Vital signs monitoring to detect patient deterioration: An integrative literature review

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Vital signs monitoring is an important nursing assessment. Yet, nurses seem to be doing it as part of a routine and often overlooking their significance in detecting patient deterioration. An integrative literature review was conducted to explore factors surrounding ward nursing practice of vital signs monitoring in detecting and reporting deterioration. Twenty papers were included. The structural component of a Nursing Role Effectiveness Model framework, which comprises of patient, nurse and organizational variables, was used to synthesize the review. Patient variables include signs of deterioration displayed by patients which include physical cues and abnormal vital signs. Nursing variables include clinical knowledge, roles and responsibilities, and reporting of deteriorating vital signs. Organizational variables include heavy workload, technology, and observation chart design. This review has highlighted current nursing practice in vital signs monitoring. A myriad of factors were found to surround ward practice of vital signs monitoring in detecting and reporting deterioration.

Key words: adverse events, failure to rescue, physiological deterioration, vital signs.

INTRODUCTION

Vital signs monitoring is an integral component of nursing care. Nurses are taught in school that blood pressure (BP), temperature, heart rate (HR), oxygen saturation (SpO2) and respiratory rate (RR) are crucial in reflecting a patient’s current medical status, and must be assessed consistently and accurately documented. These parameters should be the most reliable information in a patient’s chart. However, many studies highlighted that vital signs are not regularly measured, documented or interpreted in the wards. This hinders timely recognition of clinical deterioration leading to subsequent adverse events occurring in general wards which include mortality, unplanned intensive care unit (ICU) admissions, and cardiopulmonary arrests. Notably, 84% of hospital cardiopulmonary arrests were found to be potentially
such distressing result was repeatedly echoed in many studies that revealed the delay in detecting and responding to patients’ deterioration in general wards setting.\textsuperscript{3,4,7} Vital signs often provide the first indication of abnormal physiological body changes.\textsuperscript{8} Despite their importance in communicating deterioration, the act of vital signs monitoring by nurses seems to have disintegrated into a routine chore with little emphasis placed on the significance of the results. Serious concerns on incomplete and infrequent monitoring on general wards leading to delayed detection of deterioration have been raised. Currently there are inadequate studies addressing nurses’ failure to reliably assess, document and interpret vital signs.\textsuperscript{9} Through the process of integrative literature review, the aim of this paper is to explore factors surrounding nursing practice of vital signs monitoring in detecting and reporting deterioration in general ward settings. Whittemore and Knafl described integrative literature review as an approach that allows the inclusion of diverse methodologies to provide a more comprehensive understanding of a particular topic of interest.\textsuperscript{10} By describing what we know about current nursing practice in vital signs monitoring, one can gain a deeper understanding of the context within which ward nurses function and identify factors that may hamper effective monitoring practice in general ward settings.

**METHOD**

A search was conducted between 1990 to November 2012. The year 1990 was chosen as the cut-off date as this marked the publication year of the first study outlining concept of suboptimal care by Schein et al.\textsuperscript{6} Three broad search categories were developed: vital signs, deterioration and general ward patients. Keyword search was used. Search terms were used singly or in combination. All identified abstracts were assessed and the full report was retrieved for those that appeared to meet the inclusion criteria. The references of all retrieved papers were checked for additional studies. The search process and outcome were illustrated in Figure 1.

**RESULTS**

The literature reviewed was synthesized based on the structural components of a Nursing Role Effectiveness Model framework. The model was developed by Irvine et al.\textsuperscript{11} to guide the assessment of nurses’ contribution to health care. The model was based on the structure-process-outcome model of quality care. The structural component, comprising of patient, nurse and organizational variables, can influence the process of nursing care being delivered, and in turn affect patient outcomes. The process component of the model consists of the independent, dependent, and interdependent role functions of nurses. The outcome component includes the patients’ health status.\textsuperscript{11} The application of these components allowed a clearer connection between the nurse’s role in vital signs monitoring in detecting and reporting deterioration (process) to effectively prevent an adverse event (outcome). The three structural components (patient, nursing and organization variables), which were expected to influence nurses’ role performances, were used as an analytical framework to synthesize and discuss the review findings.

