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Review Paper

Clinical deterioration of ward patients in the presence of antecedents: A systematic review and narrative synthesis

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ABSTRACT

Aim: The aim of this review was to identify and synthesise published accounts of recognising and responding to patient deterioration in the presence of deterioration antecedents.
Design: The systematic review canvassed four electronic databases/search engines for studies of adult ward patients who had altered physiological parameters before developing major adverse events.
Synthesis Methods: The findings were synthesised using a narrative approach.
Results: Clinical deterioration can be missed by nurses, even with adequate charting. Delays in recognising and responding to patient deterioration remains an international patient safety concern, and strategies to enhance recognition of patient deterioration have not achieved consistent improvements. The lack of significant and sustained improvement through targeted training suggests the problem may be rooted in human behaviour and local ward culture. Nurses play a pivotal role in recognising and responding to patient deterioration; however, patient records do not facilitate tracking of all nurse decisions and actions, and any undocumented care cannot be easily captured by auditing processes.
Conclusion: Failure to recognise clinical deterioration was evident even with adequate charting. It is not clear if nurses do not recognise clinical deterioration because they failed to interpret the signs of deterioration or they made a conscious decision not to escalate based on their clinical judgement or they lacked attention at the time of the event. Whatever the reason, focus is warranted for nurses' decision-making after the recording of clinical deterioration signs and the role of human factors in delayed recognition, before maximum benefit of any strategy can be achieved.

1. Introduction

Clinical deterioration is defined as a serious physiologic disturbance or a sudden worsening of patient physiological condition.[1] Clinical deterioration is generally preceded by physiological changes (so-called antecedents).[1] If nurses recognise and act on antecedents, major adverse events including serious harm or death may be averted.[1] Identification of deteriorating patients is a complex process[2,3,4] Armitage et al[2] and Smith[3] have developed guidelines to help nurses identify and prevent patient deterioration. These models can be used to promote early in-hospital recognition of antecedents.

2. Background

Recognising and responding to patient deterioration is reliant on nurses making pertinent observations,[5] a fundamental role of nurses. It includes recognition, documentation, and

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communication of observations that may be cause for concern immediately or in future.[5] Although reporting change in a patient's condition can be achieved as part of routine observation, clinical deterioration is not always reported and hence, not acted upon.[6] Failure of timely recognition and response to patient deterioration is of concern and has become the subject of a number of international reports.[2,6]

In an effort to improve early recognition of patient deterioration, researchers have investigated failure to recognise and respond to clinical deterioration from different perspectives. In particular, researchers have attempted to identify points of failure to rescue.[7,8] For example, Pool et al.[7] found that most failures were in the observation and recognition stages. A break in the chain between monitoring and recognition of antecedents was identified by Endacott et al.[8] who investigated lapses in the care of patients in declining health. Smith[3] applied 'recognition' at the heart of the "chain of prevention model". Researchers have also studied what constitutes patient monitoring to increase nurses' identification of deteriorating signs with the aim of preventing major adverse events.[9] Vital sign deviations predict risk of deterioration.[9] In response, the concept of "track and trigger" emerged. Track and trigger systems allow identification of patients who are at risk of deterioration early enough for actions to take place.[10] These systems rely on routinely collected patient physiological parameters (tracking), where changes prompt action (triggering). Responses may range from simple action such as increasing observation times to more complex action such as calling a rapid response team and initiating resuscitation. In general, most track and trigger charts were developed to improve recognition and response to patient deterioration. Identification of deteriorating patients includes monitoring of signs that are regularly assessed, such as heart rate, respiratory rate, blood pressure, consciousness, temperature, and oxygen saturation.[10] Each sign score is weighted. However, some charts are complex and include signs that are not routinely assessed.[11]

Although previous reviews have focused on major adverse events,[12] a systematic review of the literature related to patient vital signs, antecedents, and their recognition is lacking. Conducting a systematic review in this area could offer new insights for explaining factors contributing to timely recognition of patient deterioration and, ultimately, improving clinical outcomes.

3. Method

3.1. Aim and design

In this review, we aimed to identify and synthesise evidence on recognising and responding to patient deterioration in the presence of antecedents of deterioration. This was undertaken to uncover areas in which further research is needed.

3.1.1. Review question

What is the best available evidence regarding failure to recognise early, or respond to, adult patients in general wards; who experienced antecedent(s) and developed a major adverse event?

