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Success Factors Facilitating Care During Escalation (the SUFFICE study)

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Copyright statement

Success Factors Facilitating Care

During Escalation (the SUFFICE study)

by

Jody Emma Ede

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Author's declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Doctoral College Quality Sub-Committee.

Work submitted for this research degree at the University of Plymouth has not formed part of any other degree either at the University of Plymouth or at another establishment.

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Abstract

TITLE: Success Factors Facilitating Care During Escalation- the SUFFICE study

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BACKGROUND: In the United Kingdom, there continues to be preventable National Health Service (NHS) patient deaths. Contributory factors include inadequate recognition of deterioration, poor monitoring, or delayed escalation to a higher level of care. Strategies to improve care escalation, such as vital sign scoring systems and specialist teams who manage deterioration events, have shown variable impact on patient mortality. The need for greater care improvements has consistently been identified in NHS care reviews as well as patient stories. Furthermore, current research informing escalation improvements predominantly comes from examining failure to rescue events, neglecting what can be learned from rescue or successful escalation.

AIM: The focus of this study was to address this knowledge gap by examining rescue and escalation events, and from this, to develop a Framework of Escalation Success Factors that can underpin a multi-faceted intervention to improve outcomes for deteriorating patients**.**

METHODS: Escalation success factors, hospital and patient data were collected in a mixed methods, multi-site exploratory sequential study. Firstly, 151 ward care escalation events were observed to generate a theoretical understanding of the process. To identify escalation success factors, 390 care records were also reviewed from unwell ward patients in whom an Intensive Care Unit admission was avoided and compared to the records for patients who became unwell on the ward, admitted to an

Intensive Care Unit, and died. Finally, thirty Applied Cognitive Task Analysis interviews were conducted with clinical experts (defined as greater than four years' experience) including Ward Nurses (n= 7), Outreach Nurses (n= 5), Nurse Managers (n=5), Physiotherapists (n=4), Sepsis Nurses (n=3), Advanced Nurse Practitioners and Educators (n=2), Advance Clinical Practitioners (n=2), Nurse Consultant (n=1) and Doctor (n=1) to examine process of escalation in a Functional Resonance Analysis Model.

RESULTS: In Phase 1, over half (n= 77, 51%) of the 151 escalation events observed were not initiated through an early warning score but other clinical concerns. The data demonstrated four escalation communication phenotypes (Informative, Outcome Focused, General Concern and Spontaneous Interaction) utilised by staff in different clinical contexts for different escalation purposes. In Phase 2, the 390 ward patient care record reviews (Survivors n=340, Non-survivors admitted to ICU n=50) identified that care and quality of escalation in the Non-survivor's group was better overall than those that survived. Reviews also identified success factors present within deterioration events including Visibility, Monitoring, Adaptability, and Adjustments, not dissimilar to characteristics of high reliability organisations. Finally, Phase 3 interview data were dynamically modelled in a Functional Resonance Analysis Method. This illustrated differences in the number of escalation tasks contained in the early warning scoring system (n=8) compared to how escalation is successfully completed by clinical staff (n=24). Interview participants identified that 28% (9/32) of these tasks were cognitively difficult, also indicating how they overcome system complexity and challenges to successfully escalate. Interactions between escalation tasks were also

examined, including Interdependence (how one affects another), Criticality (how many downstream tasks are initiated), Preconditions (what system factors need to be present), and Variability (factors which affect output reliability). This approach developed a system-focused understanding of escalation and signposted to process improvements.

CONCLUSION: This research uniquely contributes to international evidence by presenting new elements to escalation of care processes. This includes indicating how frequently early warning scores trigger an escalation, the different ways in which escalation is communicated, that patient outcomes may inaccurately portray the quality of care delivered and examining the interaction between escalation tasks can identify areas of improvement. This is the first study to develop a preliminary Framework of Escalation Success Factors, which will be refined and used to underpin evidenced based care improvements. A key recommendation would be for organisations to use, when tested, the Framework of Escalation Success Factors to make system refinements that will promote successful escalation of care.

PPI: This study has had Patient and Public Involvement and Engagement (PPIE) through a SUFFICE PPI Advisory Group.

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List of abbreviations

ACCP	Advanced Critical Care Practitioner
ACP	Advanced Care Practitioner
AUROC	Area Under the Receiver Operating Characteristic curve
BP	Blood Pressure
CAP	Community Acquired Pneumonia
CCOS	Critical Care Outreach Service
CHPPD	Care Hours Per Patient Day
Covid-19	Coronavirus 2 (SARS-CoV-2)
DENWIS	Dutch-Early-Nurse-Worry-Indicator-Score
EHR	Electronic Healthcare Record
EPR	Electronic Patient Records
EWS	Early Warning Score
FRAM	Functional Resonance Analysis Method
FTR	Failure to Rescue
HAP	Hospital Acquired Pneumonia
HFE	Human Factors and Ergonomics
HR	Heart Rate
HTA	Hierarchical Task Analysis
ICU	Intensive Care Unit
MET	Medical Emergency Team
MMR	Mixed Methods Research
NEWS	National Early Warning Score (2012)
NEWS2	National Early Warning Score (2017)
NHS	National Health Service
RRT	Rapid Response Team
SpO2	Peripheral Oxygen Saturation
UK	United Kingdom
USA	United States of America
WAD	Work as Done
WAI	Work as Imagined
WAP	Work as Prescribed

Glossary of Terms

Care Hours Per Patient Day (CHPPD)

Care Hours Per Patient Days (CHPPD) is a metric used in healthcare to assess the staffing levels in a healthcare facility, such as hospitals or nursing homes. It is a measure of the amount of care provided to patients or residents in relation to the number of patients or residents in the facility on a given day. CHPPD helps determine the adequacy of staffing resources by quantifying the number of care hours provided per patient day. It is calculated by dividing the total number of care hours delivered by the facility during a specific period by the total number of patient days during the same period.

