieved by (1) gathering information, (2) understanding that information in context, and (3) making short-term projections based on current state. A health care system that supports excellent clinician situation awareness would actively scan for risk across multiple domains (eg, proactively eliciting family concerns and using early warning scores to detect vital sign abnormalities). It would then couple these reliably with clear, expected actions.

A system that reliably identifies, mitigates, and escalates multiple categories of patient risk will likely result in safer and less costly care. We have begun to test a system to improve situation awareness and prevent unrecognized deterioration at our center.<sup>4</sup> Herein, we present 2 conceptual models of situation awareness in health care and discuss how proactive multimodal risk assessment might drive situation awareness.

## SITUATION AWARENESS

More than a decade ago, the Institute of Medicine challenged health care to learn from other industries and academic disciplines that also face dynamic working conditions and constant safety threats.<sup>5</sup> The Institute of Medicine noted that "Medicine is not unique among high-risk, high-reliability industries because it too is concerned with learning how to prevent, detect, recover, and learn from mishaps and accidents." Indeed, organizational theory researchers have described High Reliability Organizations that face high risk with impressive safety records.<sup>6</sup> A core tenet of High Reliability Organizations is a sensitivity to operations on the front line. These organizations constantly seek to find and correct vulnerabilities

## AUTHORS

Patrick W. Brady, MD, MSc,<sup>1,2</sup> Derek S. Wheeler, MD,<sup>2,3</sup> Stephen E. Muething, MD,<sup>1,2</sup> Uma R. Kotagal, MBBS, MSc<sup>2</sup>

<sup>1</sup>*Division of Hospital Medicine,* <sup>2</sup>*James M. Anderson Center for Health Systems Excellence, and* <sup>3</sup>*Division of Critical Care Medicine, Cincinnati Children's Hospital, Cincinnati, Ohio*

## KEY WORDS

clinical deterioration, medical emergency teams, patient safety, rapid response systems, situation awareness

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Address correspondence to Patrick Brady, MD, MSc, Cincinnati Children's Hospital, ML 9016, 3333 Burnet Ave, Cincinnati, OH 45229. E-mail: [patrick.brady@cchmc.org](mailto:patrick.brady@cchmc.org)

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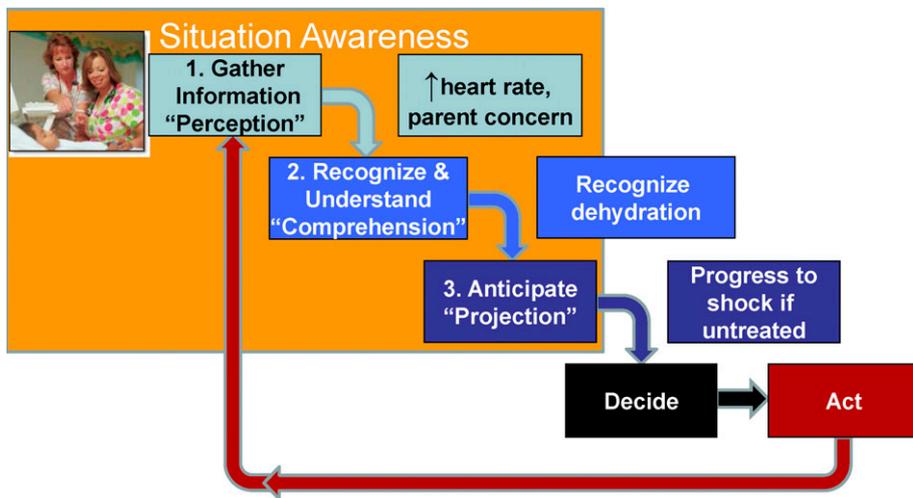
and believe fostering situation awareness helps facilitate this. Cognitive psychology and human factors engineering also offer models and wisdom on challenges in maintaining situation awareness.<sup>7,8</sup> Researchers in these fields have demonstrated the relationship between increased situation awareness and improved performance. In an analysis of commercial aviation accidents, Endsley and colleagues found 88% were attributable to poor situation awareness, most commonly when controllers failed to perceive important information.<sup>9,10</sup>

Situation awareness is used extensively by the military, aviation, and other High Reliability Organizations. Poor situation awareness is associated with increased rates of errors and accidents.<sup>9-11</sup> Situation awareness is informally defined as “knowing what’s going on.”<sup>7,8</sup> The formal definition, proposed by Micah Endsley in 1995 is “the perception of the elements of the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.” In health

care, situation awareness is most studied in the operating room, the ICU, and in simulation. More experienced clinicians have higher situation awareness when measured in trauma simulation and on ICU rounds.<sup>12,13</sup> Higher surgeon situation awareness was associated with fewer technical errors during laparoscopic cholecystectomy.<sup>14</sup> In the hospital medicine setting, teamwork training and structured resident handoff interventions have incorporated situation awareness into their development.<sup>15-17</sup>