In this review, "antecedent(s)" refers to the physiological abnormalities that precede major adverse events. While major adverse events refer to unintended harm or death arising from medical care, failure to recognise and respond refers to failure to report and/or appreciate patient physiological abnormalities, or criteria for calling a medical emergency team (MET).[13]

The review was conducted in accordance with the systematic review guidelines of the "Centre for Reviews and Dissemination."[14]

3.2. Search methods

A rigorous search was undertaken covering three electronic databases: ScienceDirect, ProQuest, and PubMed and the search engine Google Scholar. The search dates were 2004 to September 2016. Reference lists of relevant articles were also scanned for additional articles. The primary search terms were "deterioration" and "failure to recognise". Each database was searched either using these primary terms, or the terms were modified as necessary to search different databases as follows: ("failure to detect" AND deteriorat* AND delay) AND patient; ("track and trigger" AND deteriorat* AND delay) AND patient; (physiological abnormalities) AND deteriorat*; (physiological abnormalities) AND ALL (deterioration); (failure to detect) AND deteriorat*; "deteriorating patient" AND "Failure to recognise"; "deteriorating patient" AND "failure to rescue"; (Afferent limb failure) AND deteriorat*; "Failure to Rescue" AND Deteriorat* AND (Nursing OR "Care giver"); deteriorat* AND "Failure to manage" AND patient AND Nurs*; "deteriorating patient" AND "Failure to notice"; "deteriorating patient" AND "Failure to report"; "deteriorat* patient" AND antecedent, were exploded.

3.3. Inclusion criteria

Inclusion criteria for the review consisted of peer reviewed studies, published in English, and that measured alteration in the physiologic parameters (antecedents), for adult patients in general wards, who experienced delay in antecedent recognition prior to an adverse event. Either the missed antecedents stood alone as the main findings of the study or as part of the overall findings. Exclusion criteria included studies that were conducted in wards that used particular monitoring equipment to alert staff to patients' vital sign changes with audio and visual alarms —such as continuous or intermittent cardiac monitoring and cardiac telemetry. These kinds of equipment usually include clinical alarms to warn nursing staff of immediate or potential adverse patient conditions. Further, studies reporting physiological abnormalities that preceded a "do not attempt resuscitation" order and expected deaths resulting from a terminal condition were also excluded.

3.4. Search outcomes

As shown in Fig. 1, the literature search resulted in a total of 1704 studies. After removal of duplicate studies, 1553 articles remained. Following screening of titles and abstracts, 1403 were considered not applicable to the review question, and were excluded. Of the 150 remaining, 108 articles were excluded following the application of the inclusion criteria. A further 28 studies were excluded as they lacked sufficient detail. Fourteen studies remained. (See detailed explanation in Fig. 1).

3.5. Quality appraisal

The quality criteria checklist was based on the criteria identified in the Critical Appraisal Skills Programme (CASP).[15] CASP was chosen because it has tools covering a wide range of designs. The appraisal process was independently undertaken by two reviewers who looked for the strengths and weaknesses in the design, validity, and biases associated with each study. In this review the relevant CASP tool was applied to studies based on their design. Any disagreement was resolved by a third reviewer.

The included studies were mainly retrospective and prospective observational design. Prospective design has less measurement error than retrospective design; however, both are at risk of hidden unmeasured confounders and selection bias, which can influence internal validity.[16] The most commonly identified confounders

