International Journal of Nursing Studies 151 (2024) 104671

Contents lists available at ScienceDirect

International Journal of Nursing Studies

journal homepage: www.elsevier.com/locate/ns

Improving escalation of deteriorating patients through cognitive task analysis: Understanding differences between work-as-prescribed and work-as-done

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ARTICLE INFO

Article history:
Received 26 May 2023
Received in revised form 1 December 2023
Accepted 4 December 2023
Available online xxxx

Keywords:
Clinical deterioration
Early warning score
Cues
Delivery of healthcare
Communication

ABSTRACT

Background: Appropriate care escalation requires the detection and communication of in-hospital patient deterioration. Although deterioration in the ward environment is common, there continue to be patient deaths where problems escalating care have occurred. Learning from the everyday work of health care professionals (work-as-done) and identifying performance variability may provide a greater understanding of the escalation challenges and how they overcome these. The aims of this study were to i) develop a representative model detailing escalation of care ii) identify performance variability that may negatively or positively affect this process and iii) examine linkages between steps in the escalation process.

Methods: Thirty Applied Cognitive Task Analysis interviews were conducted with clinical experts (>4 years' experience) including Ward Nurses (n = 7), Outreach or Sepsis Nurses (n = 8), Nurse Manager or Consultant (n = 6), Physiotherapists (n = 4), Advanced Practitioners (n = 4), and Doctor (n = 1) from two National Health Service hospitals and analysed using Framework Analysis. Task-related elements of care escalation were identified and represented in a Functional Resonance Analysis Model.

Findings: The NEWS2's clinical escalation response constitutes eight unique tasks and illustrates work-as-prescribed, but our interview data uncovered an additional 24 tasks (n = 32) pertaining to clinical judgement, decisions or processes reflecting work-as-done. Over a quarter of these tasks (9/32, 28 %) were identified by experts as cognitively challenging with a high likelihood of performance variability. Three out of the nine variable tasks were closely coupled and interdependent within the Functional Resonance Analysis Model ('*synthesising data points*', '*making critical decision to escalate*' and '*identifying interim actions*') so representing points of potential escalation failure. Data assimilation from different clinical information systems with poor usability was identified as a key cognitive challenge.

Conclusion: Our data support the emphasis on the need to retain clinical judgement and suggest that future escalation protocols and audit guidance require in-built flexibility, supporting staff to incorporate their expertise of the patient condition and the clinical environment. Improved information systems to synthesise the required data surrounding an unwell patient to reduce staff cognitive load, facilitate decision-making, support the referral process and identify actions are required. Fundamentally, reducing the cognitive load when assimilating core escalation data allows staff to provide better and more creative care.

Study registration (ISRCTN 38850) and ethical approval (REC Ref 20/HRA/3828; CAG-20CAG0106).

What is already known

- The escalation of patients following deterioration remains problematic and improvements are required.

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https://doi.org/10.1016/j.ijnurstu.2023.104671

- Nationally adopted escalation protocols (NEWS2) do not entirely complement the way in which clinical staff escalate care successfully in variable work systems.
- There is a constant realignment between protocol-driven care (work-as-prescribed) and actual delivered care (work-as-done) as standardised processes are often theoretical in their nature and overestimate system stability.

What this paper adds

- Experts identified stark differences between work-as-prescribed (NEWS2 protocols) and work-as-done (everyday escalation tasks) with 28 % (9/32) of escalation tasks described as cognitively difficult.
- Three out of the nine variable tasks ('*making the critical decision to escalate*', '*synthesising all data points*', *and* '*identifying interim actions*') were closely coupled within FRAM Model 2b indicating potential points of weakness in the escalation process.
- The ability to efficiently synthesise data is a central task during escalation, and when effective, allows staff to use creative strategies to manage deterioration.

1. Introduction

Avoidable patient deaths occur in healthcare services worldwide. In the United States, it is estimated that more than 20,000 deaths per year are avoidable (Rodwin et al., 2020). In the United Kingdom, 3 % of deaths are potentially avoidable (Hogan et al., 2012) and failure to detect patient illness is central to many critical events, National Health Service (NHS) review papers (NCEPOD, 2018) and quality improvement approaches (NHS Improvement, 2016).

One in four post-operative patients who deteriorated is usually managed within a ward environment (Mohammed Iddrisu et al., 2018). Swift detection and communication of this deterioration, known as an escalation of care, is essential to improving patient outcomes (Findlay et al., 2012). Vital signs aggregate scoring systems (Early Warning Scores) were developed to quantify vital signs derangement and indicate a patient's risk of a significant event or an unplanned Intensive Care Unit (ICU) admission (Gerry et al., 2017). NEWS2 is a standardised scoring system implemented across the UK NHS (Pimentel et al., 2018; Prytherch et al., 2010), with benefits such as providing clinical decision support, a common language between professions, quantifiable evidence of clinical concern (Ede et al., 2020; Welch et al., 2022) and facilitating health organisations to screen and audit the care of unwell patients (National Health Service, 2022).

There have been slow patient safety improvements to date and the full benefit of NEWS2 may or may not have been actualised as often work-as-prescribed (WAP) differs from actual care delivered (work-as-done) (Sujan et al., 2022). Escalation processes are unlikely to respond to simplistic and reductionist approaches (Sujan et al., 2022) and interventions need to consider the whole system (Carayon et al., 2014) to reduce assumptions about the nature of real work (Clay-Williams et al., 2015). Protocols are often an idealised way in which tasks or process are undertaken, and overestimates the stability of systems and neglects the inherent system challenges (Verhagen et al., 2022). In everyday work, staff consider tradeoffs and workarounds due to competing demands in a resource scarce and dynamic system (Clay-Williams et al., 2019). Initial steps in escalation process redesign, founded on systems thinking, should be understanding how people or organisations adapt to manage complexity, take action and improvise when things go wrong (Lay et al., 2015; Sujan, 2018).

Several human factors methods exist to investigate everyday work to underpin improvements to patient care and assist in identifying key tasks and challenges involved when escalating. Cognitive Task Analysis (CTA) is a collection of methods that help researchers identify cognitive skills needed to complete certain tasks with the aim of improving system design and processes (Militello and Hutton, 1998; Pickup et al., 2019). Researchers need significant training to use these methods proficiently, however a modified CTA method available, known as the Applied Cognitive Task Analysis (ACTA), is specifically designed to be used with no formal CTA training (Militello and Hutton, 1998) and is therefore accessible to the healthcare community. ACTA is useful at exploring mentally demanding tasks, but it does not identify the relationship between tasks such as their interdependence and resonance (interactions which can amplify outputs). Another method called the Functional Resonance Analysis Method (FRAM) is a potentially complementary method to ACTA, representing how an activity is usually carried out (process model) using data derived from interviews, field observations or document reviews (Hollnagel, 2012). The model can assist in identifying performance variability, the effects that this variability may have on outputs and ultimately also identify how to strengthen system resilience (Hollnagel, 2012; Sujan et al., 2022). FRAM can be used to model successful or reliable system processes as well as identify those that require improvement. These methods may prove particularly useful when examining the escalation of care process given the number of tasks involved, their complexity, and the existing slow improvements to patient safety seen to date.