**Patient variables**

Patient variables in this context refer to the signs of deterioration displayed by the patient. From the reviewed literature, these signs were classified into physical cues and abnormal vital signs.

*Physical cues as early signs of deterioration*

Physical cues of deterioration, such as noisy breathing and agitation, altered skin colour, clammy to touch, and verbalization of feeling unwell, could be detected through physical assessment.\textsuperscript{12,13} These cues are often displayed in patients during the early compensatory period of deterioration, where deviations from baseline vital signs may not be prominent. It is therefore crucial for nurses to recognize these early cues and act on them before patients become clinically compromised and develop vital signs abnormalities in the decompensating stage.\textsuperscript{12} However, the ability to undertake physical assessment to assess changes in patient’s health status was reported by both the quantitative and qualitative studies to be lacking in the non-registered nursing staff.\textsuperscript{11–15}

*Vitals signs to confirm deterioration*

Changes in vital signs are important to the recognition of deteriorating patients as they helped nurses to confirm or quantify their suspicions of deterioration.\textsuperscript{13–16} Evidence from quantitative studies indicated that vital signs abnormalities occur in patients multiple hours preceding deterioration. Altered RR was regarded as the most
significant predictor of deterioration.\textsuperscript{17–19} Buist \textit{et al.}\textsuperscript{18} found bradypnoea (< 6 breaths/min) to be the strongest predictor for adverse event. In contrast, tachypnoea was reported to be the strongest predictor in the other two reviewed papers.\textsuperscript{17,19}

The different outcome measurement employed by the reviewed studies could be a possible reason for the inconsistent value of RR indicator as a predictor of adverse event. While Buist \textit{et al.}\textsuperscript{18} used mortality as the outcome measure, Fieselmann \textit{et al.}\textsuperscript{17} measured cardio-pulmonary arrest. Fagan \textit{et al.}\textsuperscript{19} employed both of these outcome measures in addition to unexpected ICU transfers. Although RR was commonly found to be the most significant predictor of deterioration, the other vital signs are equally important too. This was highlighted by Buist \textit{et al.}\textsuperscript{18} who demonstrated that each additional abnormal vital sign was associated with an increase in mortality risk.

\textbf{Nurse variables}

Three characteristics of the nursing staff were identified as factors affecting the practice of vital signs monitoring in detecting and reporting deterioration on general wards. These include clinical knowledge, roles and responsibilities, and reporting of deteriorating vital signs.

\textit{Clinical knowledge}

Nurses need to have the clinical knowledge to interpret abnormal vital signs accurately in order to detect deterioration early. There were evidences derived from quantitative studies indicating that nurses were unable to recognize or unaware of clinical deterioration. De Meester \textit{et al.}\textsuperscript{4} found that nurses could have reported their concerns for abnormal vital signs relatively late in deteriorating situations. This result is congruent with an earlier study conducted by Fuhrmann \textit{et al.}\textsuperscript{2} on 877 patients in a teaching hospital. In spite of abnormal vital signs being displayed in

\textbf{Figure 1.} Flowchart describing details of literature search.
one-fifth of the patients, the nurses in the study were unaware of these abnormal findings in more than half the cases.\textsuperscript{2}

Additionally, there seems to be a disparity on the level of importance placed on the different vital signs among nurses. The RR, although being known to be a significant predictor of deterioration, was highlighted by the reviewed studies to be largely underemphasized by nurses. RR was consistently found to be the most frequently omitted vital sign as reflected by a lack in documentation in many studies.\textsuperscript{1-5} In contrast to RR, BP, temperature, and HR were reported to be the most diligently recorded parameters.\textsuperscript{3,5} A mixed method study by De Meester \textit{et al}.\textsuperscript{4} did a retrospective review of 63 patient records revealed a total absence of RR documentation in all of the patients’ charts within eight hours preceding their adverse event. Although RR has been frequently termed the neglected vital sign,\textsuperscript{20} the reason behind this was unclear. It was suggested from a qualitative study that nurses may view pulse oximetry as a substitute for RR monitoring.\textsuperscript{14} Another possible reason could be due to a lack of RR monitoring equipment.\textsuperscript{14}

