Patient monitoring, wearable devices, and the healthcare information ecosystem

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Summary

Conventional patient vital signs monitoring fails to detect many signs of patient deterioration, including those in the critical postoperative period. Wearable monitors can allow continuous vital signs monitoring, send data wirelessly to the electronic healthcare record, and reduce the number of unplanned admissions to intensive care.

Keywords: big data; cost; patient monitoring; quality and safety; rescue; system redesign; wearable devices

Advances in healthcare technology in recent decades have seen the introduction into patient care of a variety of electronic devices capable of monitoring and recording a greater number of physiological measures than previously possible.¹,²

The article by Eddahchouri and colleagues³ in this issue of the British Journal of Anaesthesia may be seen as another step in this process of technological advancement, namely evidence of the ability of wearable technology to monitor multiple patient vital signs continuously using a small noninvasive device linked to each patient’s electronic healthcare record by a wireless network. Conventional patient vital signs monitoring is typically conducted manually by nursing staff at intervals hours apart. Previous studies have shown the benefits of careful vital signs monitoring in order to facilitate early intervention when patient deterioration is detected.⁴,⁶ However, many of these studies used patient surveillance requiring manual observations,⁵ observations taken automatically hours apart,⁴ or observations taken by bulky bedside monitoring devices.⁵ In Eddahchouri and colleagues’ study, a single device worn on the wrist monitored patients’ ventilatory frequency, heart rate, blood pressure, and oxygen saturation at minute intervals, and sent this information continuously to the electronic healthcare record. With the addition of core body temperature entered intermittently by the nurse, an early warning score was automatically calculated and stored in the electronic healthcare record.

During a 2-yr before-and-after study involving 3896 patients, those using the wearable monitor required fewer rapid response team calls (71 vs 107, P=0.022) and fewer unplanned admissions to the ICU (54 vs 84, P=0.029) than those in the conventional monitoring group.³ In addition, such a reduction in unplanned ICU admissions was not seen in other wards in the study hospital using conventional monitoring during the same period. These results indicate that the use of such a wearable monitor allowed more effective early identification of patient deterioration, resulting in a reduced need for ICU admissions. In the longer term these quality improvements would be expected to save costs and lives. Such outcomes are consistent with the Triple Aim of the Institute of Healthcare Improvement: (1) improving the patient experience of care (including quality and satisfaction); (2) improving the health of populations; and (3) reducing the per capita cost of healthcare.⁷

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Costs and benefits

One of the most common objections to the adoption of new technology in healthcare is that of cost. At least to begin with, any new technology is expensive. However, cost objections very often consider only the immediate cost of the new technology, and not the downstream savings from improved care and avoided harm, considerations that are critical to effective system redesign. In addition, hospital budgets are often siloed in the sense that savings across multiple departments stemming from a safety initiative paid for by one are not tracked or cross credited. Decisions made with only a consideration of the immediate cost often seem short-sighted in the longer term, particularly when the cost of a technology decreases rapidly, or the extent of the savings from improved care becomes evident. One thing we have all learnt in the past 20 yr from the major reports by the US Institute of Medicine, the UK Department of Health, and the WHO is that injuring and even killing patients during their care is extraordinarily expensive and unacceptably common.

On postoperative hospital wards, patient vital signs are typically assessed manually by nurses at intervals of 4–8 h, a practice that has changed little in the past century. A recent study in the USA compared conventional postoperative vital signs monitoring conducted manually by nursing staff with readings made by the same wearable monitors as used by Eddahchouri and colleagues on the same patients. Saab and colleagues found that in the 782 study patients, 878 hypotensive episodes and 2893 desaturation episodes were detected by the wearable monitor. However, only 21% of the hypotensive episodes and 18% of the desaturation episodes were likely to have been detected by conventional monitoring because of its relative infrequency. Other evidence suggests that such rates of detection may be even lower when using conventional postoperative vital signs monitoring conducted manually by nursing staff with the same wearable monitors as used by Eddahchouri and colleagues.

The need for improved vital signs monitoring seems obvious, and therefore need continuous vital signs monitoring is itself a big data problem as the risk factors remain poorly understood. Alarm fatigue is a separate and wider problem than postoperative monitoring; sustainable solutions are needed, and work is underway to provide these. For example, current approaches to reduce the number of alarms use a variety of techniques including use of artificial intelligence to filter alarm data, and coordination and prioritisation of alarms at the level of each individual patient, so that each device attached to a patient does not alarm independently.

Wearable monitoring also has applications in other contexts, such as the ability to assist clinicians during telemedicine consultations, something considerably more relevant in a socially distanced world during the COVID-19 pandemic. Given the propensity of electronic devices to become smaller, more powerful, and less expensive, it is not conceivable that in the not-too-distant future wearable patient vital signs monitoring technology could become incorporated into each patient’s hospital identification band, and continuous monitoring could begin at patient admission. The data from the wearable monitors used in Eddahchouri and colleagues’ study migrated wirelessly and continuously to each patient’s electronic healthcare record, and it seems likely that many other forms of data generated by various devices associated with care will soon do the same, creating a kind of healthcare information ecosystem centred on the patient.

What is certain is that given the increased emphasis on patient safety in recent years, considerations of whether a new technology should be introduced into clinical use must not simply consider the immediate cost, but also must carefully consider the potential quality improvements and cost savings from reduced iatrogenic harm. Larger, more robust clinical studies are therefore needed of wearable vital signs monitoring devices in order to better measure quality improvements and cost savings.

Future approaches and big data

More patient monitoring may cause some to worry about worsening the already concerning problem of alarm fatigue in clinical environments. However, in patient vital signs monitoring, no news is not good news. The wholesale entry of computerised devices into healthcare will inevitably lead to more data of all types, but the benefits should far outweigh the disadvantages. With new and more powerful approaches to better understand our patients, tailor their care, and detect unwanted variability in outcome pathways, the era of healthcare big data has finally arrived. For example, determining which patients may be at most risk of postoperative deterioration, and therefore need continuous vital signs monitoring, is itself a big data problem as the risk factors remain poorly understood. Alarm fatigue is a separate and wider problem than postoperative monitoring; sustainable solutions are needed, and work is underway to provide these. For example, current approaches to reduce the number of alarms use a variety of techniques including use of artificial intelligence to filter alarm data, and coordination and prioritisation of alarms

Declarations of interest

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