The 3 levels of situation awareness each have unique threats and hence potential systems- and training-level interventions to address. A true-life clinical example illustrates these threats (Fig 1). In our figure, we present an adapted and simplified version of Endsley’s model of situation awareness to illustrate how it applies in the care of a hospitalized patient. For ease of discussion, we present these steps of level 1, 2, and 3 situation awareness as occurring in series, but cognitive psychology has revealed that situa-

tion awareness and decision-making is a substantially more complex, parallel, and iterative process.<sup>10,18</sup> A young infant hospitalized with acute gastroenteritis is briefly improved after initial fluid resuscitation. As the stool losses worsen, the child’s parents note that she is less playful. The busy clinical team never elicits this concern from the parents and hence does not have all of the information needed for level 1 situation awareness. Interventions to target this threat might focus on systematic data gathering from all parties around risk status. Later the child’s heart rate increases and urine output decreases. Level 2 situation awareness involves comprehending what these data mean (in this case, that the child has worsening dehydration and may be in a state of compensated shock). Interventions to target this might include diagnostic tools or protocols to bring expert clinicians to the bedside. Because the shock is still not recognized, the child becomes somnolent. Level 3 situation awareness consists of short-term projection of potential outcome (in this case, that the hypovolemic shock will worsen and may progress to arrest if immediate action is not taken). Potential solutions to increase level 3 situation awareness could include time-bound plans and automatic escalation pathways. We believe that a system that improves situation awareness and links it to clear action will enable clinical teams to more rapidly identify, mitigate, and, when necessary, escalate the recognition of risk in deteriorating patients. Reliable escalation could bring more resources in the form of people, equipment, and clinical experience to the bedside of the sickest patients.



**FIGURE 1** Model of application of three levels of situation awareness in healthcare. The relationship between the three levels of situation awareness and clinical examples of how the levels fit together in healthcare.

As the example illustrates, situation awareness provides a paradigm for identifying risk in multiple domains.

Physiologic abnormalities, particularly when their assessment, reporting, and required actions are standardized in early warning scores, are one important way to improve risk detection. These scores are particularly useful for quantifiable data such as heart rates but may be limited in their treatment of “softer” data such as subtle mental status changes. A large prospective study recently showed the additional value of physician “gut feeling” to that of the standard clinical assessment in children.<sup>19</sup> A system that proactively seeks to incorporate these gut feelings or tacit knowledge of front-line clinicians will improve situation awareness and risk detection. A shared language that describes this risk may improve shared mental models and situation awareness.<sup>20</sup> When coupled with structured communication tools such as

SBAR (situation, background, assessment, recommendation) and standardized handoff documents, this shared language has even greater potential to improve situation awareness and hospital care.<sup>17,21</sup> Similarly, increased empowerment and engagement of patients and families to share their unique knowledge about normal baselines and subtle changes are needed for optimal situation awareness.

Early identification and mitigation of deterioration is important because deterioration, we believe, does not occur linearly. Figure 2 shows our conceptual model of patient deterioration. We believe that a system, including front-line providers, that proactively identifies patients at risk and predicts their course will reduce profound deteriorations, in-hospital arrests, and mortality.

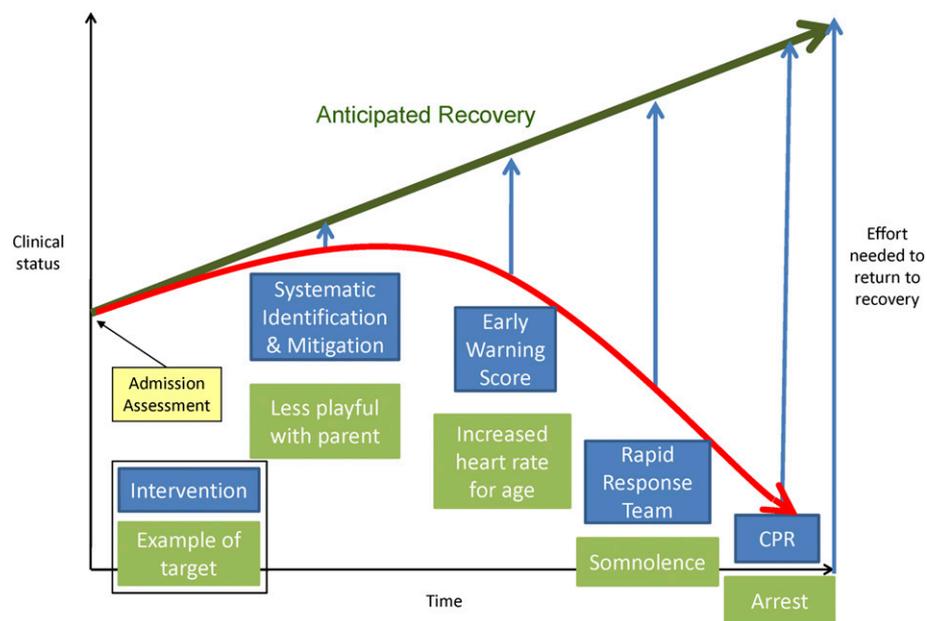
Safer health care will need to build on expertise not just in the clinical sciences but in organizational theory, psychology, and human factors engineering. Our model of situation awareness in health care is one promising example of how to do this. We believe that reliable and systematic identification of multiple risk triggers will ultimately allow for simpler and more effective mitigation strategies and improved outcomes. When this identification exists within a system that demands 100% mitigation or escalation, breakthrough safety aims are likely to be achieved. We will continue to test this model at our center, but our hope is that other institutions will test solutions in their local environments building from this conceptual model to increase our collective learning.

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**FIGURE 2** Model of deterioration over time and potential interventions to identify and mitigate. The y-axis represents clinical status, with the top being excellent health. The intersection with x-axis represents cardiopulmonary arrest. Our patient with acute gastroenteritis is admitted to the hospital in less than perfect health, and the anticipated recovery is upward and depicted as linear. As the deterioration accelerates, the degree of effort and cost needed to return to the recovery path increases. Interventions that identify and mitigate deterioration most proximally will thus improve health outcome while decreasing cost and improving the patient and family experience. CPR, cardiopulmonary resuscitation.

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