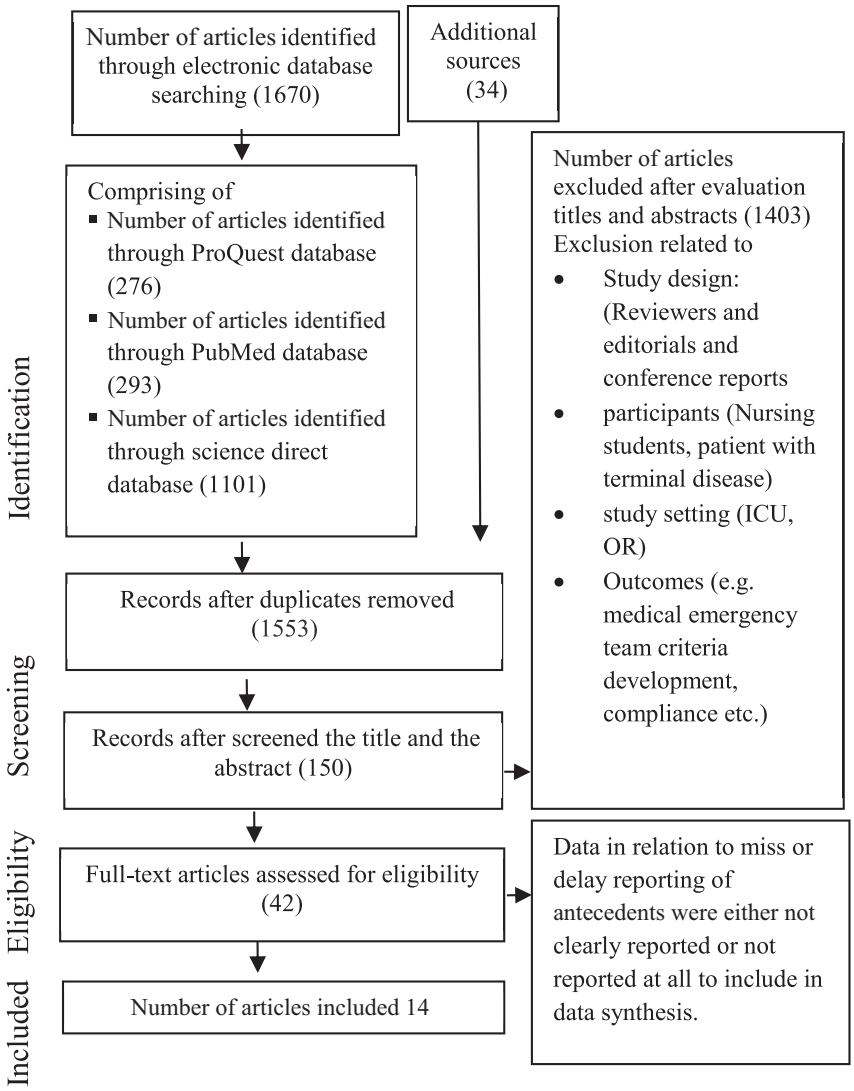

Fig. 1. Flow diagram of the study selection process. ICU = intensive care unit.

potentially influencing the recognition of physiological abnormalities are factors related to the patients, nurses, and the health system.[17] Some authors acknowledged the methodological limitations of their studies. For instance, Makris[18] reported that hidden unmeasured confounders such as change in staffing, bed block, referral patterns, and admission diagnosis, introduced unintended bias in their retrospective case-controlled study. In their randomised prospective controlled trial, Mitchell et al.,[19] indicated that it was difficult to control the number of cases included in the intervention period and the control period due to the unpredictability of hospital admissions. The quality of the mixed-methods studies,[16,17] was assessed using both quantitative and qualitative quality criteria. Since the quality of the included studies was sufficient, no studies were excluded based on their methodological quality. The quality indicators for each study are provided in Tables 1 and 2.

3.6. Data extraction

The quality indicators for the quantitative and qualitative data in mixed-method studies are recorded in Tables 1 and 2. Relevant information from the primary studies was identified, extracted, and is presented in Table 3. Organising relevant data such as time of onset, type of antecedent(s), and how antecedents were communicated, assists in the identification of patterns, and facilitates the next stage of analysis.

3.7. Data analysis

Heterogeneity in study focus and design prevented meta-analysis; however, a Cochrane style narrative synthesis was undertaken[32] Variables were identified in the individual studies and their reported findings. Those variables that have the same pattern were grouped under a specific code. This synthesis technique allows the identification of emerging themes relevant to the problem of failure to recognise and respond to clinical deterioration.[32] However, various findings from one study could come under different themes. The findings were then summarised in a narrative manner. In this review, two broad themes were identified: the first theme is failure due to inadequate charting and second theme is failure with adequate charting. Specific themes which come under failure due to inadequate charting are (1) overall poor vital signs charting and (2) lack of appreciation of some vital signs. Specific themes which come under failure with adequate charting of vital signs are (1) judgemental error, (2) inattention, (3) failure to interpret deterioration signs due to lack of knowledge, (4) delay in communicating of findings, and (5) resistance to intervention.

Table 1
Quality indicators of the quantitative studies.

Author(s)/& origin	Was the study design appropriate to answer the research questions?	Was there a clear focused question for the study to address?	Was the cases allocated appropriately?	Was randomisation for subject selection applied?	Was there appropriate comparison?	Was the analysis sufficiently described?	Were the Likelihood ratio, odds ratio, CI calculated and described?	Were potential confounding factors taken into account?
Kause et al.[22] UK, Australia, New Zealand	Yes	Yes	Yes	No	NA	Yes	NA	Partially
Mitchell et al.[19] Australia	Yes	Yes	Yes	Yes	Yes	Yes	NA	Partially
Trinkle & Flabouris[23] Australia	Yes	Yes	Yes	No	NA	Yes	NA	Not clear
Quach et al.[30] Australia	Yes	Yes	Yes	No	NA	Yes	Yes	Not clear
Ludikhuize et al.[31] The Netherlands	Yes	Yes	Yes	No	NA	Yes	NA	No
Fuhrmann et al.[29] Denmark	Yes	Yes	Yes	No	NA	Yes	NA	Not clear
Meester et al.[20] Belgium	Yes	Yes	Yes	No	NA	Yes	NA	Partially
Nurmi et al.[28] Finland	Yes	Yes	Yes	No	NA	Yes	Yes	Not clear
Adelstein et al.[25] Australia	Yes	Yes	Yes	No	Yes	Yes	NA	Partially
Makris et al.[18] Australia	Yes:	Yes	Yes	No	Yes	Yes	NA	Partially
Pattison & Eastham[21] UK	Yes:	Yes	Yes	No	NA	Yes	NA	Partially
Petersen et al.[26] Denmark	Yes	Yes	Yes	No	NA	Yes	NA	No
Massey et al.[27] Australia	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Boniatti et al.[24] Brazil	Yes	yes	Yes	No	NA	Yes	Yes	No

CI = confidence interval.