1.1. Aim

The aims of this work were to:

i) develop a representative model detailing escalation of care,
ii) identify performance variability that may negatively or positively affect escalation of care, and
iii) examine linkages between steps in the clinical escalation process.

2. Methods

2.1. Design

An interview study was conducted to understand ward-based escalation of care for adult patients who have clinically deteriorated. This study employed a novel integration of two human factors methods, firstly to collect qualitative data (ACTA) and then to model care escalation (FRAM). The study design is illustrated in Supplementary File 1.

2.2. Setting

Interviewees were selected from two contrasting NHS hospitals. Site A is a group of three tertiary referral hospitals and one smaller hospital with almost 1500 beds and serves a population of over 600,000. The total hospital ICU bed capacity is approximately 48 beds with no established Critical Care Outreach Team. Site B is the main provider of acute hospital services for the population of approximately 500,000 people. The hospital has over 800 beds and a well-established, nurse-led critical care outreach team and an ICU capacity of 16 beds.

2.3. Participants

Interviews were conducted with 30 NHS clinical staff from medical, nursing, allied health professionals' backgrounds. Staff were eligible to be interviewed if they had self-reported experience of detecting or managing deteriorating adult ward patients, were aged 18 or over and able to give informed consent. Staff were also eligible if they had at least 4 years' clinical experience. Following careful consideration by the research team, an experience threshold was employed specifically within this study to maximise the opportunity to access expertise

from interview participants. Eligible staff were consented by researchers trained in the process and signed the consent form before taking part in the interview.

2.4. Data collection

Data were collected through ACTA interviews (See Supplementary File 2). ACTA is a collection of CTA methods that centres on eliciting *expert* knowledge used to perform key tasks (Militello and Hutton, 1998) such as escalation of care. For the purposes of this study and to ensure consistency with the ACTA method, 'expert' is defined as a registered health care professional with greater than 4 years' clinical experience (Bobay et al., 2009; Hruska et al., 2016). Clinical staff participants will herein be referred to as 'experts' in this manuscript. During the interviews, experts were firstly asked to describe key elements of ward care escalation (Task Diagram) and then responded to open-ended questions probing expertise when escalating and how they manage patient deterioration (Knowledge Audit) (Militello and Hutton, 1998). All interviews lasted <1 h and followed a piloted interview topic guide. The tool was initially piloted with 1 participant not included in the final analysis and tested to ensure data met the aims of the study. The guide design and content were assessed by one of the developers of the original ACTA methodology (RH) to ensure that it was consistent with the original design. Finally, three early interviews were jointly assessed. To facilitate identification of escalation tasks that were cognitively challenging and therefore had a high likelihood of performance variability experts were asked "of the steps you have just identified, which require difficult cognitive skills?" (Supplementary File 2). Experts were asked to provide an overview of why these tasks were cognitively challenging (to them or a novice) as well as the cues and strategies used to overcome this.

2.5. Analysis

ACTA interview data were transcribed verbatim, and spot-checked for accuracy which entailed randomly picking sections of data and re-listening to audio files to corroborate content. Data were thematically analysed adapting a Framework Analysis (FA) approach by using the ACTA output tables as a heading guide (Ede et al., 2021). The FA process followed 5 key methodological steps described by Ritchie and Spencer (1994): familiarisation, identifying a thematic framework, indexing (selecting the interesting fragments-coding), charting/summarising (key difference between this and content analysis) and interpretation. Familiarisation of the data started during interviews and transcripts were read and re-read several times. The thematic framework chosen related to the original ACTA methods and output tables. FA headings focussed on the difficult cognitive elements of escalation, why these were difficult, common errors, and strategies used when escalating care. Coding and charting occurred simultaneously and related to specific elements of expertise described by the experts. FA provides a clear structured output in the form of a Coding Matrix (Gale et al., 2013) to encourage comparison and interpretation across data sets and within case data. Completeness of data was based on the principal of 'information power' whereby the broad aim of understanding escalation required a larger sample size (Malterud et al., 2016). A sample size of 30 interviews held appropriate information power for analysis of key escalation tasks and the nuance surrounding their interactions.

2.5.1. Functional resonance analysis method

The original coded ACTA data from the 30 interviews (specifically the identified escalation tasks) were modelled using the Functional Resonance Analysis Methods (FRAM). The concept of functional resonance in this instance relates to the adjustments made in sociotechnical systems from which intended or unintended consequences can emerge (Hollnagel, 2012). Our FRAM analysis was conducted using the FRAM Visualiser software® (FRAM Model Visualiser Pro, v. 2.1.4). The focus of this is to visualise key escalation tasks (termed functions in the FRAM literature – represented with hexagons in the FRAM diagrams), how each task is related to another (couplings) and what elements that task requires to occur (input, output, resources, time, preconditions, control) (Hollnagel, 2012; Sujan et al., 2022). Tasks can be either upstream or downstream; if downstream, they need to be completed prior to another task. If upstream, they occur once another task has been completed (Hollnagel, 2012). It should be acknowledged that it is a novel approach to combine both the ACTA and FRAM methods. The benefit of this combination of methods was that relationships *between* tasks were visible such as their *interdependence* (how tasks interact and create functional resonance), allowing tabular data to be represented dynamically. The researcher referred to the in-depth FRAM methods handbook (Hollnagel et al., 2014) and interviews were conducted by a researcher (JE) formally trained in the method. Tasks are referred to as functions in some parts of the FRAM literature; for ease of reading, the term 'task' is used in this paper.

To provide a point of reference and add further meaning to the ACTA data, the NEWS2 escalation protocol clinical actions and responses were initially transcribed into a model of escalation of care and constituted FRAM Model 1. Escalation tasks were extracted from the national NEWS2 protocol (WAP) by one researcher (JE) and cross-checked by the study team and interview participants. NEWS2 score thresholds were not considered a unique escalation task but were included for illustration purposes. FRAM Model 1 was collectively agreed upon by the study team (RE, BK, RH). Two group members had clinical experience with the NEWS2 protocol, and one member reviewed this from a human factors' perspective. A further two FRAM models were developed to represent key escalation tasks as cited by the interview experts and which of these were variable and cognitively challenging.

To address confirmability, the research team attended data meetings and was presented with key themes which were jointly agreed upon. ACTA and FRAM data were presented back to 5 interview experts (three from Site A and two from Site B) to ensure there was consistency in the data interpretation. The study team kept an audit trail and developed a codebook (Supplementary File 3) which ensured coding consistency and transparency. To ensure transferability, the novel application of the methods has been described in detail to allow study replication if required.

