Editorial

WHY INVESTIGATE VIGILANCE?

Failures of clinical vigilance contribute to a considerable proportion of preventable anesthetic mishaps with substantive negative outcome. Between 2,000 and 6,000 incidences of death or permanent brain damage related to anesthesia occur every year in the United States [1,2]. Many of these are perceived to be preventable. The mortality from these preventable anesthetic mishaps (approximately 1 to 3 deaths per 10,000 anesthetics administered) is more than 100 times greater than the average yearly rate of 125 deaths per 200 billion passenger miles associated with American commercial aviation accidents through 1984 (L. Jones, personal communication, 1985). Based on 1979 statistics, anesthesia is a more frequent killer of Americans than pulmonary tuberculosis, epilepsy, meningitis, multiple sclerosis, viral hepatitis, cerebral palsy, or cystic fibrosis [3].

Holland [4] identified 286 deaths occurring during anesthesia in New South Wales, Australia, in which the anesthetic was somehow responsible for the fatality. He found that in one-third of these cases "inadequate patient observation" could be cited as a contributing factor. Cooper et al [5] recently reported that among 859 "critical incident" reports they collected in an uncontrolled fashion, 69% could be attributed to human error; only 13% were caused by equipment failure. Of the 70 incidents with "substantive negative outcome," 28 (40%) were due to "technical errors," 23 (33%) to "judgmental errors," and 16 (23%) to "monitoring or vigilance errors."

It is clear that clinicians with their unaided senses are far from infallible monitors. Very little information exists on what "vigilance" in the operating room entails and how it influences an anesthesiologist's performance. "Anesthesia vigilance" could be defined as a state of clinical awareness whereby dangerous conditions are anticipated or recognized and promptly corrected. It is preferable to anticipate rather than to react.

Thus the anesthesiologist, with the willing assistance of the engineer, has implemented an array of electronic monitoring instruments and thereby has expected enhanced clinical vigilance. However, some critics of modern monitoring warn that intraoperative electronic instruments and automated alarms can lull clinicians into a false sense of security. These devices, they say, may trick with artifacts, distract with irrelevant data, or rob the anesthetist of the motivation to observe, record, and thus appreciate, clinical data. Recently, for example, Noel [6] decried the development of the computerized anesthesia record because the act of recording clinical information forces the clinician to maintain an awareness of the patient's status, and thus an automated record would "bypass the anesthesiologist, making it easier for essential information to go unrecognized."

To the modern monitoring enthusiast such arguments are as doomed to eventual ridicule as were the statements of an earlier era whose guardians of tradition maintained that street lighting was against divine order, which had ordained the night to be dark, or who railed against travel by motorized means, which would accelerate the human body to entirely unphysiologic and hence dangerous velocities.

Concerns about the drawbacks of electronic monitoring cannot be brushed aside with arguments that progress has always had its foes. Rather, we need studies that demonstrate when instruments may further the care of our patients in the operating room and when they may hinder it. Such studies are difficult.

In this issue Kay and Neal present the results of their attempt to examine one aspect of intraoperative vigilance ("Effect of Automatic Blood Pressure Devices on Vigilance of Anesthesia Residents," p 148). They clamped the tubing connected to the esophageal stethoscope and measured the time required for clinicians to recognize the disappearance of this important auditory information. The authors compared anesthesia residents in a training program in which blood pressure was always taken manually with those in another program in which automated blood pressure devices (ABPDs) were used 90% of the time. They found that among residents with 7 to 12 months of training the time to recognition was significantly longer in the group that predominantly used ABPDs, but there was no significant difference between the two groups among residents with 0 to 6 months or more than 13 months of training. The study, as does any ground-breaking study, raises questions that it cannot answer because, as the authors point out, the number of observations is small and the design is such that no firm conclusions can be drawn.

One must remember that vigilance is a task-specific endeavor largely dependent on training. The two groups may have differed in the way they were taught to rely on esophageal stethoscopes, blood pressure devices, and other monitoring techniques by the faculty from the two separate institutions. The authors recognize that one cannot necessarily extrapolate a decrease in clinical monitoring performance from an increase in time for recognition of esophageal stethoscope failure. The residents using ABPDs could have learned to obtain the information provided by the esophageal stethoscope in other ways (e.g., watching the patient, the electrocardiogram, or the reservoir bag). Nevertheless, the study raises fundamental questions about the disadvantages of automated devices. It focuses on the automated blood pressure monitor, but the authors might as well have chosen any other device that represents automated, electronic monitoring in general.

Thus, despite their study's limitations, the authors should be applauded for their attempt to tackle a crucial new area of anesthesia research. This field of investigation, which one of us (M. W.) has called "anesthesia ergonomics," emphasizes how the interaction between the anesthesiologist and the operating room environment (especially the anesthesia equipment) influences vigilance and monitoring performance. Psychologists have studied vigilance as a theoretical phenomenon for many years, and investigators in many fields outside of medicine, most notably in aviation and aeronautics, have already applied this information to the understanding of performance on a wide range of complex monitoring tasks. Because preventable anesthetic morbidity and mortality impose a large societal cost, these research techniques must now be used to objectively analyze and assess vigilance and monitoring performance in the operating room environment.

Paget et al [7] present an excellent review of some of the information available from basic vigilance research regarding factors that could influence the anesthetist's monitoring performance. They discuss the effects of time-sharing; signal frequency, strength, and mode of presentation; noise; environmental pollution; and sleep deprivation. Probably the most comprehensive study to date that effectively uses these ergonomic techniques was published by Boquet et al [8]. They filmed the actions of anesthetists at work and measured, with an oculometer, where the anesthetists were looking at any instant. They analyzed 16 hours of film and, breaking down the anesthetic activities into discrete components, examined the frequency and duration of 24 visual and 31 manual tasks. They found that 60% of the visual activity was spent on either the patient or the surgical field; only 10% was spent looking at the reservoir bag, and less than 5% was spent on the monitors. Seventy-two percent of the manual activity was "idle" time, and only 6% was spent actually making contact with the patient or writing on the anesthetic record. Manually taking a blood pressure averaged 16 seconds, chart work averaged 12 seconds, watching the surgical field took 10 seconds, and most other activities, including looking at the monitors, took 3 to 8 seconds.

More investigators must tread the path laid by these pioneering studies. Clinicians and engineers are invited to think about the complex system in which anesthesiologists care for their patients. We suggest that future anesthesia ergonomic studies use proven human factors techniques to produce objective and reproducible results.

Little emphasis has been placed on funding research that might reduce anesthetic morbidity and mortality. At the same time, hundreds of millions of dollars are

spent yearly on aviation safety and on research into the cause and treatment of disease processes that may impose a lower overall cost on American society than does the occurrence of preventable anesthetic mishaps.

A better understanding of anesthetic vigilance and intraoperative monitoring performance will lead to improvements in clinical practice. We must define not only the difficulties that excellent equipment design can overcome but also the problems that appropriate user education can solve. Research directed toward decreasing the incidence of anesthetic mishaps should be a high priority. We owe it to our patients.

J. S. Gravenstein, MD
Editor

Matthew B. Weinger, MD
Department of Anesthesiology
University of California, San Diego
San Diego, CA 92093

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