Table 2
Quality indicators of the qualitative part of the mixed-method studies.

Author(s) & origin	Was the relationship between the researcher and participant adequately considered?	Was the ethical issue taken into consideration?	Was the analysis rigour?	Did the study clearly state findings?
Meester et al.[20] Belgium	Not clear	Yes	Yes	Partially
Pattison & Eastham[21] UK	Not clear	Yes	Not clear	Yes

4. Results

4.1. Description of the included studies

The fourteen studies included were conducted in seven different countries: Australia (n = 6), Denmark (n = 2), the Netherlands (n = 1), Belgium (n = 1), Finland (n = 1), Brazil (n = 1), UK (n = 1), and New Zealand (n = 1). Failure to recognise antecedents has been found in wards within the same hospital,[4,17,25] nationwide,[15,24] and internationally wide.[18,20,22,23,25,30,31] These studies show that missing the signs preceding adverse events is a global issue. Despite variations in healthcare systems and nursing practice cultures, the results are consistent.

4.2. Type of unrecognised antecedents

Unrecognised antecedents fall into three main categories: cardiac-related signs, respiratory distress–related signs, and neurological-related signs, and all are documented as part of the routine nursing practice of charting patients' vital signs. These antecedents should be easily identified and well-known to all nurses. A significant decrease in blood pressure and alteration in pulse rate, respiratory rate, and oxygen saturation were reported in four studies.[19,27,29–31] A fall in the level of consciousness was reported in four studies.[18,22,25,28] However, a decrease in consciousness level was never identified as a sole sign and mainly appeared as a consequence of respiratory or cardiac distress.

4.3. Development of major adverse events

The review used development of adverse events to assess the process of recognising and responding to clinical deterioration. The fourteen studies reviewed included 1668 patients who suffered major adverse events, whether they had shown antecedents or not.

4.4. Failure to recognise and respond to clinical deterioration

As mentioned previously, two broad themes and specific subthemes were identified from data synthesis. The first broad theme is about failure due to inadequate charting and the second broad theme is about failure with adequate charting.

Table 3
Extracting data from the included studies.

Author(s)	Study purpose	Time of onset of the first antecedent	The nature of the antecedents						Obvious	Communicating the antecedents with other healthcare members	Availability of strategies to enhance recognition	Authors' concerns and recommendations
			Resp Rate	O_2 saturation	Blood Pressure	Heart Rate	Glasgow Coma Scale	Fluid imb.				
Kause et al.[22]	To investigate the incidence of antecedents preceding primary events	24 h before the adverse event			✓		✓		✓	Records showed that doctors were not informed	Not available	• A review of practices of patient observation, documentation, and the response system of hospital professionals to acute medical crises is required.
Mitchell et al.[19]	To determine whether the introduction of a multifaceted intervention to detect clinical deterioration in patients would decrease the rate of predefined adverse outcomes	Not given							✓	No difference in the number of documented communication between nursing staff and medical officers following an episode of clinical instability	An educational package aimed to promote the understanding of physiological principles of vital signs, reasons for measurement, and derangement and providing a structure for succinct communication and initial resuscitation.	• There was still a significant number of episodes when the MET was not activated in the control subgroup and in the intervention subgroup. • The reasons for such failures include cognitive failure, poor priority setting, and the patient being deemed suitable for palliation without appropriate medical orders
Trinkle & Flabouris[23]	To describe failure to call rapid response system (RRS)	8 h prior to the adverse event	✓		✓	✓			✓	Delay in MET call	MET	• It is unclear as to why ward staff chose not to call a MET for any one particular patient despite documenting quite markedly deranged vital signs. • Judgemental error
Quach et al.[20]	To describe the characteristics and outcomes of patients receiving a medical emergency team (MET) review for the MET syndromes of respiratory distress or hypotension and to assess the effect of delayed MET activation on their outcomes	5 to 8 h prior to the adverse event	✓	✓	✓				✓	Not available	MET, protocol call	• A delayed MET activation was more common and the delay longer for patients with respiratory distress. • The reasons for this delay are unknown and cannot be identified in a retrospective study. • Authors highlight the need to optimise the function of the afferent arm of any rapid response system if patient safety is to be ensured. • They also highlight the need for continued education and awareness-raising activity
Ludikhuize et al.[31]	To describe the current practice in measurement and documentation of vital signs and the possible usefulness of the Modified Early Warning Score (MEWS) to identify deteriorating patients on hospital wards	25 h prior the adverse event			✓	✓			✓	Only 12.2% of nurses have worries and concerns	Not available	• In our study, despite the incomplete measurement of vital signs, 81% of deteriorating patients could still be identified early before the event.
Fuhrmann et al.[29]	To estimate the incidence, staff awareness, and subsequent mortality of patients with abnormal vital signs on general wards in a Danish university hospital	Not given	✓	✓	✓				✓	Nursing staff were unaware of all abnormal vital signs in 67 patients (43%). For 20 patients (13%), staff	Not available	• The study's results demonstrated a marked lack of awareness of patients with abnormal vital signs among ward nurses, who were unaware of almost half of the patients with abnormal vital signs.

