

# Critical Care Nurses' Cognitive Ergonomics Related to Medical Device Alarms

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## KEYWORDS

• Decision making • Monitor alarms • Alarm fatigue • Intensive care • Human factors

## KEY POINTS

- Intensive care nurses integrate multiple factors into consideration when deciding how quickly or even whether an alarm will be responded to.
- Difficulties encountered in responding to alarms included low staffing, multiple job responsibilities, and competing priority tasks.
- Less experienced nurses tend to rely on monitor alarms to alert them to a patient problem.
- Less experienced nurses are more tolerant of alarms sounding owing to a lower threshold of comfort with resetting or silencing alarms.
- Future studies should include effective use of alarm-related equipment trainings and/or innovative user-centered alarm management clinical decision support systems to enhance intuitive nurse–device interactions.

## INTRODUCTION

Acute care nurses are responsible for the safety of critically ill patients around the clock in the increasingly complex technology-rich intensive care units (ICUs) by making distinctions between clinical changes that warrant emergent intervention and those that do not.<sup>1</sup> In this high-pressure work environment, numerous devices, often complicated, are commonly used to enable continuous measurements of the physiologic function of the patient and function of the medical devices.<sup>2</sup> To increase safety, alarms are embedded in almost every device in the ICU to alert critical care nurses of potential problems early so they can institute appropriate interventions. Nurses are

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expected to monitor and respond appropriately to the plethora of pathophysiologic data and alarms produced by the patient and devices.

Ironically, the very alarm systems created to enhance patient safety have become an urgent patient safety concern.<sup>2</sup> Just a bedside cardiopulmonary monitor alone generates 187 audible alarms per bed per day, averaging 1 alarm every 7.7 minutes.<sup>3</sup> To exacerbate the alarm problem further, up to 90% of alarms are deemed false or non-actionable with very few indicating serious clinical events.<sup>4–10</sup> The constant demand to respond to alarms and mistrust of the alarm system owing to high numbers of clinically irrelevant alarms reduce the alertness of the clinicians. Clinicians become accustomed to ignoring false alarms and, as a result, may overlook an alarm that signals a true emergency, producing a phenomenon known as alarm fatigue. Patient injury and death resulting from inadequate attention to alarms have been reported.<sup>11</sup> In addition, silencing alarms is the second most common task performed by nurses, accounting for approximately 16% of a nurse's bedside tasks.<sup>12</sup>

As more tasks are handled by technology, humans are becoming responsible for tasks that require inference, diagnoses, judgment, and decision making.<sup>13</sup> In the ICU, ever-growing and complex technology places nurses at a greater cognitive demand. As defined by the International Ergonomics Association, cognitive ergonomics (or human factors) is “concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. (Relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system design.)”<sup>14</sup> Decision making, a process that humans use to determine a forward path of action,<sup>15</sup> is 1 of 10 key human factors topics relevant for patient safety.<sup>16</sup> To design an effective alarm management program, we propose to focus on cognitive ergonomics by understanding critical care nurses' cognitive processes, specifically intricacy of decision-making capabilities, related to prioritizing, responding to, and managing medical device alarms in ICU, when under conditions of high uncertainty, time pressure, and risk.

## THEORETIC FRAMEWORK

The situated clinical decision-making framework provides a structured approach to analyze nurses' decision making in clinical practice and to guide the selection of relevant strategies to support development of clinical decision making.<sup>17</sup> In this framework, 4 phases have been identified to comprise the clinical decision-making process—cues, judgments, decisions, and evaluation of outcomes.<sup>18</sup> A nurse's clinical decision-making process is triggered by recognition of a cue from the patient, either a response or lack of something expected. Once the initial cue is noticed, the nurse collects additional cues to build an understanding of the situation. Cues can be collected from multiple sources, including patient observation and assessment, statements from patients or others, objective data, and the nurse's intuition. Ongoing cue collection is informed by a nurse's evolving understanding of the situation. For example, when a device alarm sounds, the nurse is cued to a possible change in patient condition. This alarm may trigger a reminder of a comment made by the patient, such as a previous complaint of discomfort. Judgment is defined as the best conclusion that can be reached at a point in time, given the available information. This definition reflects the dynamic process between possible judgements and collected cues. Ongoing cues further informs one's judgment. *Decision* is committing to a course of action, whether it is “waiting and watching” and/or “trying something.”<sup>18</sup> The nurse may choose to proceed with a tentative course of action and remain open to revise

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