Critical Care Outreach Service (CCOS)

CCOSs support all aspects of the acutely & critically ill patient pathway, including early identification of patient deterioration, timely admission to a Critical Care bed when required and delivery of effective follow-up for patients post discharge. CCOSs are also fundamental in providing educational support to enhance skills and knowledge of the multi-professional ward teams in general ward areas when caring for the at-risk and deteriorating patient.

Early Warning Score (EWS)

Early Warning Score systems allocate a cumulative score to physiological measurements taken from hospital patients. This contains six simple physiological parameters forming the basis of the scoring system (respiratory rate, oxygen

saturations, temperature, systolic blood pressure, pulse rate, level of consciousness). A score is allocated to each as they are measured, the magnitude of the score reflects how extreme the parameter varies from the norm. The score is then aggregated and uplifted for people requiring oxygen.

Functional Resonance Analysis Method (FRAM)

Functional Resonance Analysis Method (FRAM) is a methodology developed by Erik Hollnagel in the field of Human Factors and Ergonomics (HFE). It is a systemic approach used to understand and analyse complex socio-technical systems and how they function in dynamic and unpredictable environments. FRAM aims to identify and describe the underlying mechanisms and interactions that contribute to system performance, safety, and resilience.

Failure to Rescue (FTR)

Failure to rescue refers to a situation in healthcare where a patient experiences a significant complication or deterioration of their condition, but appropriate and timely interventions to rescue are not successfully executed, leading to adverse outcomes such as disability, morbidity, or mortality. It involves the failure of healthcare providers to recognize or respond adequately to the signs and symptoms of clinical deterioration or to implement appropriate actions to prevent or address complications.

Hierarchical Task Analysis (HTA)

Hierarchical Task Analysis (HTA) is a systematic method used to analyse complex tasks or activities by breaking them down into a hierarchical structure of sub-tasks. It

provides a detailed representation of the steps, actions, decisions, and interactions involved in accomplishing a particular task.

Human Factors and Ergonomics (HFE)

Human Factors and Ergonomics (HFE) is an interdisciplinary field that studies the interaction between humans and their environment, with the aim of optimizing system performance, safety, and user experience. It combines knowledge from various disciplines, including psychology, engineering, physiology, industrial design, and biomechanics, to understand human capabilities, limitations, and behaviour to design systems, products, and environments that accommodate and enhance human abilities.

Hypercapnic Respiratory Failure (HRF)

Hypercapnic respiratory failure, also known as Type II respiratory failure, is a medical condition characterized by an inability of the respiratory system to effectively eliminate carbon dioxide (CO2) from the body, resulting in an abnormally high level of CO2 in the bloodstream (hypercapnia). It typically occurs when there is a significant impairment in the function of the lungs, chest wall, or respiratory drive.

Intensive Care Unit (ICU)

An Intensive Care Unit, commonly referred to as the ICU, is a specialised medical facility within a hospital that provides comprehensive care to critically ill patients. It is designed to deliver highly specialised treatment and close monitoring to individuals who are facing life-threatening conditions or require constant medical intervention.

Medical Emergency Team (MET)

A Medical Emergency Team (MET), also called a Rapid Response Team, is a specialised group of healthcare professionals within a hospital or healthcare facility. The primary purpose of a Rapid Response Team is to provide urgent assessment, intervention, and management for patients who show signs of clinical deterioration outside the intensive care unit (ICU) setting.

Rapid Response Team (RRT)

A Rapid Response Team (RRT), (also called a Medical Emergency Team) is a specialised group of healthcare professionals within a hospital or healthcare facility. The primary purpose of a Rapid Response Team is to provide urgent assessment, intervention, and management for patients who show signs of clinical deterioration outside the intensive care unit (ICU) setting.

Work-as-Done (WAD)

Work-as-Done (WAD) refers to the actual activities, actions, and processes performed by individuals or teams to accomplish a task or achieve a specific goal. It represents the practical and observable aspects of work as it is carried out in real-world situations, accounting for the complexities, variations, and adaptations that occur during the execution of tasks.

Work-as-Imagined (WAI)

Work-As-Imagined (WAI) is a term used in the field of organizational management and work system design. It refers to the conceptual or idealized version of work as envisioned or intended by those who design work processes, procedures, and systems

within an organization. Work-as-Imagined is often contrasted with Work-as-Done, which refers to how work is performed in practice**.**

Work-as-Prescribed (WAP)

Work-as-Prescribed (WAP) is a term commonly used in industrial or operational settings to describe a work management philosophy or approach. It refers to a method of executing tasks or activities exactly as they are outlined, prescribed, or planned without any deviations or improvisations.

1. Chapter One: Introduction

1.1. Introduction to the study

Internationally, it is believed that 10% of adverse events in hospital are avoidable, with 7% (IQR 0.6-30) of these being fatal (Schwendimann *et al.*, 2018). As a result, the most recent figures suggest that there are up to 11,000 preventable deaths in England National Healthcare Service (NHS) Trusts each year (Hogan *et al.*, 2012). More recent United Kingdom (UK) avoidable death estimations are currently unavailable, but a study in the United States (US) referenced a mortality of 3.1% (95% CI 2.2-4.1%) indicating 22,165 deaths each year (Rodwin *et al.*, 2020). Avoidable patient deaths are of international significance.

Avoidable deaths, also known as Failure to Rescue (FTR), have been attributed to poor care such as monitoring, diagnostic errors or inadequate fluid management (Hogan *et al.*, 2012, 2014) when managing an acutely deteriorating patient. For instance, the National Reporting and Learning System (NRLS) within the UK has demonstrated that 170,000 incidents, across multiple NHS Trusts, were related to poor implementation of care and ongoing monitoring (NHS Improvement, 2019) (see Figure 1).