(*continued on next page*)

Table 3 (*continued*)

Author(s)	Study purpose	Time of onset of the first antecedent	The nature of the antecedents						Obvious	Communicating the antecedents with other healthcare members	Availability of strategies to enhance recognition	Authors' concerns and recommendations
			Resp Rate	O_2 saturation	Blood Pressure	Heart Rate	Glasgow Coma Scale	Fluid imb.				
										were aware of some of the abnormal vital signs		• Strategies to improve identification of patients at risk should be an initial step in preventing serious adverse events in the general wards.
Meester et al.[20]	To investigate the circumstances of nursing care 8 h before serious adverse events (SAEs) on medical and surgical nursing units with subsequent in-hospital mortality in order to identify the extent to which these SAEs were potentially preventable	Not given								Not available	Not available	• Adverse events were considered potentially preventable by expert reviewer examining clinical details of the cases. • Almost two of three nurses stated that they were unaware of their patients' deterioration before the situation became critical the last time they cared for a patient in crisis.
Nurmi et al.[28]	To analyse the effectiveness of observation practice to detect abnormalities in vital signs prior to cardiac arrest	4 h prior the adverse event		✓			✓		✓	13 patients did not receive any intervention (e.g. supplemental oxygen or medication), 8 received intervention within 1 h, and 9 received intervention after more than 1 h.	Not available	• The causes of hospitalisation of the patients who suffered cardiac arrest in the ward were mainly diseases that are not expected to be necessarily fatal. • The interventions prior the adverse events were either insufficient or performed too late.
Adelstein et al.[25]	To evaluate the time taken for delivery of each component of care following patient deterioration and to assess the effect on response times of strategies implemented to improve the system	Not given			✓		✓		✓	Nurses were responsible for the delay in MET call	The hospital implemented an Rapid Response Team system referred to as Pre Arrest Criteria for Escalation system, known more widely in Australia as a MET system	• Factors that contributed to delays were the times for nursing staff to activate a call for help and, where needed, for physicians to activate the ALS team. • Despite education of staff about the clinical signs of deterioration and policies to expedite medical care to a patient observed to have breached these signs, 26% of patients did not receive medical attention within 30 min.
Makris et al.[18]	To identify patient-, intensive care-, and ward-based risk factors for early, unplanned readmission to intensive care unit	Not given	✓	✓			✓		✓	Not available	Not available	• Physiological abnormalities on the ward could predict intensive care readmission; however, clinical response to these changes appear suboptimal.
Pattison & Eastham[21]	To explore referrals to the critical care outreach team, the associated factors around patient management and survival to discharge, and the qualitative exploration of referral characteristics (identifying any areas for service improvement around critical care outreach team). Secondary aims included exploring 3 and 6 month survival, alongside unit and hospital outcome.	Average 3 h			✓	✓	✓	✓		There was a delay between the point at which patients deteriorated (as verified by retrospective record review and MEWS score triggers) and the time at when patients were referred	Modified Early Warning System triggers	• Late referrals maybe related to overconfidence in managing the at-risk patient. Further situational ward factors of ward nurses such as workload affects referrals
Petersen et al.[26]	To evaluate the performance of a new early warning score (EWS) system by reviewing all serious adverse events in	At least 24 h								27 of cases have no documentation that the attending physician	Early Warning System triggers	• There were a concerning number of serious adverse events, and in only 12 events (8%), the escalation protocol was strictly adhered

	our hospital over a 6-month time period.							had been alerted by nursing staff.		• The study has not reported to what extent escalation protocols were followed, and what treatment, if any patients received.
Massey et al.[27]	To identify the relationship between one example of an RRS, specifically an after-hours Clinical Team Co-Coordinator (CTC), and the incidence of MET activations and adverse and major adverse events in medical patients.	Not given	✓		✓	✓	✓	A total of 130 patients exhibited physiological abnormalities that should have activated the MET yet it was only activated five times.	MET	• In this study the MET was clearly underutilised. In the intervention group, 45% of patients met criteria for MET activation and 2.6% had a MET activated • Researches required to better understand how ward nurses accept, implement, and integrate new patient safety initiatives into everyday clinical practice.
Boniatti et al.[24]	To determine whether there was an association between delayed medical emergency team calls and mortality after a medical emergency team review	8 h	✓	✓		✓	✓	Delayed MET calls	MET	• The prevalence of delayed MET calls was 21.4% in our study. • The findings show that afferent limb failure continues to be a serious problem for RRSs, • Identifying the causes of this delay is an important step in the system evaluation process • This suggests that there may be an error of judgement and not simply a failure to identify the problem. • This also suggests that implementing an RRS is not sufficient.