2.6. Ethical considerations

This work reports methods from the published protocol paper (Ede et al., 2021) and used the COREQ checklist (Supplementary File 4). This study forms part of a larger research study: the SUFFICE study. Ethical approval was provided by the Queen Square London Research and Ethics committee (REC Ref 20/HRA/3828; CAG-20CAG0106) and the study was registered with the International Standard Randomised Controlled Trial Number (ISRCTN 38850). All experts were aware that participating in the study was voluntary and signed a consent form. All collected data were stored in a password-protected computer and anonymised.

3. Results

3.1. Participant demographics

Thirty ACTA interviews were conducted with experts comprising of Ward Nurses (n = 7), Outreach or Sepsis Nurses (n = 8), Nurse Manager or Consultant (n = 6), Physiotherapists (n = 4), Advanced Practitioners (n = 4), and Doctor (n = 1) with 80 % of interview experts being aligned to a female gender. Median expert age was 31 years (IQR 29–38.3) and median years qualified was 8 (IQR 5.6–14.3) (see Supplementary File 5).

3.2. FRAM models overview

Three FRAM models were developed from the ACTA data:

- FRAM Model 1 - The NEWS2 protocol was best illustrated/described as a simplistic linear escalation model. The model demonstrated the protocol to consist of eight unique tasks (Fig. 1).
- FRAM Model 2a - Key escalation tasks were derived from the ACTA interview data (Task Diagram and Knowledge Audit data). This demonstrates escalation complexity and a higher-level representation of escalation (Fig. 2).
- FRAM Model 2b - Illustrates those tasks that the experts found cognitively challenging (Knowledge Audit) and are therefore at high risk of performance variability. This also demonstrates variable tasks that are closely coupled (Fig. 3).

3.3. WAP and WAD escalation tasks

Escalation tasks taken from the participant descriptions during the Task Diagram and Knowledge Audit, naturally grouped into four key temporal escalation phases: Exploratory, Critical Decision, Action, and Evaluation (Table 1). Along with the eight work-as-prescribed tasks identified in the NEWS2 FRAM, interview experts identified an additional 24 escalation tasks (work-as-done) undertaken to escalate a deteriorating patient's care. Of these, nine (9/32, 28 %) were cognitively difficult (inherently difficult/complex tasks or system issues adding to difficulty). Two of the nine were key decision-making points ('*making critical decision to escalate*' and '*escalating to medical team*') and the remaining seven tasks captured actions requiring some form of additional investigation to build up a more complete picture of the patient's condition. Three of the difficult to perform and variable tasks ('*making the critical decision to escalate*', '*synthesising all data points*', and '*identifying interim actions*') were closely coupled within FRAM Model 2b (highlighted in Fig. 3) and may indicate a point of weakness in the escalation process. These findings were summarised in a Cognitive Demands Table (Table 2).

Making the critical decision to escalate was the most frequently described 'difficult' task in the interviews (n = 9) and is dependent on the completion of several other downstream tasks. Identifying the cause of concern (should not be conflated with a diagnosis but clarifying concerning cues and soft signals) and conducting an A–E assessment may need to be completed before making the critical decision to escalate and were in fact some of the first key tasks which initiated the escalation process. Examining warning scores formed part of this wider assessment. These escalation tasks were cited as difficult due to diagnosis uncertainty and symptoms that closely mimic other conditions (for example Myocardial Infarction, MI, presenting as abdominal pain). Driving this was the need to choose who to refer to and making a convincing referral to get a suitably prioritised response. Common novice errors identified by the interview experts were not collecting the correct data, not using the family to understand the patient's deterioration, and normalising physiological abnormality. All of which may ultimately impact on the ability to make a critical decision to escalate. In some instances, the Outreach team was used as a supportive strategy in decision making.

Synthesising all data points was identified in many of the interviews (n = 8) and is the process of assimilating all the relevant patient, contextual and organisational data together to create a cohesive understanding of the patient deterioration status. This is again a downstream task before a critical decision to escalate. Experts noted that the mental workload of assimilating the relevant data from multiple separate information technology (IT) systems, often with poor usability, substantially added to the cognitive task of synthesising a likely diagnosis. They also described the challenges surrounding the deterioration detection reliability of the current NEWS2 scoring system. In some instances, this would generate alerts for patients who were unlikely to have a deterioration, resulting in an increased workload through medical and nursing reviews. Similarly, experts described how the system would not alert for some patients who were clearly unwell with examples of patients who