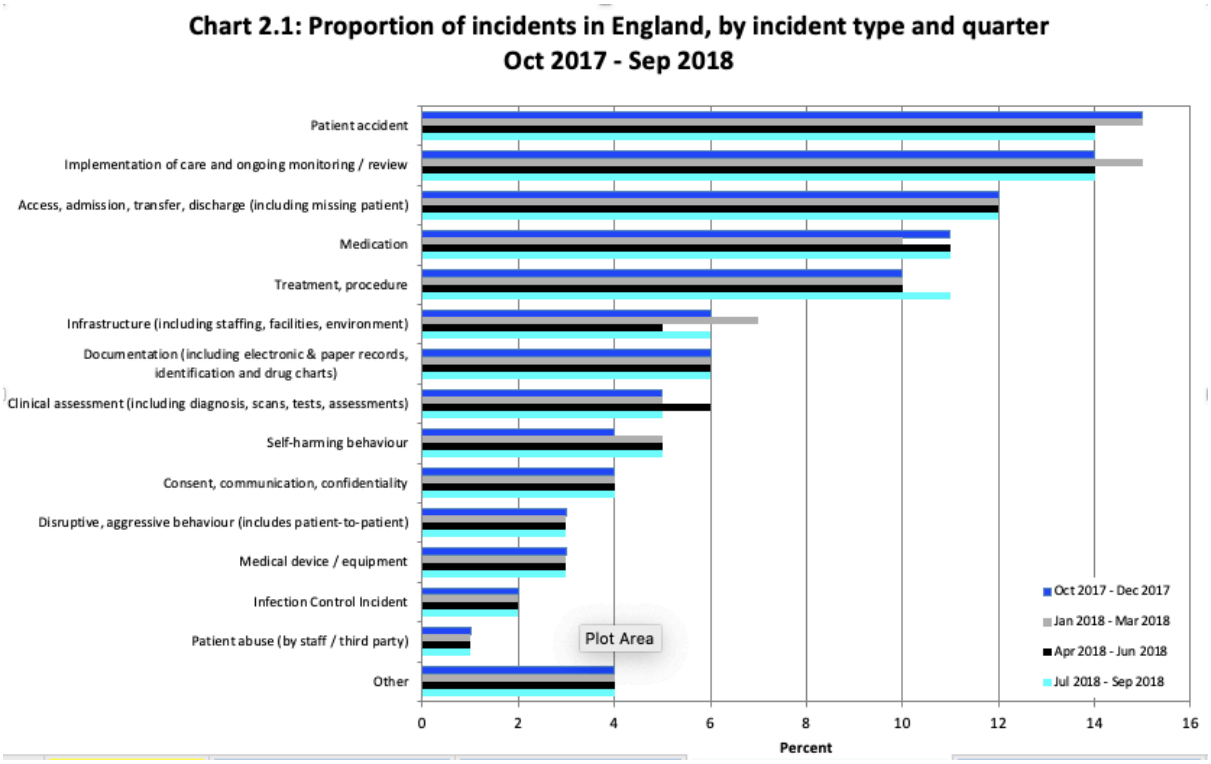


Figure 1 National Reporting and Learning System Data October 2019-March 2020, https://report.nrls.nhs.uk/nrlsreporting/

It is estimated that one in four post-operative patients will experience clinical deterioration, which is usually managed within a ward environment (Mohammed Iddrisu, *et al*, 2018). Deterioration can lead to In-Hospital Cardiac Arrests (IHCA), following which only 15% of patients will survive to hospital discharge (Hogan *et al.*, 2019). Events such as IHCA are often preceded by mild to severe vital signs abnormalities several hours before a cardiac event (Andersen *et al.*, 2016). This indicates opportunities for staff to intervene through implementing interventions to avoid further deterioration.

Urgently improving the detection and management of acute clinical deterioration is high on the NHS agenda, and is a common theme to seminal National Confidential

Enquiry into Patient Outcomes and Death (NCEPOD) reports (Fox, 2005; Findlay *et al.*, 2012; NCEPOD, 2018). The earliest NCEPOD report to identify problems in patient deterioration management was published in 2005, however this is still a common problem highlighted in the most recent 2018 report (NCEPOD 2018).

Despite many studies examining FTR events, strong evidence of safety improvements is lacking (Hogan *et al.*, 2019). NHS safety investigation approaches often seek to learn from negative events and identify a root cause, but this may limit understanding and the identification of potential solutions (Sujan *et al.*, 2016). As a result, there is much understood about FTR, however, the process of rescue has not been fully explored. There is a dearth of literature exploring, or describing, the potential learning from events where patients are successfully rescued from deterioration. This thesis systematically addresses these gaps, with the focus of this study being to understand the process of escalation and rescue from multiple perspectives, examine care escalation success factors and identify how these can be applied more effectively. From this work, a Framework of Escalation Success Factors was developed to inform further process improvements.

Described in this chapter are the background for the study, the theoretical framework underpinning this study, the researcher's background, and the impact of the Covid-19 pandemic. Finally, the aims, objectives, significance of the study, overview of the research and thesis structure are described.

1.2. Background to the study

1.2.1. Patient deterioration

Patients are living longer, with a greater number of co-morbidities and can have more complex surgery than previously (Forster, *et al.*, 2018). These result in an increasingly frail hospital population with greater chances of adverse events, and higher mortality rates (Redfern *et al.*, 2020). During an in-hospital admission, it is possible that there may be a progression of patient's illness leading to harm or death (Subbe *et al.*, 2019). This progression, or deterioration, is described as evolving, predictable, symptomatic (Lavoie *et al.*, 2016), presenting as physiological or biochemical instability and may be secondary to conditions such as pulmonary embolism (PE), bleeding, renal failure, or sepsis (Mohammed Iddrisu, *et al*, 2018).

There has been an evolution in our understanding of what constitutes deterioration, and which vital sign abnormalities assist clinical staff to predict patient mortality or unplanned Intensive Care Unit (ICU) admissions (Gerry *et al.*, 2020). In the 1990s, vital signs charts consisted of a simple paper document, which included blood pressure, Glasgow Coma Score (GCS), pulse rate, temperature, urine output and pain

assessment. No values of derangement, scores or clinical actions were given, and decision making was left primarily to clinical judgement (see Figure 2).