ALS = advanced life support; BP = blood pressure.

4.4.1. Failure due to inadequate charting

Failure due to inadequate charting was captured in two sub-themes: (1) overall poor vital signs charting and (2) lack of appreciation of some observation signs.

Overall poor vital signs charting. A prompt response to a deteriorating patient relies entirely on documentation of the antecedents and the activation of a call for assistance. If documentation of these signs fails, no subsequent intervention occurs. Some studies reported that documentation of vital signs is insufficient.[19,31] Some physiological signs are rarely assessed by nurses in general wards.[28] Further, Fuhrmann et al.[29] stated that the need to assess some vital signs was entirely reliant on nurses' judgement.

Lack of appreciation of some vital signs. Nurses appeared to appreciate some criteria more than others.[25] Signs of respiratory distress such as tachypnoea and bradypnoea are important in determining whether patients require attention.[33] However, respiratory rate is less frequently recorded than blood pressure and pulse rate.[19,25,27,28,30,31] Of particular interest is the delay of an average of 12 h for patients who had respiratory distress–related signs compared to 5 h for patients who had low blood pressure,[30] indicating that respiratory distress–related signs are not appreciated to the same extent. Nurmi et al.[28] stress the importance of teaching nurses and medical staff about assessing respiratory rate and recording this observation.

4.4.2. Failure with adequate charting

Failure with adequate charting was captured in five sub-themes: (1) judgement error; (2) inattention; (3) failure to interpret deterioration signs; (4) delay in communicating of deterioration; and (5) resistance to intervention.

Judgement error. Insufficient nursing intervention including documentation of deterioration signs accounts for most of the delay in the timely management of patients. It is not clear if nurses' in action is because they failed to recognise the signs or they made a conscious decision not to escalate based on their clinical judgement.[18–20,24,31] Unfortunately, insufficient data were provided by all studies to identify the exact nursing strategies or behaviour following the recording of the first antecedents. However, some studies noted that judgement error may explain such delay. Nurmi et al.[28] included nursing notes as a part of their evaluation of the practice of observation to identify patients at risk of deterioration and found that some patients who deteriorated (n = 13) did not receive even a simple intervention such as administering oxygen, and others (n = 8) received a delayed intervention. Nurses were responsible for delays in MET calls after documenting antecedents.[18,25] Mitchell et al.,[19] attributed this delay to nurses' inability to judge and set priorities for patients at risk of deterioration.

Meester et al.[20] revealed that sometimes nurses do more assessments after recording the first deterioration signs to confirm their assumption, which may influence their judgements regarding the timing of referral. Boniatti et al.[24] stated that although the rapid response protocol has been implemented for a long time and nurses are well prepared on how to utilise it, failure of the afferent limb continues to occur. The reasons for such delays are unclear, and the authors stress the need to review nurses' judgement and work to improve nurses' observation and recognition of clinical deterioration. Using the Modified Early Warning Score, Ludikhuize et al.[31] retrospectively calculated the MET call criteria by extracting data from patients' vital signs charts. Although there was incomplete charting of vital signs, 81% of deteriorating patients showed varying levels of instability in their vital signs parameters and could be identified before the development of the subsequent adverse event. Ludikhuize et al.[31] stated that failure to identify such patients reflects a lack in clinical judgement.

Inattention. The clinical changes that appear in patients could identify those who require attention, and nurses' responses to these changes appear to be inadequate.[18] Specific concerns should be documented in nursing notes, and close, frequent monitoring should be undertaken by nurses as a simple strategy after recording abnormalities in patient vital signs charts. Fuhrmann et al.[29] interviewed nurses after patients showed abnormal readings in vital sign charts and found that approximately 43% of the nurses were not aware of changes that occurred in their patients' physiological status, and 13% of the nurses were aware of some antecedents. Meester et al.[20] found that 30% of nurses in their study missed their patients' critical changes. Some researchers consider that it is unclear why some nurses do not activate the call for help, despite documenting significant physiological changes.[23] Makris et al.[18] and Pattison and Eastham.[21] attributed this failure to factors such as the high patient-to-nurse ratios, nurses' workload, and divided attention.

