Detecting Abnormalities on Displays of Patient Information

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Objective: In the ICU, alarms have the important task of alerting clinicians about emergency events and keeping them apprised of patients with deteriorating physiological status. However, these alarms contribute to alarm fatigue (Meredith & Edworthy, 1995). Moreover, the current visual information displays used by clinicians represent patient data across multiple locations, which may hamper a clinician's ability to recognize ongoing patient physiologic trends and maintain a comprehensive view of a patient's state (Anders, 2012). We tested a new configural display that combines information about blood pressure, heart rate, and blood oxygen saturation into a single visual indicator represented as a colored rectangle on a two-dimensional graph (Drews & Doig, 2014). We examined whether the configural display can reduce emergency event detection time, improve detection accuracy, and reduce the number of threshold alarms triggered during patient monitoring. We also examined the impact of cognitive load on performance.

Methods: The study used a 2 (cognitive load) x 3 (display configuration) x 8 (emergency event) experimental design to examine the speed and accuracy of emergency event detection. Cognitive load was manipulated with an *N*-back task with two levels: $N = 1$ (low) or $N = 2$ (high) load. The display configuration compared detection performance with the configural display, a numerical display, or both. Eight emergency events were tested. Eight undergraduate students at Tennessee State University with normal or corrected to normal vision completed six ten-minute monitoring blocks in which they were asked to monitor the patient vital sign displays in peripheral vision while completing an *N*-back task in central vision. Each block used a combination of one of the two load conditions and one of the three display configurations. All eight emergency events occurred once during each block. Participants were asked to indicate whether any values were close to triggering an alarm, which monitored value was abnormal, and the direction of the abnormality. If a patient's vital sign values exceeded the alarm threshold, an auditory alarm, presented at 60 dB, was triggered.

Results: Results from preliminary data indicated that correct responses to emergency events were faster when the configural display was present (numerical and configural display together: $M = 3.33$ s, 95% C.I. [2.39, 4.27]; configural display only: $M = 3.44$ s, 95% C.I. [2.49, 4.40]) than when it was not (numerical display only: $M = 6.03$ s, 95% C.I. [3.15, 8.90], $F(2,12) = 6.12$, $p = 0.01$, $\eta^2_p = 0.50$). In addition, only 17.1% of correctly-detected emergency events required a triggered threshold alarm when both the configural and numerical display were shown (95% C.I. [2.5%, 31.7%]), in comparison with 28% of emergency events when only the configural display was shown (95% C.I. [14.2%, 41.9%]) and 57.2% when only the numerical display was shown (95% C.I. [28.0%, 86.4%], $F(2,7) = 7.52$, $p = 0.006$, $\eta^2_p = 0.52$).

Conclusion: Configural displays may reduce the time it takes to respond correctly to emergency events, and the combination of data from numerical displays and configural displays may reduce the number of alarms generated during patient care. Configural displays of patient physiological data have the potential to aid in the development of multisensory alarms that speed the detection of patient abnormalities and reduce the number of alarms.

References:

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