Simulator evaluation of head-mounted displays for patient monitoring

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Aims. We evaluated the effect of head-mounted displays (HMDs) on anesthesiologist detection of moderately unexpected intraoperative events. We tested whether unexpected events are detected later or are more likely to be missed (1) with HMD plus standard monitoring *vs.* with standard monitoring alone and (2) with specific combinations of HMD depth of focus, ongoing task location and event location.

Background. Simulator studies have found that HMDs speed detection of dramatic incidents[1], reduce the need for anesthesiologists to look back towards the monitor[2], and lead to greater confidence of detecting events[3]. However, these studies have not investigated the potential disadvantages of HMDs reported in the aviation literature: reduced unexpected event detection[4] and eye mis-accommodation[5].

Methods. Twelve anesthesiologists from the Royal Adelaide Hospital provided anesthesia in a METI ECS^{TM} simulator with custom extensions[6] while wearing a Microvision Nomad^{TM} HMD. Participants experienced three 35-40 minute scenarios: standard monitoring (control condition), HMD with near focus, HMD with far focus. Eight events per scenario were constructed from combining distance of the anesthesiologist's ongoing task (close, distant) with the location of the event (HMD, anesthesia machine, patient, elsewhere in the OR). Participants' direction of gaze was coded from video data and the proportion of time spent looking towards either the patient or anesthesia machine was calculated. Differences in event detections and head turning were tested for significance using repeated-measures ANOVAs with α=0.05.

Results. Neither HMD usage nor depth of focus affected event detection (p=0.664) or speed (p=0.769). However, event location had a significant effect on event detection (p<0.001) and speed (p<0.001). Participants using the HMD spent more time looking towards the patient and less towards the machine compared to using standard monitoring only (p<0.001). Differences between the near and far focus settings of the HMD were not significant, but 8/12 participants reported preferring the near over the far focus.

Event Location	# Events Detected	Detection Time
HMD	5.8 / 6.0	23.0 s
Machine	4.9 / 6.0	63.5 s
Patient	4.0 / 6.0	90.3 s
OR	3.3 / 6.0	127.9 s

Monitoring Condition	# Events Detected	Detection Time	Proportion of time looking		
			Patient	Machine	Other
Control	6.1 / 8.0	72.8 s	41.3%	30.1%	28.6%
HMD-Near	5.8 / 8.0	77.6 s	47.7%	24.4%	27.9%
HMD-Far	6.2 / 8.0	78.3 s	47.1%	25.6%	27.3%

Conclusions. Event detection times were not reduced by the HMD as in prior studies[1] but were affected by the location of events. We reproduced earlier findings that the HMD allowed participants' to direct their visual attention towards the patient more often[2]. We did not reproduce the disadvantages of HMDs found in aviation[4,5] and found no difference between near and far focus settings. Overall, in the simulated OR there was no clear benefit with the HMD, but also no evidence that deficiencies seen in aviation will occur.

References:

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