Advanced auditory displays and head-mounted displays:
Advantages and disadvantages for monitoring by the distracted anesthesiologist

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Summary

Study tests whether auditory displays and head-mounted displays in combination with standard patient monitoring displays help distracted anesthesiologists detect clinically significant events in simulated patients. Anesthesiologists were more likely to detect clinically significant patient events only when auditory displays were present.

Introduction

Advanced auditory displays for monitoring patient vital signs have been shown to support faster detection of simulated patient events and better timesharing performance[1,2].

Head-mounted displays (HMDs) offer similar advantages to advanced auditory displays, such as faster detection of patient events and less need to rely upon visual scanning[3,4], but they might produce attentional capture and cause events to be overlooked.[5]

We examined the relative effectiveness of advanced auditory displays and HMDs for patient monitoring by anesthesiologists when distracted, and therefore challenged in their ability to maintain situational awareness and preserve patient safety.

Methods

Participants were 16 anesthesiologists at Royal Adelaide Hospital. Participants were given one hour of training in the advanced displays. The auditory displays were respiratory sonification (continuous two-tone auditory display of RR, $ETCO_2$ and V_t) and blood pressure earcons (intermittent musical motifs for SBP and DBP from NIBP cuff). The HMD was the monocular transparent Microvision Nomad™.

All participants served in four 22-minute anesthesia scenarios in a full-scale anesthesia simulator. Scenarios included induction and maintenance. All participants experienced four display conditions in a counterbalanced order that varied across participants:

Visual—Standard visual monitor with variable-tone pulse oximetry.
HMD—Visual plus HMD
Audio—Visual plus advanced auditory displays
Both—Visual plus HMD plus Audio.

Participants supervised the activities of a junior anesthesia colleague while carrying out a reading-based distractor task that oriented them away from the visual monitor (see images). If participants detected an anesthesia event that could harm the simulated patient, they informed their junior colleague verbally, pressed a button on the computer screen, and/or informed a nearby experimenter.

Results

Detections were scored for the three major events of each scenario. Compared with detections in the Visual condition, participants detected significantly more events in the Audio and Both conditions but not in the HMD condition. Questionnaire results indicated that compared with the Visual condition, monitoring was rated easier (7=easiest) in the HMD, Audio and Both conditions.

	Visual	HMD	Audio	Both
Detections	52%	75%	**90%**	**92%**
Rated ease	2.7	**4.7**	**4.3**	**4.8**

Bold *= significantly different from Visual at p<0.05 in Tukey HSD tests*

Participants felt they had been adequately trained prior to the experiment and gave opinions of the new displays.

Discussion

Auditory displays give the distracted anesthesiologist an advantage in maintaining peripheral awareness of a simulated patient's status. The HMD did not strongly improve performance over a conventional visual monitor plus variable-tone pulse oximetry, and it did not give a significant further advantage to monitoring with auditory displays. Participants' strong belief in the ease of monitoring with the HMD by itself was not matched by significantly improved event detection performance with the HMD.

A limitation of the study is that its findings generalise only to extreme cases of anesthesiologist distraction. We are currently investigating other monitoring contexts.

References

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Disclosures

The respiratory sonification used in this study is the subject of US Patent 7070570 (inventors Watson and Sanderson). The blood pressure earcons are the subject of PCT/AU2003/001622 (inventor Watson).