Failure to interpret deterioration signs due to lack of knowledge. Nurses may record some alteration in vital signs; however, no intervention was initiated. This could be due to lack of knowledge of the importance of such signs in identifying clinical deterioration.[27] Makris et al. referred failure to interpret clinical deterioration signs to lack of experience.[18] Some studies recommended further training in interpreting vital signs in hospital nursing practice.[20]

Delay in communicating deterioration. A lack of timely communication of deterioration was identified in most of the studies included. Reviews of records showed that medical officers were not informed by nurses of the changes in patients' conditions.[22,26] Adelstein et al.[25] found that nurses delay communicating their findings to physicians. Nurses prefer to call junior medical staff rather than more senior clinicians.[25] Trinkle and Flabouris[23] investigated afferent limb failure where nurses documented critical physiological changes but failed to act. Trinkle and Flabouris[23] found that antecedents were most likely evident in vital signs charts in the 4-h period before an event developed, causing the authors to question why nurses failed to communicate deterioration, despite documenting markedly abnormal vital signs. Adelstein et al.[25] followed emergency calls initiated by nurses, in an attempt to capture incidents in real time. The time between the appearance of the first antecedent and the call for assistance was calculated for each incident. Adelstein et al.[25] found that about 30% of total incidents did not receive medical attention within 30 minutes of acute deterioration. In a multicentre study, Kause et al.[22] searched all types of patient documents in 90 hospitals in three countries for the recording of antecedents prior to major adverse events such as death, cardiac arrest, and ICU admission. The researchers found that although antecedents were charted during the 24 h prior to major adverse events, the patients experienced delay in or no referral to senior clinicians.

Resistance to intervention. Some of the included studies have utilised track & trigger protocols to improve the recognition of antecedents. Nevertheless, the problem remains. Adelstein et al.[25] assessed the effect of utilising a model for identifying the chain of response time from the onset of antecedents to activation of the call protocol by comparing two periods of time (2005 and 2006) in an attempt to improve response time in reporting antecedents. Adelstein et al.[25] found that nurses were responsible for most of the delay in reporting, as antecedents were initially observed by nurses; however, in 16% of cases in 2005 and 7% of cases in 2006, nurses did not activate the call protocol. This caused the authors to query the reasons for such percentages, despite educating nursing staff about deterioration signs and implementing polices to accelerate medical attention. The authors concluded that such simple strategies are possibly not sufficient to bring about changes in complex nursing practices.

Mitchell et al.[19] conducted a prospective, controlled before-and-after trial to identify whether a multifaceted intervention would improve the detection of clinical deterioration in patients. Their study revealed that although the number of patients being reviewed by METs increased, cases where the MET call was not initiated still occurred.[19] Similarly, Quach et al.[30] investigated the response time between recording antecedents and activation of the MET call protocol, focusing on specific types of physiological criteria that require the call protocol to be initiated: hypotension, tachypnoea, bradypnoea, and desaturation. They found that despite implementing the MET program, 12-hour delays were reported between documenting abnormalities and MET activation. Pattison and Eastham[21] found that in 24% of cases, there was a delay of 3 h on average between the points at which patients deteriorated and when cases were referred to critical care outreach teams.

5. Discussion

Nurses are well placed to identify changes in patients' medical condition and can identify any abnormality in vital signs through routine observation. The review suggests that some antecedents present in patients receive insufficient attention, and nurses are responsible for most of the delay. The review also clearly shows the risks patients face due to missed or delayed recognition of signs of deterioration.

Infrequent recording of vital signs on patient charts is repeatedly cited as a factor affecting timely response to clinical deterioration; however, this review found that this is not an issue in the failure to report deterioration. When recording some signs in patient charts, deterioration can be detected if nurses appreciate the abnormalities in signs, or they may be alert generally, but cannot see what they need to see.

Frequent and intense charting of vital signs does not always guarantee early recognition. Nurses may be familiar with their patients who are at risk of developing adverse events, and they may even start establishing more frequent monitoring of vital signs at regular basis in response, but some of their patients may still develop adverse events. This could be due to lack of concentration and the presence of distractions at the time of the appearance of the first antecedents, particularly in rapidly developing conditions.[34,35] Further, less experienced nurses may lack of knowledge of the importance of some early signs in identifying clinical deterioration. In a study conducted by Mok et al.,[36] nurses were found to perceive blood pressure as the first sign of deterioration, although blood pressure is a relatively late sign generally preceded by compensatory mechanisms of increasing heart and respiratory rates. Therefore, it is not about the frequency of measuring vital signs, it is about paying attention and knowing how to interpret and appreciate them.

Delay in responding may be attributed to the long process of communication.[37] For example, measuring vital signs maybe assigned to, for example, student nurses then referred to a junior registered nurse to review findings for comprehensive assessment. The junior registered nurse may seek advice from a more senior nurse. This long communication process can significantly contribute to the delay in responding with consequential threats to patient safety. Nurses' adherence to patient safety guidelines should be investigated.