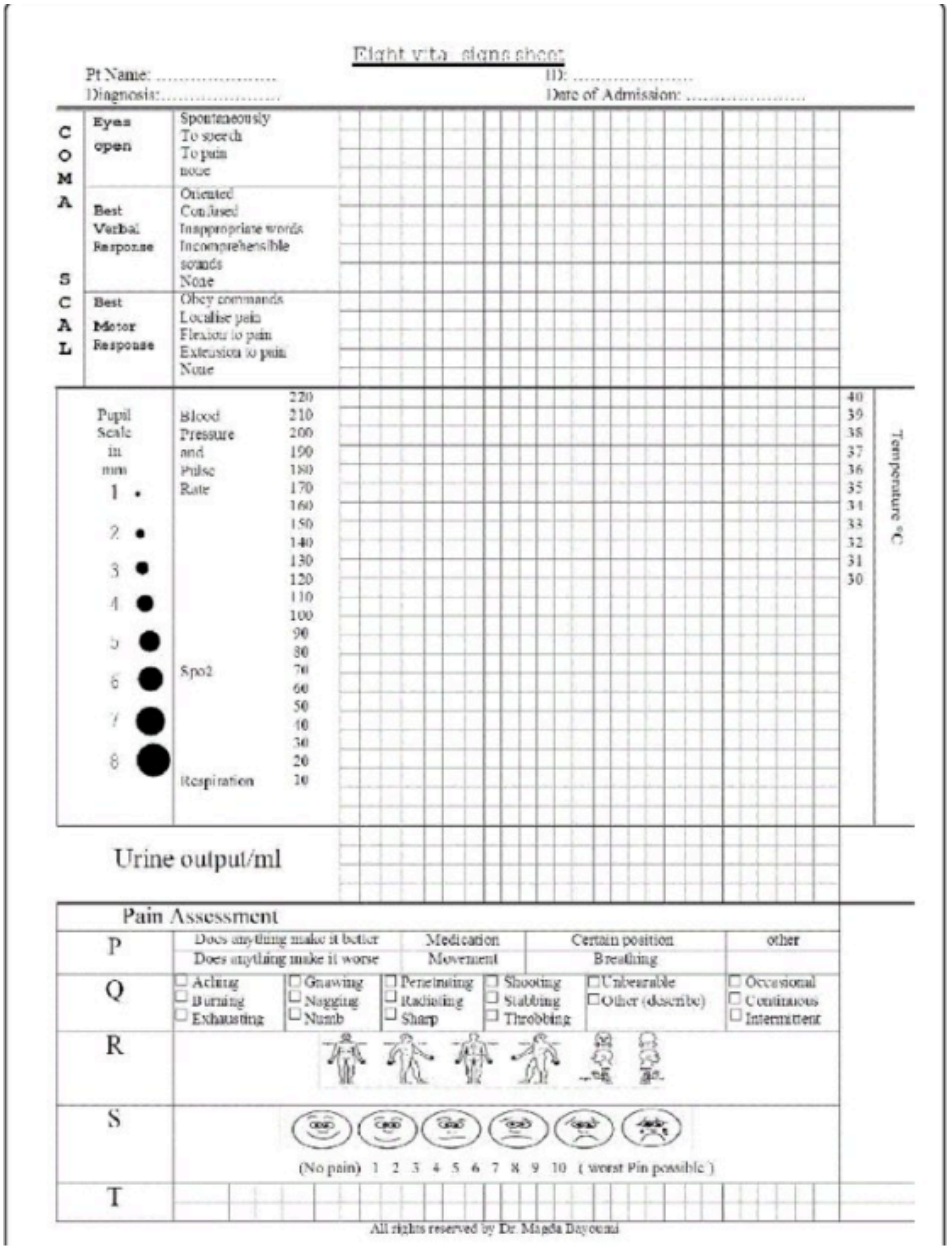


Figure 2 Early vital signs documentation

It is noteworthy that there has been a progression in understanding of clinical signals that predict a pending adverse event, as demonstrated by the evolution of data added to regression analysis in deterioration studies (see Table 1).

Table 1 Physiological parameters predicting increased risk of death

Buist *et al* (2004)	**SOCCER study (Harrison *et al* (2006)**	**Gerry *et al* (2017)**	**Watkinson *et al* (2019)**
Glasgow Coma Score Onset of coma, Hypotension <90mmhg Respiratory rate <6 min Oxygen saturation <90% Bradycardia >30 min	Oxygen Saturations Systolic blood Pulse rate Temperature Breathlessness	Respiratory rate Heart rate Oxygen saturation Temperature Systolic blood pressure Level of consciousness Age Sex	Respiratory rate Heart rate Oxygen saturation Temperature Systolic blood pressure Level of consciousness Age Sex Laboratory results Diagnostic codes Race Social deprivation Index Surgery type

The early literature focused on a standard physiological data set such as blood pressure, heart rate, and respiratory rate (Buist *et al.*, 2004). The SOCCER study (Harrison *et al.*, 2006) authors then expanded on existing work and distinguished between Early Signs (ES) and Late Signs (LS) of patient deterioration, giving more detailed physiological ranges of concern and their associated risks. Recently, there has been a tendency for Early Warning Score-based (EWS) prediction models to incorporate other patient parameters, such as patient age and sex, to assist in the prediction of deterioration risk (Gerry *et al.*, 2017). Frailty has also been proposed as a potential predictor given that the more frail patients have increased odds of hospital

death (Redfern *et al.*, 2020; Malycha *et al.*, 2022). However, this variable has not been fully utilised due to limitations in the way organisations measure this.

