Guest Editorial

Enhanced monitoring for postoperative hospital wards – Evidence to implementation

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Anaesthesiologists have incessantly emphasised patient safety and we have made significant strides to ensure it, particularly intraoperatively, despite the upsurge in patients with multiple comorbidities. However, postoperative adverse events are still common, accounting for approximately 7.7% of global deaths annually, with three leading causes – major bleeding, myocardial injury after noncardiac surgery (MINS) and sepsis – being collectively responsible for about half of them.[1,2] Most cases of MINS (like silent myocardial infarction) occur in the first three postoperative days and have a strong association with hypotension.[3-5] About half of all adverse postoperative events in hospitalised patients occur in hospital wards and are responsible for more than 85% of all postoperative mortality.[6,7]

Most patients who suffer an in-hospital cardiopulmonary arrest have aberrations in one or more vital signs during the few hours leading up to the event, with a higher risk of mortality with increasing numbers of pre-arrest vital sign abnormalities.[6] A global practice is spot checking the vital signs of ward patients every 4–12 h which is distinctly different from the highly monitored intensive care unit (ICU) environment.[8] These subjective measurements are prone to inaccuracies and they frequently miss respiratory and haemodynamic perturbations and prevent learning from recorded patterns.[9-13] A delay of a mere 15 min in recognising deterioration increases the risk of adverse outcomes.[14] Automated and continuous monitoring with wearable devices circumvents these issues and should be utilised on most if not all patients.[8,15,16]

Postoperative hypotension and respiratory depression are important contributors to the mechanistic of postoperative complications, including MINS and mortality.[5] Approximately half of the episodes of mean arterial pressures below 65 mmHg are missed during intermittent monitoring, while over 90% of desaturation episodes are overlooked using routine measurements.[5,10,13,17] About half of all patients receiving opioids postoperatively experience at least one episode of opioid-induced respiratory depression (OIRD) detected by continuous monitoring, about one in five suffer from desaturation of less than 90% each hour, and approximately 40% of patients suffering acute respiratory events die.[11,18-21] Risk prediction models suggest that older male patients with heart failure and sleep-disordered breathing are at a notably increased risk of OIRD.[18] Notably, a significant proportion of OIRD occurs about 2 h after the last intermittent check, and all of these are largely preventable with education and improved monitoring.[20] Current evidence relevant to patient-centric outcomes, limited to retrospective or before–after type studies, suggests a reduction in the

risk of rapid response calls, rescue events, ICU transfers and cardiorespiratory arrests after the implementation of continuous monitoring.[21-23] These results are promising, but we still need to perform robust and appropriately powered prospective randomised trials to change clinical practice.

Major implementation challenges to continuous ward monitoring include alarm fatigue, data and connectivity issues and lack of cost-benefit data.[8] At Wake Forest University Medical Center, we successfully implemented continuous ward monitoring about eight years ago using a wireless, wearable device that captured vital signs, including heart rate, respiratory rate, oxygen saturation, blood pressure, atrial fibrillation, mobility or posture and body temperature every 15 s. Large display screens and central monitors project data and trends continuously in the hallways of these monitored wards [Figure 1]. We utilise this continuous monitoring system on about 80% of all hospitalised ward patients in our 900-bedded university hospital. Large volumes of data flow from patient monitors to a local data server and then to a cloud-based device server for future retrieval and analysis as needed. The clinical workflow is set up in a manner where alarm thresholds are set up for maximum specificity and minimisation of false alerts. Alarm alerts go to the individual nurse taking care of a patient and escalate to all unit nurses and nurse managers in case of a response failure at each level. A study at Wake Forest comparing post-implementation data with a pre-implementation historical cohort showed a decrease in rapid response call frequency, which was statistically significant.[24] These results align with the finding of reductions in ICU transfers and rapid response calls reported in a large hospital system in the UK that used the same technology as ours.[25] Using our dataset of 34,636 patients, when contemporaneous propensity-matched intermittent spot checks were compared with continuously monitored postoperative patients, the latter group had a significantly lower likelihood of ICU transfer or death during hospitalisation, along with a reduction in heart failure, myocardial infarction and kidney injury.[25] Preliminary data from a cluster randomised trial performed at our centre also suggests a decreased risk of vital sign derangements in continuously monitored patients. (NCT04574908, clinical trials.gov). Although often overlooked, monitoring of mobility is now widely recognised in improving recovery. At Wake Forest, accelerometers were used to track mobility by detecting postural changes. We found a significant association between increased mobilisation (each 4-min increase) and improved outcomes, including reduced risk of a composite of complications (myocardial injury, ileus, stroke, venous thromboembolism, pulmonary complications, all-cause in-hospital mortality) and hospital length of stay.[26]

Figure 1: Continuous ward monitoring showing vital signs displayed every 15 s at the Wake Forest University Medical Center hospital units (Sotera Wireless, San Diego, CA, USA). Each horizontal bar shows a patient's bed with vital signs. Vitals are displayed every 15 s, including heart rate, continuous non-invasive blood pressure, respiratory rate, oxygen saturation, temperature, body posture, device battery life and identifier. The insert is a single patient's continuous vital signs with waveform data in the bottom panel (single-lead electrocardiogram, plethysmograph and respiratory rate). The vertical bars with numbers beside every vital sign display the maximum and minimum range beyond which the alarms will be triggered. For blood pressure, systolic, mean and diastolic pressures are shown. Note that some of these alarms are turned off to lessen alarm fatigue

To conclude, continuous ward monitoring with wearable devices holds significant promise in improving patient safety and outcomes. Implementation challenges persist but may be overcome with innovative research methodology and appropriate stakeholders to support a change in current monitoring practices.

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