Whitepaper – Early Detection of Clinical Deterioration: The Critical Role of Continuous Vital Sign Trend Monitoring in Low- to Medium-Acuity Settings

Abstract

Many deteriorating patients on general hospital wards are not identified in time for appropriate escalation of care. Current vital sign monitoring relies on intermittent, manual spot checks every 4–12 hours, leaving extended periods where deterioration can go undetected. Respiratory rate (RR) and heart rate (HR) are among the strongest predictors of clinical deterioration. Continuous remote trend monitoring systems offer a transformative solution by providing automated, objective, and continuous tracking of key vital signs, including RR, HR, and, depending on the device, SpO_2. These systems enable earlier detection of clinical deterioration while reducing nursing workload. In a recent implementation study on a surgical ward at Catharina Hospital Eindhoven, the viQtor wearable was combined with an adapted early warning system. Manual measurements of blood pressure and body temperature were performed only when clinically indicated, allowing nurses to focus on meaningful care without losing control over patient monitoring.

Importance of Early Recognition of Deterioration

Preventable clinical deterioration remains a major concern in general hospital wards. The large European Surgical Outcomes Study, which analyzed 46,539 patients across 498 hospitals in 28 countries, found that 73% of in-hospital deaths occurred on general wards, without patients ever being admitted to an intensive care unit (ICU) (1). This highlights that many deteriorating patients are not identified in time for appropriate escalation of care.

Currently, in general wards, vital signs are typically assessed through intermittent spot checks every 4–12 hours, leaving extended periods where deterioration can go undetected. However, clinical deterioration is rarely sudden, vital signs often become abnormal or show concerning trends for hours before a critical event. For example, in a case-control study of cardiac arrests, the Modified Early Warning Score (MEWS), respiratory rate, and heart rate showed significant changes up to 48 hours prior to cardiac arrest (2). Detecting these early warning signs in time enables timely intervention, which can reduce severe adverse outcomes, and improve patient survival (2-7).

Moreover, intermittent measurements are typically performed manually by healthcare professionals, making them inherently prone to human error. Measuring multiple vital parameters at set intervals is time-consuming and adds to nursing workload, which can lead to delays in assessments. Additionally, these manual checks provide only a snapshot of the patient's condition at a single point in time. As a result, important changes or trends in a patient's status may go unnoticed, increasing the risk that clinical deterioration is recognized only after more severe symptoms have developed (8).

Which Vital Signs Indicate Clinical Deterioration?

Among all vital signs, respiratory rate (RR) is the strongest predictor of clinical deterioration, followed by heart rate (HR) (9-11). RR reflects dysfunction across multiple body systems, not only

respiratory, but also cardiovascular and metabolic, making it a sensitive marker for adverse events such as cardiac arrest and unplanned ICU admission (12). Even a slight increase of just three to five breaths per minute above a patient's baseline can indicate early hypoxemia or impending respiratory failure (13).

Despite its clinical importance, RR is often inaccurately measured or entirely missing from patient records. The common method, counting breaths for 15 seconds and multiplying by four, is error-prone, and studies show that nurses frequently 'guesstimate' values as 16 or 20 breaths per minute rather than counting precisely (9, 14). At Amsterdam Medical Center, research showed that RR was recorded in only 23% of cases in the 48 hours preceding a life-threatening event (15). This inconsistency delays recognition of deterioration, underlining the urgent need for more accurate, continuous, and automated RR monitoring.

HR is the second most predictive vital sign for identifying clinical deterioration (9-11). Tachycardia is a frequent trigger for rapid response team activations in general wards (11) and correlates with higher rates of unplanned acute care admissions and mortality (16). In acutely ill patients, elevated HR has been linked to fever (17), while in septic patients, it serves as a strong predictor of death (18).

Oxygen saturation (SpO_2) is another critical marker of physical instability. Hypoxemia (SpO_2<90%) not only impairs wound healing but also increases the risk of serious complications, such as brain dysfunction (19), arrhythmias (20), and myocardial ischemia (21). However, intermittent spot-checks of SpO_2 have serious limitations. Research has shown that up to 80% of desaturation episodes go undetected with routine spot checks on general wards (22). Many patients with abnormal breathing at rest or during sleep may appear to have normal or near-normal SpO_2 levels when aroused for measurement. Additionally, nurses may unintentionally skew results by encouraging deep breathing before documenting readings, masking true hypoxemic status (23).

These limitations are underscored by recent findings: in a study of 500 postoperative patients, 96% experienced at least one desaturation episode (SpO_2 <90%), with 25% showing prolonged hypoxemia lasting an average of 15 minutes per hour (24). Similarly, the VISION study reported that 37% of 833 non-cardiac surgical patients had postoperative hypoxemia for at least one hour, yet nurses rarely identified these events during routine checks. Together, these findings highlight how intermittent SpO_2 monitoring fails to capture the frequency and severity of desaturation events, delaying recognition and timely intervention (23).

Continuous Remote Trend Monitoring Systems as a Solution

Continuous remote trend monitoring systems are emerging as a transformative solution to overcome the limitations of traditional intermittent spot checks (8, 10, 25). These systems enable automated, objective, and continuous trend monitoring of vital signs, allowing clinicians to detect vital sign alterations early, before they escalate into emergencies (26, 27). In addition to improving patient safety, these systems can reduce the workload for nurses and support more efficient care delivery. This, in turn, can help lower healthcare costs by minimizing complications, avoiding escalations of care, and improving overall efficiency (7).

Implementation of Continuous Trend Monitoring on the General Ward

Currently, intermittent spot checks typically include HR, RR, SpO_2, blood pressure (BP), and body temperature. These manual measurements are combined into an overall Early Warning Score (EWS). The implementation of continuous remote trend monitoring systems requires a shift in both mindset and workflow. While not all parameters included in standard EWS are measured by continuous remote trend monitoring systems, key predictors such as RR, HR, and, depending on the device, SpO_2 are continuously monitored. Importantly, the availability of continuous trend data of these key vital signs may reduce the need for routine measurements of BP and body temperature, without compromising patient safety.

In a recent implementation study on a surgical ward at Catharina Hospital Eindhoven, this targeted approach was put into practice using the viQtor wearable monitoring device (28). An adapted EWS based solely on HR, RR, and SpO_2 was used, while body temperature and BP were measured only when clinically indicated, such as when deterioration was detected or based on the nurse's clinical judgement. Although final results from the study are still being analyzed, early feedback from nurses has been highly positive. They reported saving valuable time, especially during morning rounds, without feeling loss of control over patient monitoring, allowing them to provide more efficient and meaningful care.

Conclusions

Early recognition of clinical deterioration in low- to medium acuity settings is essential for improving patient outcomes. Although RR and HR are the most predictive indicators of deterioration, they remain underutilized due to the limitations intermittent, manual spot checks.

Continuous remote trend monitoring systems offer a practical solution to this challenge. By providing automated, objective, and continuous tracking of vital signs, these systems generate trend data that cannot be captured with only a few manual measurements per day. Even when monitoring a limited set of key vital signs, emerging evidence suggests this can be sufficient to detect clinical deterioration earlier than with manual spot checks. Such systems not only enable earlier timely interventions but also reduce workload on nursing staff and support more efficient care delivery.

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