\textbf{Roles and responsibilities}

With the expansion of the role of registered nurses (RNs), vital signs monitoring is increasingly being delegated to the non-registered staff.\textsuperscript{13-15} However, concerns with regard to their ability to recognize clinical deterioration have been raised. Although they are trained to perform vital signs monitoring, they may not be trained to interpret the assessment findings.\textsuperscript{14} It was highlighted from two qualitative studies that the competence of healthcare assistants in identifying deteriorating patients when carrying out vital signs monitoring remains uncertain.\textsuperscript{14,15} This may suggest that the delegation of this task could be given without assurance of the ability of non-registered staff to recognize clinical deterioration.\textsuperscript{15} Although the role of vital signs monitoring may fall on the non-registered staff, there is a general consensus that the role of the responder to deteriorating vital signs should fall within the domain of responsibility of the RNs.\textsuperscript{14,15}

\textbf{Reporting of deteriorating vital signs}

When deteriorating cues are picked up, credible evidence of physiological decline must be reported for appropriate actions to be taken. Vital signs are known to make a convincing and effective referral language as they are quantifiable and unambiguous.\textsuperscript{16} Although the necessity of presenting factual evidence using objective vital signs for quicker medical referrals were recognized by nurses, a qualitative study by Andrew and Waterman\textsuperscript{16} reported that nurses have difficulty in expressing subtle changes in patients. As a result of lack of confidence and experience, nurses often used subjective social language to communicate deterioration.\textsuperscript{16} While more experienced nurses tend to have a higher tendency to employ medical language,\textsuperscript{16} less experienced nurses had negative attitudes towards seeking medical help for fear of looking stupid.\textsuperscript{21} This is worrying as physicians reported that quantifiable evidence is needed for them to prioritize workload as well as to make decision to review the patient promptly.\textsuperscript{16}

\textbf{Organizational variables}

Organizational variables including workload, technology and observational chart design were identified as variables affecting practice of vital signs monitoring in the clinical ward setting.

\textbf{Heavy workload}

The impact of heavy workload has been identified to influence the quality of vital signs monitoring.\textsuperscript{13-15} With a high nurse-patient ratio on general wards, nurses reported they are often overwhelmed with the excessive workload to fit in time for the observations.\textsuperscript{14} James \textit{et al}.\textsuperscript{13} reported in a descriptive study that 42\% of the non-qualified staff felt distracted by other patients’ needs within the ward environment. This was in congruence with the observational data gathered in Wheatley’s qualitative study\textsuperscript{15} which showed a surgical nurse being distracted for approximately five times by other patients when taking a patient’s vital signs. Consequently, RR and temperature values were overlooked by the nurse. Conversely, a mixed method study by De Meester \textit{et al}.\textsuperscript{4} did not provide evidence to support the impact of workload on nurses’ compliance with vital signs documentation.

\textbf{Technology}

Technological advances, together with the need for faster assessment, have resulted in an over-reliance on electronic monitoring equipment to acquire vital signs. Electronic vital signs monitoring equipment are usually favoured for their efficiency as they decrease monitoring time. However, the negative impact of technology on patient deterioration was highlighted by two qualitative studies.\textsuperscript{14,15} Electronic vital signs monitoring may
limit nurse’s interaction with the patient and cause opportunities to identify early physical deteriorating cues to be easily missed.\textsuperscript{15} Additionally, current electronic monitoring equipment is unable to pick up a patient’s RR which could be one of the possible reasons for omission of RR assessment by nurses.\textsuperscript{14}

