

An Ounce of Prevention May Equate to a Pound of Cure

Can Early Detection and Intervention Prevent Adverse Events?

NO matter what the disease process, intervention, or physical status of a patient, the operating suite and intensive care unit (ICU) are the safest places in most hospitals. Each of these environments has a high ratio of clinicians per patient, and these providers have high-density clinical data that are provided in near real time, because of the ability to monitor many vital physiologic functions. However, because patients are getting older, heavier, have more comorbidities, and have expectations for no recall and minimal pain after any procedures, they still have risk of dying or developing complications. In this issue, Taenzer *et al.*¹ study the effects of implementing a pulse oximetry patient surveillance system on a postoperative orthopedic surgical ward as a first step to introduce a more continual physiologic monitoring to a traditional hospital floor (*i.e.*, nonmonitored unit). Early intervention guided by this system reduced the need for patient rescue interventions, including ICU transfers. These results could have important implications for hospital wards throughout the country.

Few monitors that have become major components of routine practice have undergone rigorous study to prove effectiveness. Studies of pulse oximetry in more than 20,000 patients did not show differences in outcome when it was used as a monitor during anesthesia.² Despite studies like this, we have used continuous pulse oximetry for every anesthetic and monitoring every ICU patient since the late 1980s. Attempts to demonstrate clinical utility of pulse oximetry in postoperative patients have also been unsuccessful. A 2003 review article of perioperative pulse oximetry concluded that studies of perioperative monitoring with pulse oximetry were not able to show an improvement in various outcomes.³ Because of the lack of scientific evidence as well as the economic implications, intensive monitoring on most hospital wards remains the recording of vital signs every 2 h. Many things can happen to the average postsurgical patient in a 2-h window; for example, a patient who is receiving narcotics and who has a high body mass index and sleep apnea. It has been well documented that these patients are at significantly higher risk for perioperative complications.⁴ The multimillion dollar question remains whether

the introduction of continuous monitoring can improve the quality of care in traditionally unmonitored settings.

A common economic principal is utilization of technology to amplify human capital. In most medical service sectors, personnel costs account for a majority of expense, not uncommonly greater than two-third the budget of the average medical center. The safest way to monitor and treat a patient during the postoperative period would be one-on-one care, analogous to the operating room, but the cost would be prohibitive. A recent high-profile death involving propofol infused in an unmonitored home environment implies that even individualized care will fail. While a hospital ward may seem a far cry from a propofol infusion administered in a private home, the monitoring in each of these situations is more analogous than what happens in any operating room or ICU. Why should we expect different outcomes?

An ideal monitor for patients at risk on the hospital floors has been a hot topic for years. The vital signs ordered every 2 h, 4 h, or each shift is an ineffective way to monitor patients and prevent adverse outcome, as repeated sentinel events demonstrate. The literature and each of our own clinical experiences have examples of physicians on rounds, or nurses coming in to check patients who have been dead for hours. So what is the ideal early warning monitor, with the acceptable rate of false alarms that will allow us to make clinically relevant improvements in postoperative outcomes? Our understanding of physiology reveals that oxygen desaturation is a late sign of a deteriorating clinical situation. Circulation failure, apnea, or other catastrophic events might imply that 12-lead electrocardiographic, end-tidal carbon dioxide, breath sound monitoring, or combinations of these with pulse oximetry could lead us to the promised monitoring Nirvana. Unfortunately, this level of monitoring for every postoperative patient is economically impractical with the currently available technology and may have adverse clinical implications (immobilization with monitors contributing to muscle wasting, venous stasis, or pneumonia). Regardless of what we monitor, we must develop systems for how to pro-

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cess this new information and how to respond to improve clinical outcomes.

Taenzer *et al.* show that a system that electronically analyzes pulse oximetry data of postoperative orthopedic patients and triggers communication with the patient's nurse when predetermined physiologic limits are violated is associated with significant reduction in rescue events and ICU admissions. The investigators choose rather a low oxygen saturation trigger of less than 80%, which could be further lowered, and a 30-s time delay to decrease the incidence of false alarms. From the perspective of physicians who work in the operating suite and ICU, these alarm parameters are disturbing. However, the implications of false alarms have been well documented. Alarms that are 90% accurate are usually acted upon, whereas those that are only 10% accurate are ignored.⁵ In an ICU setting, alarms are less than 1% accurate.⁶ When seen from this perspective, the decision of the investigators to only trigger an alarm when there was little ambiguity that an intervention was necessary assured response on the part of the clinical staff.

The implications of this study are broad. The introduction of pulse oximetry and other monitors into the postoperative environment has not, in the past, been successful. The importance of the Dartmouth study is introduction of a rudimentary electronic decision support system to a traditionally unmonitored ward and its associated results. We believe that Taenzer *et al.* have shown us a glimpse of the future. Not only will such systems allow us to improve the quality of care of our patients, but will also be a key to lowering costs. As this technology improves, as algorithms are refined, and as mul-

timodal analysis is introduced, we will be able to care for more patients with fewer clinicians. These systems will be able to filter those patients who require our intervention from those who do not. Lowering the rate of unnecessary interventions and complications and increasing the productivity of clinicians will be the key elements of future medical care.

John P. Abenstein, M.S.E.E., M.D., Bradly J. Narr, M.D., Department of Anesthesiology, College of Medicine, Mayo Clinic, Rochester, Minnesota. narr.bradly@mayo.edu

References

1. Taenzer AH, Pyke JB, McGrath SP, Blike GT: Impact of pulse oximetry surveillance on rescue events and intensive care unit transfers: A before-and-after concurrence study. *ANESTHESIOLOGY* 2010; 112:282-7
2. Moller JT, Johannessen NW, Espersen K, Ravlo O, Pedersen BD, Jensen PF, Rasmussen NH, Rasmussen LS, Pedersen T, Cooper JB, Gravenstein JS, Chraemmer-Jorgensen B, Djernes M, Wiberg-Jorgensen F, Heslet L, Johansen SH: Randomized evaluation of pulse oximetry in 20,802 patients. II. Perioperative events and postoperative complications. *ANESTHESIOLOGY* 1993; 78:445-53
3. Pedersen T, Moller AM, Pedersen BD: Pulse oximetry for perioperative monitoring: Systematic review of randomized, controlled trials. *Anesth Analg* 2003; 96:426-31
4. Gali B, Whalen FX, Schroeder DR, Gay PC, Plevak DJ: Identification of patients at risk for postoperative respiratory complications using a preoperative obstructive sleep apnea screening tool and postanesthesia care assessment. *ANESTHESIOLOGY* 2009; 110:869-77
5. Bliss JP, Dunn MC: Behavioural implications of alarm mistrust as a function of task workload. *Ergonomics* 2000; 43:1283-300
6. O'Carroll TM: Survey of alarms in an intensive therapy unit. *Anaesthesia* 1986; 41:742-4