When assessing the ability of vital signs to predict an event there are also differences in the strength of association between vital signs and the various outcomes. For instance, if the primary outcome is an ICU admission, there is a much stronger correlation with hypoxia, and if the outcome of interest is death, there is a stronger correlation with systolic hypotension (Churpek *et al.*, 2013). The driver to model and understand deterioration, based on the presence of abnormalities in vital signs and other clinical observations, is to prospectively assist clinicians in predicting patient risk, facilitate early intervention, promote rescue and reduce FTR (Jones *et al.*, 2013; Weenk *et al.*, 2017).

1.2.2. Failure to Rescue (FTR)

The death of a patient following reversible complications is classified a FTR event, although an agreed definition does not exist (Hall *et al.*, 2020). Despite literature that describes warning signs of impending deterioration, as identified by studies, and models that can predict those patients with increased mortality and ICU admission odds, patients continue to die and fail to be rescued. Early FTR studies examining care outcomes for NHS surgical patients suggest a prevalence of 7-17% (Jones *et al.*, 2010). More recent estimations in surgical populations are still between 8-16.9% (Johnston, *et al.*, 2015) indicating little change to overall rates. To assess an organisation's delivery of care during patient deterioration events, studies employ primary outcome measures that largely centre around IHCA and unplanned admissions to ICU, rates of which are

influenced by human, staffing, and organisational factors, not simply clinicians' response to abnormal vital signs.

1.2.2.1. Measures of FTR-Cardiac arrests

It is clear that patient deterioration that is not managed effectively can lead to IHCA (Hogan *et al.*, 2019), with abnormal vital signs often preceding an event (Buist *et al.*, 2004; Hogan *et al.*, 2019). In their study of over 7000 patients within a Norwegian hospital, Andersen (2016) found 50% of patients who had a cardiac arrest had documented abnormal vital signs 1-4 hours prior, of these 13% were severely abnormal. The National Cardiac Arrest Audit (NCAA) (*ICNARC - National Cardiac Arrest Audit (NCAA)*, 2021), the largest central database for IHCA events, suggests that survival rates following cardiac arrests are low, with Return of Spontaneous Circulation (ROSC) between 47-48% but other studies suggest much lower rates of survival (Hogan *et al.*, 2019). NCAA data also show that, between 2015 and 2021, 30-40% of IHCA are admitted to ICU (see Table 2).

Table 2 Comparisons of National Cardiac Arrest Audit Data 2015-2016 and 2020-2021

	NCAA Data 2015/16	NCAA Data 2020/21
Number of audit sites (Hospitals)	188	171
Total number of hospital admissions	12,564,141	10,401,902
Total number of cardiac arrests	16,025	10,414
Return Of Spontaneous Circulation n (%)	7,832 (48.9%)	4,924 (47.3%)
Number of patients who went to ICU	2,884 (34.9%)	2,178 (41.9%)

Nationally adjusted data (minimising confounders) suggest that there are variations between Trusts in terms of IHCA and survival rates indicating organisational influences on outcomes (Hogan *et al.*, 2019). This is supported by data demonstrating that 33% of all avoidable patient deaths relate to monitoring and escalation responses (Hogan *et al.*, 2019). A reduction in IHCA rates from 4.3/1000 to 1.1/1000 has been observed through addressing modifiable organisational influences, improving the reliability of clinical observations, documentation of target saturations, identification of hypoxia and the completion of a structured response to hypoxia (McGregor *et al.*, 2017). Local safety cultures may also explain why patients cared for in areas deemed not appropriate for their illness are 12 times more likely to suffer an avoidable cardiac arrest (Hodgetts *et al.*, 2002). These data indicate that the quality of care delivered to patients affects their chances of survival and risk of adverse events such as unplanned ICU admissions.

1.2.2.2. Measures of FTR- Unplanned admission or readmission to ICU

Poor recognition of pending deterioration and adverse events has a significant impact on critical care services as indicated by the large number of IHCAs requiring ICU. This impacts critical care's ability to serve the local organisation and population. Critical care beds are a limited and expensive healthcare resource, with the UK having lower ICU beds compared with other European countries (see Figure 3) (OECD.org, 2020).

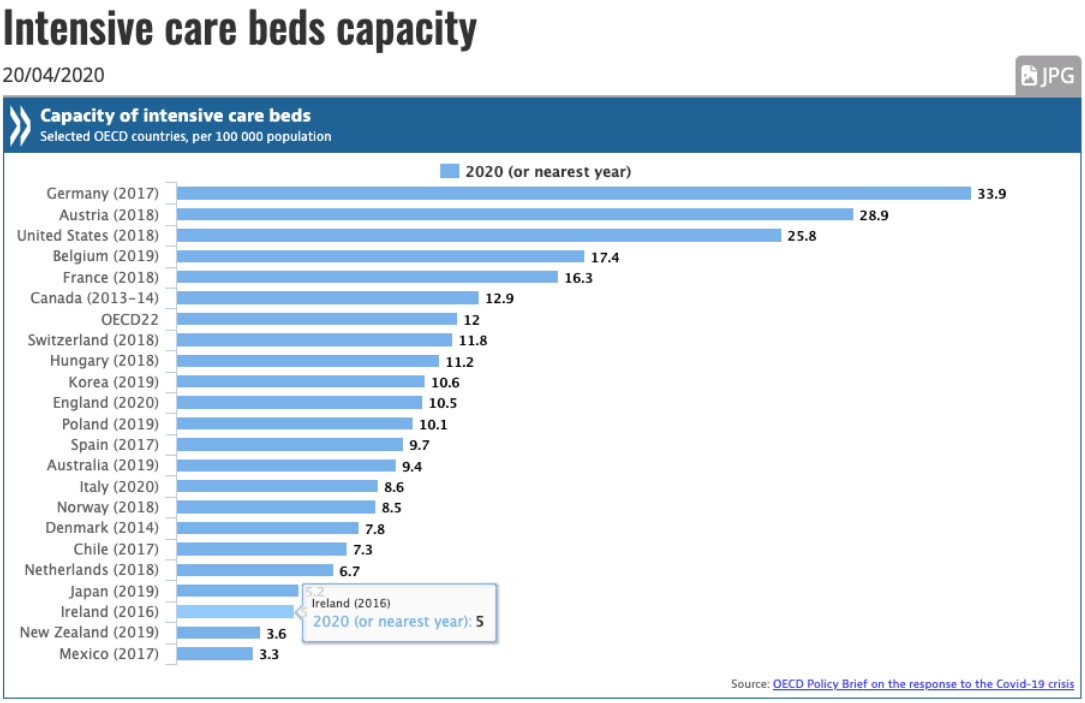


Figure 3 Hospital beds per 1,000 inhabitants: UK and OECD EU nations (OECD.org, 2020)