The use of continuous physiological monitoring to replace traditional intermittent manual vital signs recording has been proposed as a strategy for early recognition of abnormal physiological signs among general ward patients. Two randomized controlled trial (RCT) studies conducted to explore the effect of continuous electronic vital signs monitoring on patient outcomes had inconsistent findings. A single-site study conducted by Watkinson et al.\textsuperscript{22} could not identify any significant difference on adverse events between high-risk ward patients in the control arm receiving usual ward care and those receiving continuous vital signs monitoring. Conversely, a larger scale, multi-centre study conducted by Bellomo et al.\textsuperscript{23} found the use of automated electronic vital signs monitors to be significantly associated with quicker acquisition of vital signs, increase in the proportion of rapid response team (RRT) calls activated by respiratory criteria, as well as improved survival rate of patients receiving RRT calls.

A possible reason to explain the inconsistent outcomes could be attributed to the way the electronic vital signs monitors were put to use in the two studies. The electronic physiological monitors used in Watkinson et al.’s study\textsuperscript{22} only displayed patients’ vital signs with no specific responses to abnormalities detected. In contrast, the electronic vital signs monitors used in Bellomo et al.’s study\textsuperscript{23} had an additional advisory function which reflected specific responses to physiological abnormalities. This function could have likely increased nurses’ confidence to seek help from the RRT which consequently contributed to the study’s positive outcome.

Although continuous vital signs monitoring can potentially improve detection of deteriorating vital signs, Gross et al.\textsuperscript{24} and Fagan et al.\textsuperscript{19} were doubtful of the frequency of alarm loads generated and their clinical significance. Gross et al.\textsuperscript{24} found that only 34% and 63% of critical alarms and high-priority alarms respectively were true. Nevertheless, it is generally agreed upon that standard critical care alarm limits are too sensitive for ward patients and could give rise to possible alarm fatigue. This would turn out to be counter-productive as alarm fatigue can desensitize the ward staff to the alarms that are originally intended to safeguard patients.\textsuperscript{24}

**Observation chart design**

Most hospitals rely on observation charts—documents which vital signs are periodically recorded, to alert nurses of impending deterioration. Observation charts are generally designed according to the subjective preference of healthcare professionals (HCPs) at individual institutions causing a lack of standardization.\textsuperscript{25} Three quantitative studies conducted to explore the effect of observation chart design on the ability of ward staff to recognize deterioration supported that well-designed observation charts could assist in optimizing detection of deterioration.\textsuperscript{25–27} Two of the studies measured accuracy and speed of chart users in detecting vital signs abnormalities,\textsuperscript{25,27} whereas the other study measured the completeness of vital signs recording.\textsuperscript{26}

In a study conducted by Preece et al.,\textsuperscript{27} HCPs including nurses committed significantly lesser errors and responded significantly faster when using a newly-designed chart that was developed based on the consideration of a human-factor perspective. However, prior experiences of the HCPs with particular chart designs were not controlled for in the study. Christofidis et al.\textsuperscript{25} continued to explore from Preece et al.‘s study\textsuperscript{27} by controlling for the chart users’ previous experience and arrived at similar results. Putting these findings together, it could be demonstrated that a better-designed replacement chart could yield significantly better performance for the users.

Unlike the previous two studies which explored on competency level of chart users in detecting physiological abnormalities, Cahill et al.\textsuperscript{26} explored on their compliance level in vital signs documentation using a newly-designed observation chart and an educational programme to reinforce correct practices. Findings from Cahill et al.’s study\textsuperscript{26} reflected a highly significant improvement in documentation of individual vital sign—RR, BP, SpO2, HR, as well a complete set of vital signs documentation. These improvements were sustained even three months after intervention. However, it is difficult to determine whether the new observation chart or the education program was the predominant driver for the improvement in documentation as both were implemented concurrently. Notably, the chart design that delivered the best results in all the reviewed studies shared similar features of integrating track-and-trigger systems, presenting observations in graphical form, use of colour-coding and banding to highlight abnormal readings, and situating respiration reading at the front and top of the chart.\textsuperscript{25–27}
DISCUSSION