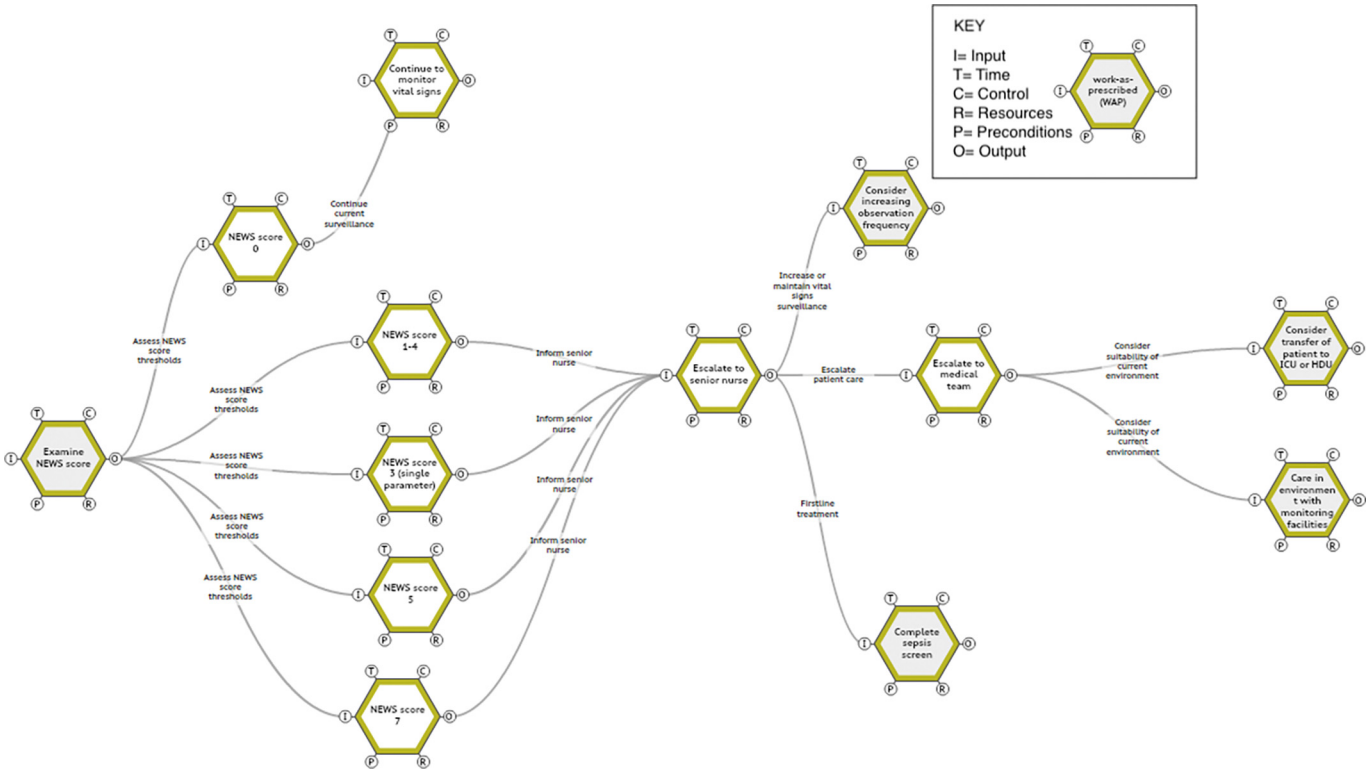

Fig. 1. FRAM Model 1 - illustrating NEWS2 escalation tasks (work-as-prescribed).

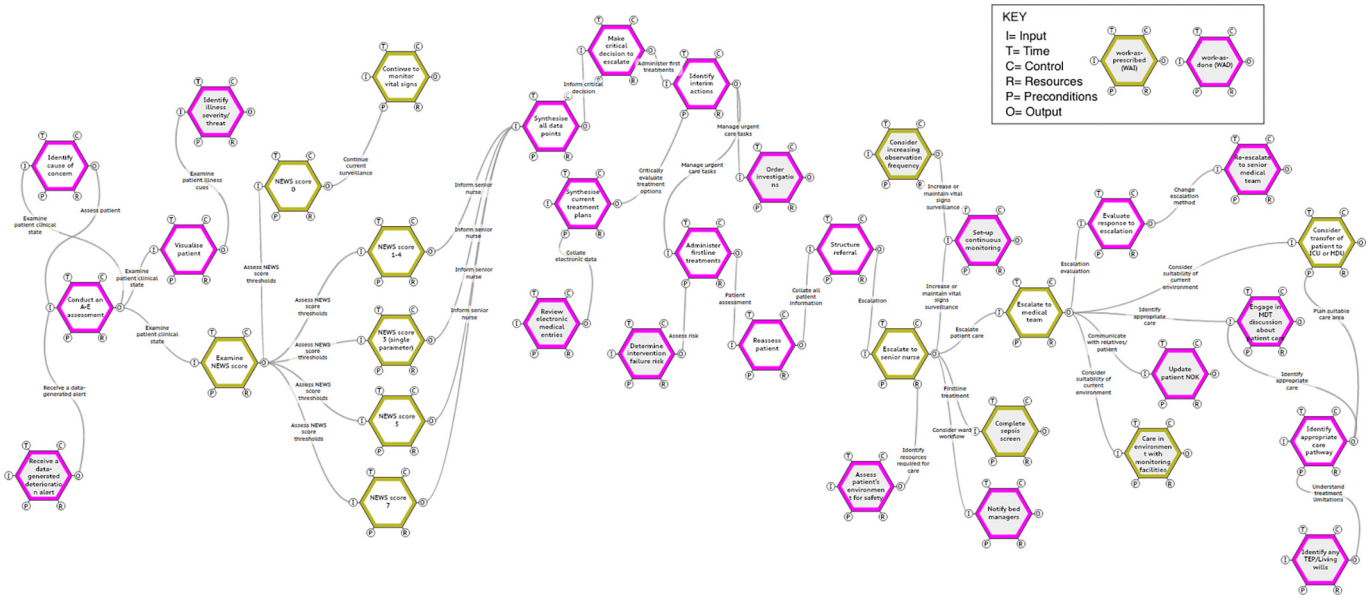

Fig. 2. FRAM Model 2a - illustrating NEWS2 escalation tasks plus ACTA escalation tasks (work-as-done).

were bleeding, had chest pain or were vomiting. Experts also described simply feeling overwhelmed with the volume of data which needed considering when examining an unwell patient whilst trying to provide bedside care and interventions. As clinical staff became more familiar with patient deterioration events and honed their ability to synthesise multiple data points (expertise), they were then able to identify potential system wide (the bigger picture) performance blocks which could impact on the way the deterioration event was managed such as identifying critical care capacity, resource limitations and patient frailty indicating longer term care limitations.

Identification of interim actions is an upstream task from the critical decision to escalate and was described as cognitively challenging due to having limited experience of deteriorating patients when in the novice phase, lacking in confidence and feeling overwhelmed by the situation. This results in clinical staff directing concern elsewhere and focussing on elements of the situation that are unimportant. Strategies described by the experts to overcome these issues are using the senior nursing team, Outreach or Advanced Care Practitioners (ACPs) to support identification of care priorities. Similarly, Outreach or ACPs could also request or initiate more advanced treatments (such as arterial blood gases) improving the timeliness of deterioration interventions. Experts would also utilise other senior staff/Outreach to help reframe issues and identify appropriate action sets or refer to guidelines to reduce cognitive load. Experts were aware that interim actions may mask deterioration temporarily and would view a clinical improvement cautiously.

4. Discussion

NEWS2 was internationally adopted to improve the recognition of unwell ward patients and facilitate escalation (Royal College of Physicians, 2017). However our findings indicate discordance between the NEWS2 protocol (eight tasks) and reported escalation tasks from

