Liu, D., Jenkins, S., Sanderson, P.M., Watson, M.O., Russell, W.J., Leane, T., & Krys, A. (in press). Monitoring with head-mounted displays: Performance and safety in a full-scale simulator and part-task trainer. *Anesthesia and Analgesia.*

Monitoring with head-mounted displays: Performance and safety in a full-scale simulator and part-task trainer

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Abstract

Background. Head-mounted displays (HMDs) can help anesthesiologists with intra-operative monitoring by keeping patients' vital signs within view at all times, even while the anesthesiologist is busy performing procedures or unable to see the monitor. The anesthesia literature suggests that there are advantages of HMD use, but research into head-up displays in the cockpit suggests that HMDs may exacerbate inattentional blindness (a tendency for users to miss unexpected but salient events in the field of view) and may introduce perceptual issues relating to focal depth. These issues were investigated in two simulator-based experiments.

Methods. Experiment 1 investigated whether wearing an HMD would affect how quickly anesthesiologists detect events, and whether the focus setting of the HMD (near or far) makes any difference. Twelve anesthesiologists provided anesthesia in three scenarios within a simulated operating theater environment. There were 24 different events that occurred either on the patient monitor or in the operating room.

Experiment 2 investigated whether anesthesiologists physically constrained by performing a procedure would detect patient-related events faster with an HMD than without. Twelve anesthesiologists performed a complex simulated clinical task on a part-task endoscopic dexterity trainer while monitoring the simulated patient's vital signs. All participants experienced four different events within each of two scenarios.

Results. Experiment 1 showed that neither wearing the HMD, nor adjusting the focus setting, reduced participants' ability to detect events (the number of events detected and time to detect events). In general, participants spent more time looking towards the patient and less time towards the anesthesia machine when they wore the HMD than when they used standard monitoring alone. Participants reported that they preferred the near focus setting.

Experiment 2 showed that participants detected two of four events faster, and one event more slowly with the HMD. They turned to look towards the anesthesia machine significantly less often when using the HMD. When using the HMD, participants reported that they were less busy, monitoring was easier, and they believed they were faster at detecting abnormal changes.

Conclusions. The HMD helped anesthesiologists detect events when physically constrained, but not when physically unconstrained. Although there was no conclusive evidence of worsened inattentional blindness, as found in aviation, the perceptual properties of the HMD display appear to influence whether events are detected. Anesthesiologists wearing HMDs should self-adjust the focus to minimize eyestrain and should be aware that some changes may not attract their attention. Future areas of research include developing principles for the design of HMD displays, evaluating other types of HMDs, and evaluating the HMD in clinical contexts.