Despite ICU bed capacity issues, the Intensive Care National Audit and Research Centre (ICNARC) data suggest that 1% of unplanned ICU admissions may be avoidable (Redfern *et al.*, 2020). Furthermore, unplanned admission to ICU has long been associated with significant morbidity and mortality (McQuillan *et al.*, 1998; Magor *et*

al., 2022). A landmark study that looked at the care of patients prior to admission to the ICU was undertaken by McQuillan (1998) who identified that 40% were potentially avoidable. More recently, lower rates of ICU admission avoidability of 13% have been suggested (Dhillon *et al.*, 2017), which may demonstrate improvements in care or that initial rates were overestimated. The timeliness of an ICU admissions can also impact survival, with delays being independently associated with higher patient mortality (Kiekkas *et al.*, 2022).

Certain patient characteristics appear to make patients more susceptible to unplanned ICU admissions, such as being male, increasing age, heart failure and Diabetes (Malycha *et al.*, 2019). Avoidable adverse events preceding an ICU (re)admission include diagnostic errors, inappropriate or inadequate treatment, technical error, adverse drug event, inappropriate IV fluid management, problems with medical or surgical procedure (Garry *et al.*, 2014). Numerous post-ICU problems in care have also been identified, such as suboptimal rehabilitation, poor nutrition plans, out-of-hour discharges and inadequate sepsis management (Vollam *et al.*, 2020). Similar to ICU admission, readmission to ICU is associated with 2-10 times higher hospital mortality rate than those that survive an ICU admission and do not require a readmission (Rosenberg and Watts, 2000). Improving escalation of care would undoubtedly improve outcomes for patients requiring an ICU admission. To understand organisational factors contributing to patients receiving variable care standards in the general ward patient population, nurse staffing, human factors and organisational factors will be explored.

1.2.2.3. Factors associated with FTR-Nurse Staffing

The Mid Staffordshire NHS Trust was identified as having a higher-than-expected standardised mortality ratio (SMR), indicating between 400-1200 more patient deaths occurred than were expected (Ball *et al*., 2014). A pivotal public enquiry into the organisation identified that understaffed clinical areas led to poor standards of nursing care (Francis, 2013). Currently, there are no legislated minimum staffing levels in UK hospitals other than for Critical Care (Intensive Care Society, 2016). Rather ironically, a study from the US (Lasater *et al.*, 2021) estimated the nursing adjusted cost (adjusted for fixed hospital characteristics and size) of reducing patient mortality by 1% to be a modest $2035, as well leading to a reduction in complications, failure to-rescue, readmission, and shorter lengths of stay. Even more interesting is the fact that the greatest improvement in patient outcomes was seen for the most at-risk patients, likely to be because nurses are often the first responders in deterioration episodes (Lasater *et al.*, 2021).

Staffing levels affect many patients outcomes including length of stay, restraint use, quality of care, mortality, medication errors and FTR (Twigg *et al.*, 2019). Higher numbers of registered nurses has been shown to result in lower rates of failure to respond in the deteriorating ward patient (Smith, *et al.*, 2020). This may be, in part, related to the late or missed observations being higher during shifts with lower RN staffing levels (Redfern *et al.*, 2019). This suggestion corroborates findings from a large national cross sectional survey study of nearly 3000 registered nurses, which showed higher mean numbers of missed care items (mean number of missed care items 7.78) in wards that were deemed 'failing' when compared to those who were deemed

'excellent' (mean number of missed care items 2.37) (Ball *et al.*, 2014). Another finding from this survey was that nurses reported patient surveillance was often left "undone" and therefore may explain the causal mechanism between staffing and FTR (Ball *et al.*, 2014).

A mismatch between staffing and acuity is problematic. Evidence suggests that in ward areas with lower than average staffing levels, patients have an increased risk of death by 3% for every day in suboptimal staffing conditions (Griffiths *et al.*, 2018). This finding has been replicated internationally in several other countries such as Korea, USA and Belgium (Ball *et al.*, 2014). In recent years, the focus on tracking acuity of hospital in-patients has increased (NICE, 2014) to encourage organisations to balance workload with appropriate staffing levels, reducing the negative Human Factors (HF) effects on patient care (Department of Health of United Kingdom, 2012). Workload and poor skill mix were identified in a realist evaluation as two of the primary HF influencing poor escalation practices (McGaughey *et al.*, 2017).

1.2.2.4. Factors associated with FTR-Human Factors

Staff escalation behaviour frequently deviates from expected in relation to the frequency of monitoring, score calculation and escalation (Smith, *et al.*, 2020). Several HFs influence how a patient is managed (see Figure 4) during a deterioration event and it has been noted within the literature that a more in-depth understanding is required of the interpersonal interactions that can affect escalation outcomes (Ghaferi and Dimick, 2017).