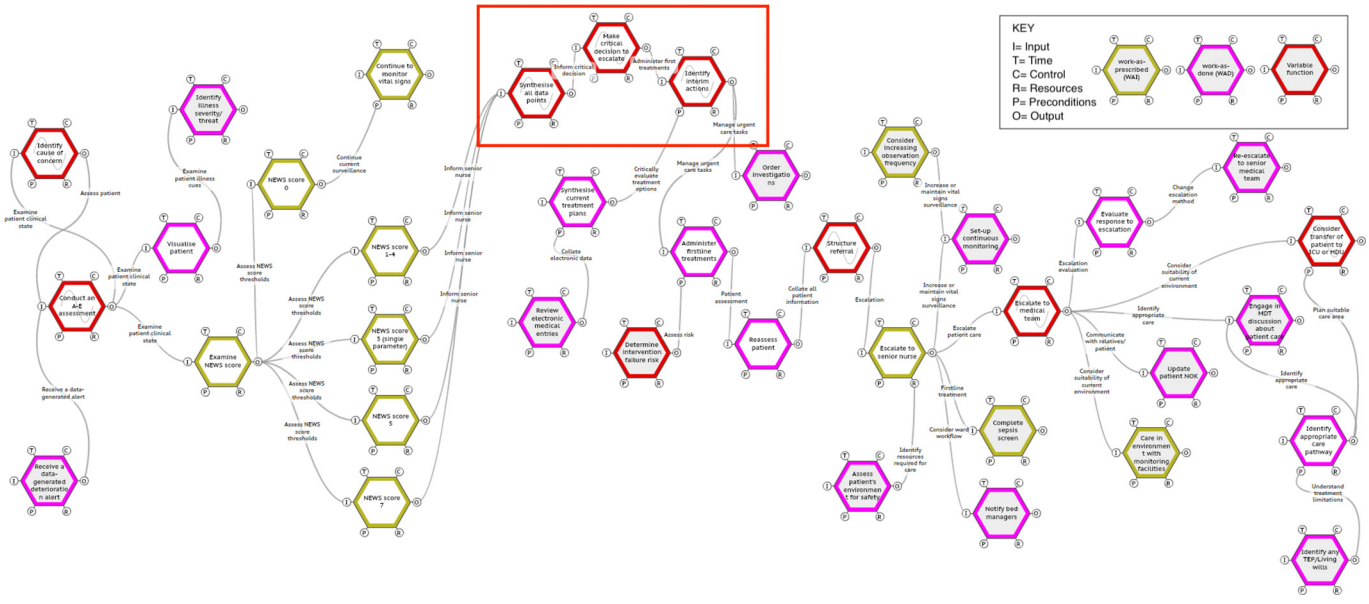

Fig. 3. FRAM Model 2b - escalation tasks at high risk of performance variability (highlighted in red).

Table 1
All escalation tasks detailing work-as-prescribed and work-as-done from ACTA interviews.

Temporal escalation phase	NEWS2 escalation tasks (WAP) n = 8	ACTA escalation task (WAD) n = 24
Exploratory (pre-escalation)		
	Examine NEWS2 score (includes all individual score thresholds e.g., NEWS Score 0, NEWS Score 1–4)	Visualise patient
		Conduct an A–E assessment
		Receive a data-generated deterioration alert
		Synthesise all data points
		Identify a cause of concern
		Synthesise current treatment plans
Critical Decision (pre-escalation)		
		Identify deterioration severity and threat
		Identify appropriate care pathway
		Identify any treatment escalation plans or living wills
		Make critical decision to escalate
Action (escalation)		
	Complete sepsis screen	Review all medical electronic entries
	Continue to monitor vital signs	Identify all interim actions
	Escalate to medical team	Administer firstline treatments
	Care in environment with monitoring facilities	Determine intervention failure risks
	Escalate to senior nurse	Structure convincing referral
		Order investigations
Evaluation (post-escalation)		
	Consider increasing observations frequency	Notify bed managers
	Consider transfer of patient to ICU/HDU	Assess patient's environment for safety
		Set-up continuous monitoring
		Reassess patient
		Evaluate response to escalation
		Re-escalate to medical team
		Update next of kin
		Engage in Multi-Disciplinary Team (MDT) discussion about patient care

the ACTA interview data (24 tasks). Over a quarter of these tasks were described as cognitively challenging and were not supported by NEWS2. Three variable tasks ('*making the critical decision to escalate*', '*synthesising all data points*', and '*identifying interim actions*') were closely linked within the final FRAM model, suggesting a significant point of weakness and should be a focus of improvement work.

The use of warning scores to detect deterioration is an internationally adopted strategy (Douw et al., 2016; Peng et al., 2021; Romero-Brufau et al., 2014) and NEWS2 is the most commonly utilised system in the world (Royal College of Physicians, 2017). The use of NEWS/NEWS2 has demonstrated many benefits (Welch et al., 2022). However, our study shows that the critical decision to escalate is driven by more than elevated score (NEWS2) thresholds (Pimentel et al., 2018). Experts in our study still rigorously assessed a score's trustworthiness, and do not solely rely on mandated responses at particular score thresholds, further contributing to uncertainty during a critical decision to escalate (Wood et al., 2019). Although NEWS2 guidance states that clinical judgement should be used alongside scoring systems and protocols (Royal College of Physicians, 2017, 2012), Trusts often internally audit against the protocol and there are governmental fiscal incentives to increase compliance (NHS Institute for Innovation and Improvement, 2022). Our findings suggest that auditing of early warning score responses may be problematic. Incorporating patient assessment into warning system responses may address this and has been shown to reduce false positive workloads with no increase in patient mortality (Nielsen et al., 2022) and can precede traditional scores thus facilitating earlier recognition (Clifton et al., 2015; Douw et al., 2016). It may be feasible to improve clinical practice further (deterioration recognition and audit performance) by systematically facilitating the significant amount of professional judgement (work-as-done) and clinical adjustment we have shown experts already use in our escalation models.

Having to synthesise and access multiple data points was cognitively difficult due to poor electronic information quality and usability of IT systems and relate to task complexity domains such as ambiguity, variability and unreliability (Liu and Li, 2012). This problem is not unique to the UK but is internationally encountered within healthcare (Kaipio et al., 2017). Importantly, working memory can hold 4–7 pieces of information (Cowan, 2010) which, when combined with cognitive difficulties in accessing that information, can lead to a decline in performance (Kelly et al., 2023). Experts found structuring a convincing referral when "bidding" for clinical time difficult, often resulting from problems in completing downstream escalation tasks such as synthesising data. When experts were able to effectively synthesise core escalation data, often by adapting to challenging system features, they were then able to consider system-wide resources linked to upstream escalation tasks, such as identifying interim tasks and interventions, and use this to their advantage. For instance, experts suggested that they may use Outreach to help validate and strengthen their concerns or assist in decision making when this service was available. Experts anticipated system performance blocks and initiated early discussions with hospital operational teams to facilitate ICU capacity and patient flow similar to other escalation studies (Sujan et al., 2022). They also maximised their utilisation of (limited) resources in other areas (A + E resus rooms) to care for rapidly deteriorating patients. However, central to this was a lower cognitive load and efficient escalation processes, thus creating opportunities to adjust and employ strategies from the wider organisation. A practice implication and relatively simple solution to this would be the development of a digital system dedicated to identifying unwell patients designed by understanding staff requirements, mirroring work-as-done and supporting staff in obtaining deterioration data more swiftly (Malycha et al., 2019; Subbe et al., 2017).

There are some limitations to this work. The aim of this study was to examine expertise and an experience threshold was justified in the methods. However, it is a possibility that data from less experienced clinical staff may have demonstrated escalation expertise or different responses. Interview participants may not be completely open with their responses and describe work-as-disclosed which may differ to work-as-done. There is little escalation task data within this work which describes consulting with patients. Interestingly, discussing deterioration with patients or relatives was a cue or strategy to support

Table 2
Escalation tasks identified as cognitively challenging.