To the best our knowledge, this is the first review of the literature to assess the existing evidence on factors surrounding nursing practice of vital signs monitoring in detecting deterioration among general wards patients. These factors were discussed using the structural components of the Nursing Role Effectiveness Model which comprise of patient, nurses and organizational variables. Current evidence showed that early signs of deteriorations could be predicted from the patient’s vital signs changes. However, no the study has identified a single overriding vital sign that will predict all deteriorations. Although RR has been termed as the most useful predictor of deterioration, assessment of other vital signs are equally important. There seems to be consensus from existing evidence that the five core vital parameters such as RR, HR, BP, temperature, and SpO2 should always be monitored to identify at-risk ward patients.

The significance of vital signs in detecting deterioration is often overlooked by nurses. Despite the importance of abnormal RR as an early sign of deterioration, there are evidences to suggest that this predictor has been largely underemphasized by nurses. Vital signs monitoring is also often delegated to the non-registered staff but their competence in identifying deterioration remains unknown. There is evidence reporting the inability of non-registered staff to interpret the vital signs reading due to knowledge deficit. With the delegation of vital signs to non-registered staff on the rise, it is crucial for the RNs to be mindful that they are still responsible for the responding of deteriorating vital signs. In addition, effective communication between non-registered staff and RNs to convey patient deterioration is essential for the RNs to seek medical care promptly. Although vital signs serve as objective and convincing evidence for quicker and successful medical referral, the review identified communication problems faced by less experienced nurses when seeking medical help for deteriorating patients.

The reviewed identified three organizational variables, including workload, technology and observational chart designs that affect the nursing practice of vital signs monitoring. Ward nurses are often overwhelmed with heavy workload affecting the quality of vital signs assessment. However, the evidence underpinning the effect of workload on vital signs monitoring remains unclear. More studies can be conducted to explore the impact of workload on nurses’ roles in vital signs monitoring.

Although technology has allowed monitoring to be taken place using electronic vital signs monitors, it appears to compromise the quality of patient assessment. Over-reliance on technology could cause deterioration cues to be missed as nurse-patient interaction is greatly reduced. The review of literature also suggested use of pulse oximetry to be a likely cause of poor RR monitoring as some nurses may regard it as a substitute for RR monitoring. The effect of technology on nurses’ role in vital signs monitoring to detect deterioration needs further exploration. Also, unlike critical care settings, very few studies have evaluated the use of continuous physiological monitoring in general wards.

In reviewing the use of observation chart to assist nurses in detecting physiological abnormalities, it appears that these well-designed charts shared similar features which include integrating track-and-trigger systems, presenting observations in graphical form, using colour-coding and banding to highlight abnormal readings, as well as situating respiration reading at the front and top of the chart. The reviewed literature also identified that a well-designed observation chart design together with proper training can most likely improve the detection of deteriorating vital signs.

There are some limitations to this literature review that need to be addressed. Firstly, although undertaken carefully, there is a possibility that not all relevant literature was identified by the search strategy. Another limitation of this review was the relatively small number of eligible studies that met the inclusion criteria as well as the unexplored possibility that their methodological approaches could have introduced bias.

Clinical deterioration should be identified and managed earlier before it progressed into serious adverse events. Such identification and management depends very much on the role of nurses to perform accurate vital signs monitoring to gather evidences of physiological signs of deterioration. This literature review contributes by identifying the factors that surround this fundamental nursing practice. In doing so, this review has clinical relevance for nurse clinicians and administrators to explore possible interventions to enhance nurses’ role in vital signs monitoring in detecting and reporting deterioration. Future studies can consider exploring on the attitudes of nurses towards vital signs monitoring in detecting and responding to deterioration. This could ultimately improve patient outcomes.
REFERENCES


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APPENDIX
Normal vital sign ranges for the average healthy adult while resting are:

- Blood pressure: 90/60 mm/Hg to 120/80 mm/Hg
- Respiratory rate: 12–20 breaths per minute
- Pulse rate: 60–100 beats per minute
- Temperature: 36°C–37.4°C
- Oxygen saturation: 95–100%

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