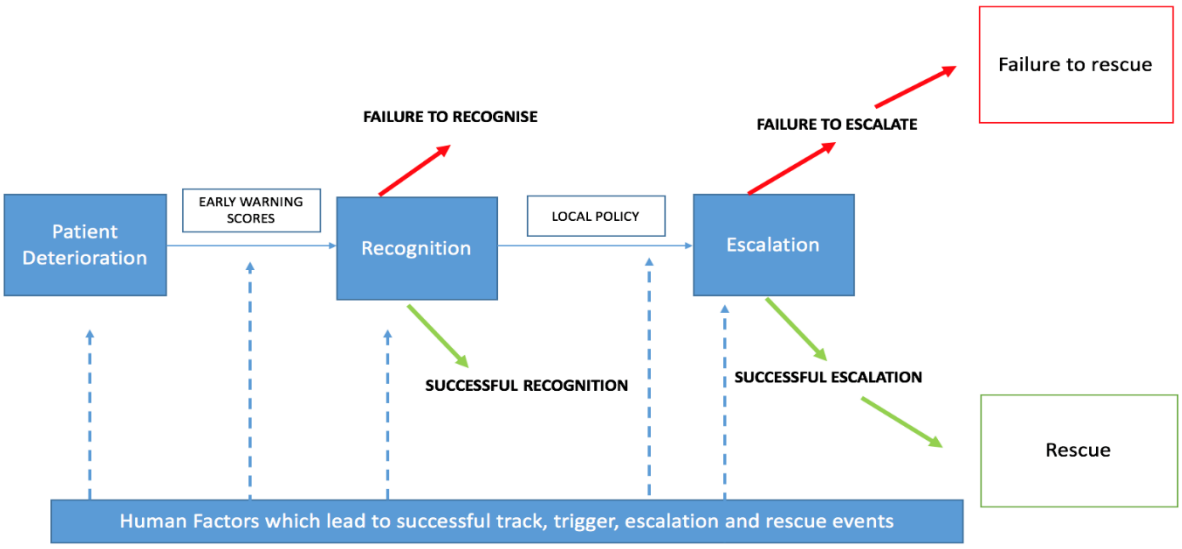


Figure 4 Representation of the influencers on escalation leading to failure to rescue or rescue

Over the past decade, communication problems were commonly reported in FTR events (Findlay *et al.*, 2012; Johnston, *et al.*, 2015; Ghaferi and Dimick, 2017) with critical information being missed or not communicated in a timely manner (Ede *et al.*, 2019). Communication escalation barriers may include negative emotions associated with fear of reprimand, making an error or causing team conflict (Astroth *et al.*, 2013; Massey *et al.*, 2017; Petersen *et al.*, 2017) when attempting to escalate. Often, deterioration communication is challenging when sick patients do not generate a trigger score (e.g. pain or bleeding), but staff have concerns (Andrews and Waterman, 2005; Ede *et al.*, 2019). Escalation protocols were felt to pose barriers in these cases (Andrews and Waterman, 2005; Ede *et al.*, 2019).

1.2.2.5. Factors associated with FTR- Organisational Factors

There are also some organisational differences that account for responses to patient deterioration with evidence suggesting complication rates do not differ significantly between hospitals, but mortality rates do (Gonzalez *et al.*, 2014). For example, patients

can be three times more likely to die following a complication in some NHS Trusts compared to others (Gonzalez *et al.*, 2014). A systematic review (n=33) explored features of hospitals with poor safety performance, as defined by below-average patient outcomes (Vaughn *et al.*, 2019). Several performance domains were identified; organisational culture, not focusing on improvement, poor staffing, poor use of digital solutions, system shocks (staff turnover, poor reports), and dysfunctional relationships with other hospitals (Vaughn *et al.*, 2019). Positive organisational factors, which actively encourage escalation, have been identified as hospital volume (number of similar procedures completed such as oesophagostomy surgery), teaching status and staffing ratios (Ghaferi *et al.*, 2010).

Hospital resources and infrastructure to care for unwell and deteriorating patients also varies between NHS Trusts. An example of this is Critical Care Outreach Service (CCOS), which is a service that was originally initiated in 2000 by the Department of Health to support the management of the deteriorating ward patient (NICE Clinical Guidelines, 2007). Referral to CCOS can be initiated by a triggering EWS and clinical response framework (see Figure 5) when a patient scores ≥ 7 (Royal College of Physicians, 2017) or by a general clinical concern criterion. Original service reviews suggest the focus of these teams are to avert or facilitate timely admissions, enable ICU discharges and share critical care skills with ward staff (Rowan *et al.*, 2004). During an adverse event there can be a mismatch between resources available (knowledge, skills, drugs, critical care provision) and patient need, which the CCOS can bridge (Jones *et al.*, 2017).