Number of interviews to support data	Difficult Cognitive element	Why difficult?	Common errors	Cues and strategies used
n = 7	Identifying cause of concern (deterioration)	Diagnosis uncertainty	Not collecting all the correct data	Discuss with patient (ascertain their perception) if able
		Referral bias	Accepting inherited diagnosis	Assess work of maintaining current physiology
		Errors in equipment	Novices believe equipment readings (e.g., oxygen saturations)	Create education opportunities for exposure to deteriorating patients such as a critical care placement
		Conditions which mimic other conditions (Pulmonary Embolism manifesting with temperature or altered conscious level)	Not using the family as an early deterioration indicator	Identify patterns of normality deviation
		Patients who lack capacity to communicate		Use equipment "failure" as a teaching case study to demonstrate clinical reasoning
				Allocate relative concern as a warning criterion
				Use of team (senior ward nurses or Outreach) to help frame decisions
n = 6	Conducting A–E assessment[a]	Being able to determine and synthesise meaningful clinical signals	Performing the process but not critically identifying cause of concern	Using the escalation process to learn skills
		Easy to get overwhelmed		Ask for a second opinion
		Intricacies of chest auscultation	Not identifying anomalies	Reflect and re-analyse anomaly cases
			Not being able to see what is absent (normal progress, symptoms)	Use Airway/breathing/circulation/disability/exposure approach to prioritise elements of urgent care
			Fails to include longer term outlook	Structured assessment leads to a structured and convincing referral
				Create a personalised algorithm to help you identify key issues and anomalies
				Key task is to identify treatment escalation plans
n = 8	Synthesising all data points	Difficult to access information	Don't identify recent scans or interventions	Stick to a systematic approach
		Variability in documentation	Patients may flag for sepsis, but may not be infection related	Identify any data anomaly
		Separate Information Technology systems		Ensure patient assessment is conducted
		Overwhelming	Patients may not flag for sepsis but have an infection	When escalating care or managing deterioration, consider the wider organisation, tools, technology, and environment to bring together all the salient information (bigger picture)
		Trustworthiness of warning scores	Do not consider system-wide implications	
n = 9	Making critical decision to escalate	Novices may not see soft signals of deterioration	Normalising flag abnormality	Use nursing team to assist decision making (shared decision making)
		Insidious deterioration	Lack of organisational awareness	Challenge decisions
		Identifying the critical point of deterioration	Uncritical acceptance of data	Understand common illness trajectories of patient groups (elderly, frail)
		Identifying a change from baseline		Challenge anomalies
		Not familiar with the patient		Troubleshoot equipment
n = 3	Structuring convincing referral	Creating a deterioration narrative	Not using a structured format	Giving the team an understanding of current deterioration and concerns
		Don't know the person who is taking the referral	Not collating all the relevant information	Use of a communication tool
		Patient Early Warning Score not triggering		Face to face referral
				Discussing with nursing/ward team before escalation
				Identify (any) abnormality to back up general concern
				Identifying a change from baseline
				Use a systematic assessment approach
				Request a review (visualise the patient) to validate concerns
				Escalate to Outreach to validate concerns

(continued on next page)

Table 2 (*continued*)

Number of interviews to support data	Difficult Cognitive element	Why difficult?	Common errors	Cues and strategies used
n = 6	Identifying interim actions	Limited experience in managing sick deteriorating patients Lack confidence Being overwhelmed and missing details	Novices don't know what is expected May be misdirecting concern elsewhere rather than focusing on critical elements Dismissing guidelines Initiating an inappropriate treatment	Advanced Care Practitioners/Outreach can request advanced investigations arterial blood gases, chest X-rays, blood work Escalate to Outreach team to provide nursing support[b] Pinpoint hospital resources to best support patient Understand that certain interventions mask true deterioration (view improvement with caution) Cluster tasks to maximise bedside presence Use senior staff to help re-frame key issues and tasks Guidelines can often reduce cognitive load during escalation events
n = 2	Determining intervention failure	Uncertainty as to clinical deterioration cause Patient response to treatment	Providing treatment despite high failure risk from feeling pressure to "provide care"	Review of case studies Reflective practice (what worked what didn't and why) Advice from team members Identify limits of care early in the interventional phase
n = 8	Escalating to medical team	Knowing whom to escalate to Medical teams rotate regularly Medical teams are not based to a single ward High medical workload/limited resources Medical team responsibilities outside of the ward (theatre) Not happening in isolation May have multiple patients who need medical attention Difficult to escalate patients who are not in the extreme.	Escalation response is not deemed proportional to urgency Lack of awareness of specialist patients Ward round follows their own priorities Overwhelmed Remote communication. Unable to grasp concerns Sepsis has a time limit for treatment	Escalate to outside resources i.e., such as ICU or Outreach Re-escalate to senior medical team Face to face referrals when possible
n = 3	Consider transferring to critical care or HDU	Lack of hospital resources Organisational limitations of higher-level care beds (no HDU) COVID-19 pandemic Staff may not recognise end-of-life	Frailty risk not fully identified (e.g., walks dog every day for 1 mile = uses mobility scooter to walk dog)	Early discussion regarding deterioration with hospital operational team

[a] A to E assessment: Structured clinical examination of systems including airway, breathing, circulation, disability (neurological) and exposure (skin, wounds, medications).
[b] Only available in Site B.

difficult escalation (Table 2) and was not a central function within the data. It may be prudent to explore this more fully in future escalation research. This paper has described some differences in the way both Trusts escalated given the presence or absence of an Outreach Team. Experts predominantly utilised Outreach (when available) or senior colleagues/ACPs to support decision-making, initiate more complex first line treatments or validate concerns. Once again, it would be prudent to further explore and undertake a more in-depth examination of the implications of an Outreach service on the difficulty and variation of escalation tasks.

Specific limitations of ACTA and FRAM are that a complete picture of escalation may not be fully grasped, and that data generated from these methods could vary across populations and pathologies leading to different conclusions. To minimise this, participants were sampled across specialities and hospitals to maximise the breadth of data. The novel use of combining both ACTA and FRAM may also be considered a limitation given there is no precedence. However, the study team views this as strongly contributing to new knowledge and approaches through being methodologically robust as possible by including subject matter experts within the research team.

5. Conclusion

The decision to escalate based on NEWS2 scores requires a significant amount of clinical judgement, and adjustments are essential to utilising scoring systems successfully. There needs to be in-built flexibility, both to escalation guidance and audit, to maximise appropriate escalation by supporting staff to adapt and adjust responses to incorporate their skills and knowledge, both of particular patients and of the local healthcare system in which they work. The amalgamation of data required to create a clear patient narrative is fundamentally difficult for staff to complete even when performing at an expert level.