Antecedents unrecognised in the current review were mainly hypotension, tachycardia, tachypnoea, bradypnoea, and desaturation, and these signs are taught to junior nursing students and nursing assistants as part of the fundamental training of

observation skills.[38] Nurses rely on these signs to recognise clinical deterioration. However, it is not fully clear why variations in these signs are not translated into action. Vital signs are not the only method nurses use to recognise changes in their patients' condition. The direct care of patients ensures that nurses accumulate knowledge about what is normal for their patient, and any deviation could be considered abnormal and trigger nurses' concerns. Indeed, studies of nurses' recognition of deterioration have shown that they felt that something was wrong with their patients, and this is often the main reason why nurses report concerns.[39] In fact, some studies consider "nurses' worry" as more important than the measurement of vital signs.[39]

Patients' carers may also have a role in identifying clinical deterioration, mediated by knowledge of patient norms.[40] In some situations, carers may identify the deterioration before nurses and other medical staff. It is not clear however if nurses' and family's worries are effective at triggering actions to prevent deterioration. These two areas are worth further investigation as it may contribute significantly towards improving the management of clinical deterioration in healthcare settings.

Nurses may decide not to escalate based on their clinical judgement. Indeed, nurses sometimes make judgement based on existing conditions where vital signs are continually unstable. Nurses also may be worried about making the wrong decision and look for further information to confirm their assumption. In both situations they may spend considerable time processing data until a believable case is built up prior to intervening.[41] Little is known about nurses' decisions at the point of identifying and prior responding. It is not possible to fully explore the process, unless the researcher witnessed the event. Perhaps deep understanding and close evaluation of nurses' decision making, in particular following the recording of antecedents, would inform the development of better measures to overcome the problem.

Misinterpreting important cues may be due to reliance of nurses on electronic monitoring.[42] Indeed, lack of nurses' knowledge of the functional limitations of these machines may contribute to failures of nurses to recognise a deteriorating patient.[42] Further, the design of vital signs chart and how information was displayed were found to have a great impact on the time required for nurses to make a decision about their patient's condition.[43] These factors may cause nurses to misinterpret important cues, which consequently interferes with the tracking aspects of "Track and Trigger Systems".

The presence of the problem internationally and its resistance to intervention through targeted training suggests that it may be rooted in human behaviour and local ward culture, rather than being specific to healthcare delivery.[44] Some reviewed studies attempted to explain failure to recognise antecedents by referring to cognition failure, lack of attention, and lack of awareness. These issues are acknowledged in cognitive psychology as factors contributing to failure in observation.[34,35] However, it appears that these human factors are undervalued in the literature, a different approach may be required to examine the problem. Studies that appreciate the perception and cognition aspects of observation would inform the development of interventions to overcome the problem.

5.1. Implications for research

This review illuminates some gaps in the literature to guide the direction of future research. Although, the importance of understanding nurses' decision-making and nurses' adherence to patient safety guidelines are well established,[45] there are no studies that explore how nurses make decisions about early signs of clinical deterioration, or how this can affect nurses' perceptions of maintaining patient safety. Evaluation of nursing judgement following recording of antecedents would elucidate factors contributing to timely recognition of patient deterioration. Future research is needed to explore these important areas. Human factors were also identified as important in impeding nurses' recognition of patient deterioration. The importance of human factors has been explored in other clinical areas such as medication administration, but research examining the importance in relation to recognising and responding to patient deterioration is lacking.

5.2. Limitations

This review has certain limitations. Since the evidence has been synthesised from retrospective and prospective observational studies, it is weak in the hierarchy of evidence. The primary studies in the current review may not fully represent the review focus, referred in the literature as indirectness.[46] However, indirectness is appropriate in the reviews when the primary studies included have examined a specific topic of interest over time (either retrospectively or prospectively), and the complete coverage of the topic of interest is not well presented.[35] Further, owing to the diversity of the studies, narrative synthesis was the only technique that could be used.

6. Conclusion

Failure to recognise clinical deterioration is multidimensional. It is not clear if failure to recognise clinical deterioration is because of failure of nurses to interpret the signs of deterioration correctly or a lack of attention at the time of the event or a conscious decision not to escalate based on their clinical judgement. Whatever the case, the action could add consequential threats to patient safety. Nurses' adherence to patient safety guidelines should be investigated. Attention must be given to nurses' behaviour and decision-making following the recording of antecedents and the role of human factors in delayed recognition before maximum benefit of any strategy can be achieved.

Ethical statement

Ethical Statement is not applicable in this systematic review

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Contributors

M.Al-M. designed the study, with contributions by S.C., M.S., and V.P. M.A-M., S.C., M.S., and V.P. analysed and interpreted the data, critically revised the article scientific content, and drafted and the revised article. All authors gave final approval of the version to be published.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.aucc.2018.06.004.

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