More usable IT systems are required to synthesise the required data surrounding an unwell patient to facilitate better decision-making, support the referral process and suggest actions required, thus reducing data assimilation cognitive load, freeing cognitive space to provide better and more creative care.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnurstu.2023.104671.

Funding

JE is funded by the National Institute for Health and Care Research [Clinical Doctoral Research Fellowship (NIHR300509)]. The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care. PW is funded by the National Institute for Health and Care Research (NIHR), UK and the NIHR Biomedical Research Centre. RE is employed by the National Institute for Health and Care Research.

CRediT authorship contribution statement

J. Ede: Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **R. Hutton:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Formal analysis, Conceptualization. **P. Watkinson:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Conceptualization. **B. Kent:** Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Formal analysis. **R. Endacott:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Data availability

Data are available on request to the lead author.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: PW provides consultancy for Arcturis and holds share in the company.

Acknowledgments

We would like to thank John Welch who reviewed this work and provided many insightful comments and suggestions.

References

Bobay, K., Gentile, D.L., Hagle, M.E., 2009. The relationship of nurses' professional characteristics to levels of clinical nursing expertise. Appl. Nurs. Res. 22, 48–53. https://doi.org/10.1016/j.apnr.2007.03.005.

Carayon, P., Wetterneck, T.B., Rivera-Rodriguez, A.J., Hundt, A.S., Hoonakker, P., Holden, R., Gurses, A.P., 2014. Human factors systems approach to healthcare quality and patient safety. Appl. Ergon. 45, 14–25. https://doi.org/10.1016/j.apergo.2013.04.023.

Clay-Williams, R., Hounsgaard, J., Hollnagel, E., 2015. Where the rubber meets the road: using FRAM to align work-as-imagined with work-as-done when implementing clinical guidelines. Implement. Sci. 10, 125. https://doi.org/10.1186/s13012-015-0317-y.

Clay-Williams, R., Blakely, B., Lane, P., Senthuran, S., Johnson, A., 2019. Improving decision making in acute healthcare through implementation of an intensive care unit (ICU) intervention in Australia: a multimethod study. BMJ Open 9, e025041. https://doi.org/10.1136/bmjopen-2018-025041.

Clifton, D.A., Clifton, L., Sandu, D.M., Smith, G.B., Tarassenko, L., Vollam, S.A., Watkinson, P.J., 2015. "Errors" and omissions in paper-based early warning scores: the association with changes in vital signs-a database analysis. BMJ Open 5, 1–7. https://doi.org/10.1136/bmjopen-2014-007376.

Cowan, N., 2010. The magical mystery four: how is working memory capacity limited, and why? Curr. Dir. Psychol. Sci. 19, 51–57. https://doi.org/10.1177/0963721409359277.

Douw, G., Huisman-de Waal, G., van Zanten, A.R.H., van der Hoeven, J.G., Schoonhoven, L., 2016. Nurses' "worry" as predictor of deteriorating surgical ward patients: a prospective cohort study of the Dutch-early-nurse-worry-indicator-score. Int. J. Nurs. Stud. 59, 134–140. https://doi.org/10.1016/j.ijnurstu.2016.04.006.

Ede, J., Jeffs, E., Vollam, S., Watkinson, P., 2020. A qualitative exploration of escalation of care in the acute ward setting. Nurs. Crit. Care 25, 171–178. https://doi.org/10.1111/nicc.12479.

Ede, Watkinson, P., Endacott, R., 2021. Protocol for a mixed methods exploratory study of success factors to escalation of care: the SUFFICE study. medRxiv 2021.11.01.21264875.

Findlay, G., Shotton, H., Mason, K., 2012. Time to Intervene? Natl. Confid. Enq. into Patient Outcome Death. pp. 1–125.

Gale, N.K., Heath, G., Cameron, E., Rashid, S., Redwood, S., 2013. Using the Framework Method for the Analysis Of Qualitative Data in Multi-disciplinary Health Research. https://doi.org/10.1186/1471-2288-13-117.

Gerry, S., Birks, J., Bonnici, T., Watkinson, P.J., Kirtley, S., Collins, G.S., 2017. Early warning scores for detecting deterioration in adult hospital patients: a systematic review protocol. BMJ Open 7, e019268. https://doi.org/10.1136/bmjopen-2017-019268.

Hogan, H., Healey, F., Neale, G., Thomson, R., Vincent, C., Black, N., 2012. Preventable deaths due to problems in care in English acute hospitals: a retrospective case record review study. BMJ Qual. Saf. 21, 737–745. https://doi.org/10.1136/bmjqs-2011-001159.

Hollnagel, E., 2012. FRAM: the functional resonance analysis method. J. Chem. Inf. Model. https://doi.org/10.1017/CBO9781107415324.004.

Hollnagel, E., Hounsgaard, J., Colligan, L., 2014. FRAM – The Functional Resonance Analysis Method - A Handbook for the Practical Use of the Method. https://doi.org/10.1017/CBO9781107415324.004.

Hruska, P., Hecker, K.G., Coderre, S., McLaughlin, K., Cortese, F., Doig, C., Beran, T., Wright, B., Krigolson, O., 2016. Hemispheric activation differences in novice and expert clinicians during clinical decision making. Adv. Health Sci. Educ. 21, 921–933. https://doi.org/10.1007/s10459-015-9648-3.

Kaipio, J., Lääveri, T., Hyppönen, H., Vainiomäki, S., Reponen, J., Kushniruk, A., Borycki, E., Vänskä, J., 2017. Usability problems do not heal by themselves: national survey on physicians' experiences with EHRs in Finland. Int. J. Med. Inform. 97, 266–281. https://doi.org/10.1016/j.ijmedinf.2016.10.010.

Kelly, F.E., Frerk, C., Bailey, C.R., Cook, T.M., Ferguson, K., Flin, R., Fong, K., Groom, P., John, C., Lang, A.R., Meek, T., Miller, K.L., Richmond, L., Sevdalis, N., Stacey, M.R., 2023. Human Factors in Anaesthesia: A Narrative Review. , pp. 479–490 https://doi.org/10.1111/anae.15920.

Lay, E., Branlat, M., Woods, Z., 2015. A practitioner's experiences operationalizing resilience engineering. Reliab. Eng. Syst. Saf. 141, 63–73. https://doi.org/10.1016/j.ress.2015.03.015.

Liu, P., Li, Z., 2012. Task complexity: a review and conceptualization framework. Int. J. Ind. Ergon. 42, 553–568. https://doi.org/10.1016/j.ergon.2012.09.001.

Malterud, K., Siersma, V.D., Guassora, A.D., 2016. Sample size in qualitative interview studies: guided by information power. Qual. Health Res. 26, 1753–1760. https://doi.org/10.1177/1049732315617444.

Malycha, J., Redfern, O.C., Ludbrook, G., Young, D., Watkinson, P.J., 2019. Testing a digital system that ranks the risk of unplanned intensive care unit admission in all ward patients: protocol for a prospective observational cohort study. BMJ Open 9, 1–4. https://doi.org/10.1136/bmjopen-2019-032429.

Militello, L., Hutton, R., 1998. Applied cognitive task analysis (ACTA): a practitioner's toolkit for understanding cognitive task demands. Ergonomics 41, 1618–1641. https://doi.org/10.1080/001401398186108.

Mohammed Iddrisu, S., Considine, J., Hutchinson, A., 2018. Frequency, nature and timing of clinical deterioration in the early postoperative period. J. Clin. Nurs. https://doi.org/10.1111/jocn.14611.

National Health Service, 2022. Commissioning for Quality and Innovation (CQUIN) Scheme for 2022/23. pp. 1–39.

NCEPOD, 2018. Themes and Recommendations Common to all Hospital Specialities.

NHS Improvement, 2016. The Adult Patient Who is Deteriorating: Sharing Learning From Literature, Incident Reports and Root Cause Analysis Investigations. 23.

NHS Institute for Innovation and Improvement, 2022. Commissioning for Quality and Innovation (CQUIN) Payment Framework. Guid 2012. pp. 1–37.

Nielsen, P.B., Langkjær, C.S., Schultz, M., Kodal, A.M., Pedersen, N.E., Petersen, J.A., Lange, T., Arvig, M.D., Meyhoff, C.S., Bestle, M.H., Hølge-Hazelton, B., Bunkenborg, G., Lippert, A., Andersen, O., Rasmussen, L.S., Iversen, K.K., 2022. Clinical assessment as a part of an early warning score—a Danish cluster-randomised, multicentre study of an individual early warning score. Lancet Digit. Heal. 4, e497–e506. https://doi.org/10.1016/S2589-7500(22)00067-X.

Peng, L., Luo, Z., Liang, L., Liu, M., Meng, L., Tan, J., Song, L., Zhang, Y., Wu, L., 2021. Comparison of the performance of 24 early warning scores with the updated National Early Warning Score (NEWS2) for predicting unplanned intensive care unit (ICU) admission in postoperative brain tumor patients: a retrospective study at a single center. Med. Sci. Monit. 27, e929168. https://doi.org/10.12659/MSM.929168.

Pickup, L., Lang, A., Shipley, L., Henry, C., Carpenter, J., McCartney, D., Butler, M., Hayes-Gill, B., Sharkey, D., 2019. Development of a clinical interface for a novel newborn resuscitation device: human factors approach to understanding cognitive user requirements. JMIR Hum. Factors 6, 1–13. https://doi.org/10.2196/12055.

Pimentel, M., Redfern, O.C., Gerry, S., Collins, G.S., Malycha, J., Prytherch, D., Schmidt, P.E., Smith, G.B., Watkinson, P.J., Pimentel, M.A.F., 2018. A Comparison of the Ability of the National Early Warning Score and the National Early Warning Score 2 to Identify Patients at Risk of in-Hospital Mortality: A Multi-centre Database Study. https://doi.org/10.1016/j.resuscitation.2018.09.026.

Prytherch, D.R., Smith, G.B., Schmidt, P.E., Featherstone, P.I., 2010. ViEWS—Towards a national early warning score for detecting adult inpatient deterioration. Resuscitation https://doi.org/10.1016/j.resuscitation.2010.04.014 (Comment in: Resuscitation.

2010 Aug;81(8):923-4; PMID: 20637973 [https://www.ncbi.nlm.nih.gov/pubmed/20637973]Comment in: Resuscitation. 2011 Jan;82(1):133; PMID: 21036456 [https://www.ncbi.nlm.nih.gov/pubmed/21036456]Comment in: Resuscitation. 2011 May;8 81, 932–937).

Ritchie, J., Spencer, L., 1994. Qualitative data analysis for applied policy research. by Jane Ritchie and Liz SpencerIn: Bryman, A., Burgess, R.G. (Eds.), Analysing Qualitative Data. Routledge, pp. 173–194.

Rodwin, B.A., Bilan, V.P., Merchant, N.B., Steffens, C.G., Grimshaw, A.A., Bastian, L.A., Gunderson, C.G., 2020. Rate of preventable mortality in hospitalized patients: a systematic review and meta-analysis. J. Gen. Intern. Med. 35, 2099–2106. https://doi.org/10.1007/s11606-019-05592-5.

Romero-Brufau, S., Huddleston, J.M., Naessens, J.M., Johnson, M.G., Hickman, J., Morlan, B. W., Jensen, J.B., Caples, S.M., Elmer, J.L., Schmidt, J.A., Morgenthaler, T.I., Santrach, P.J., 2014. Widely used track and trigger scores: are they ready for automation in practice? Resuscitation 85, 549–552. https://doi.org/10.1016/j.resuscitation.2013.12.017.

Royal College of Physicians, 2012. National Early Warning Score (NEWS) National Early Warning Score (NEWS).

Royal College of Physicians, 2017. National Early Warning Score National Early Warning Score (NEWS). 2.

Subbe, C.P., Duller, B., Bellomo, R., 2017. Effect of an automated notification system for deteriorating ward patients on clinical outcomes. Crit. Care 21, 52. https://doi.org/10.1186/s13054-017-1635-z.

Sujan, M., 2018. A safety-II perspective on organisational learning in healthcare organisations: comment on “false dawns and new horizons in patient safety research and practice”. Int. J. Health Policy Manag. https://doi.org/10.15171/ijhpm.2018.16.

Sujan, M., Bilbro, N., Ross, A., Earl, L., Ibrahim, M., Bond-Smith, G., Ghaferi, A., Pickup, L., McCulloch, P., 2022. Failure to rescue following emergency surgery: a FRAM analysis of the management of the deteriorating patient. Appl. Ergon. 98, 103608. https://doi.org/10.1016/j.apergo.2021.103608.

Verhagen, M.J., de Vos, M.S., Sujan, M., Hamming, J.F., 2022. The problem with making safety-II work in healthcare. BMJ Qual. Saf. https://doi.org/10.1136/bmjqs-2021-014396 bmjqs-2021-014396.

Welch, J., Dean, J., Hartin, J., 2022. Using NEWS2: an essential component of reliable clinical assessment. Clin. Med. J. R. Coll. Phys. Lond. 22, 509–513. https://doi.org/10.7861/clinmed.2022-0435.

Wood, C., Chaboyer, W., Carr, P., 2019. How do nurses use early warning scoring systems to detect and act on patient deterioration to ensure patient safety? A scoping review. Int. J. Nurs. Stud. 94, 166–178. https://doi.org/10.1016/j.ijnurstu.2019.03.012.