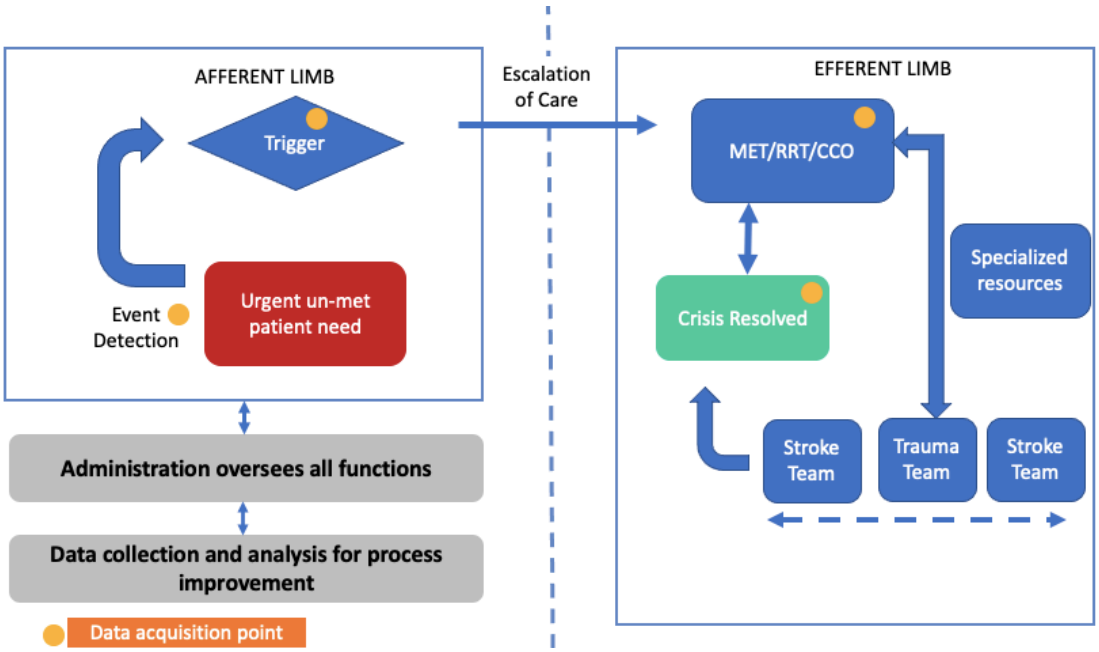


Figure 5 Adapted DeVita, et al. (2006) 'Findings of the First Consensus Conference on Medical Emergency Teams', Critical Care Medicine, 34(9), pp. 2463–2478.

Figure 5 portrays the most widely recognised diagram depicting mechanisms of escalation and was first published in 2006 (DeVita *et al.*, 2006). This illustrates the afferent and efferent limbs, which are activated following specific clinical prompts. The afferent limb is the detection of illness through EWS, clinical concern or patient concern, whilst the efferent limb is the responding team that provides critical care expertise in the management of deterioration and medical emergencies. Any barrier to these elements can increase the risk of a FTR event.

Many configurations and variables exist related to CCOS, which include calling criteria, team configurations, differences in deterioration responses, patient differences and finally clinical environments (Subbe *et al.*, 2019). A systematic review identified that these critical care services were heterogeneric and therefore difficult to evaluate (Johnston, *et al.*, 2015). It is unsurprising then that another review concluded that there is a lack of strong evidence of these systems improving patient outcomes such as

cardiac arrest rates (Hogan *et al.*, 2019). However, whilst there is a paucity of quantitative evidence for CCOS or RRT, there is qualitative evidence that ward staff value the service, feel that they improve communication and are an experienced resource for junior nurses when attempting to escalate (Hyde-Wyatt and Garside, 2020).

1.2.3. Escalation of care

An escalation of care is the recognition, communication and management of patient deterioration (Johnston, *et al.*, 2015) and has historically been viewed as inadequate in FTR events (Fox, 2005; Hogan *et al.*, 2012). An early NCEPOD report (Findlay *et al.*, 2012) found that this is often due to staff confusion in escalation pathways (Mukhal *et al.*, 2013). Escalation is a multi-step process, having up to 33 core tasks (Johnston, *et al.*, 2015) and the primary intervention implemented to simplify and promote a successful escalation of care are EWS tools.

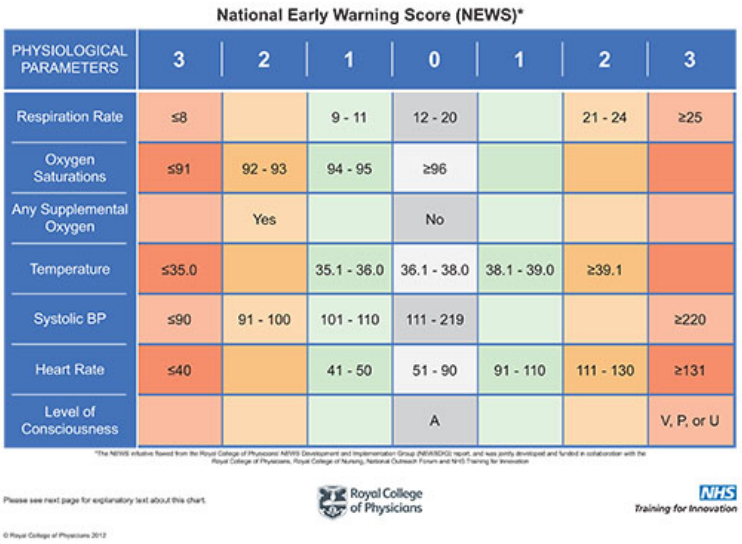
1.2.3.1. Early Warning Scores (EWS) Tools

EWS tools were developed to assist clinical staff in the detection of deterioration by identifying at risk patients, guide early intervention and avoid preventable mortality (Forster, *et al.*, 2018). EWS are derived from the patient's vital signs measurements, such as blood pressure, oxygen levels and respiratory rate and assign a physiological value reflecting how deviated they are from the norm (Pimentel *et al.*, 2018). The efficacy of these are predominantly evaluated through predictions of events such as death and IHCA, or a composite of these (Gerry *et al.*, 2020).

Early criticisms of EWS surround the single use of deranged vital signs that cannot account for individual patient factors (co-morbidity, nature of illness, frailty) or organisational factors (Forster, *et al.*, 2018). It has been increasingly recognised that the norm is something very difficult to quantify and therefore there was a spate of adjusted EWS for certain populations, such as those with respiratory failure on a background of chronic lung conditions (Eccles *et al.*, 2014). This resulted in many EWS being used and developed (Smith *et al.*, 2013) that were methodologically weak, did not perform as well as expected and may have had a negative impact on patient care (Gerry *et al.*, 2020). Therefore, these criticisms were a driver for standardisation.

1.2.3.2. National Early Warning Score (NEWS)

In 2012, the Royal College of Physicians proposed the use of a National Early Warning Score, which was to provide a standardised scoring system across the NHS (RCP, 2012) (see Figure 6).



National Early Warning Score (NEWS)*

PHYSIOLOGICAL PARAMETERS	3	2	1	0	1	2	3
Respiration Rate	≤8		9 - 11	12 - 20		21 - 24	≥25
Oxygen Saturations	≤91	92 - 93	94 - 95	≥96			
Any Supplemental Oxygen		Yes		No			
Temperature	≤35.0		35.1 - 36.0	36.1 - 38.0	38.1 - 39.0	≥39.1	
Systolic BP	≤90	91 - 100	101 - 110	111 - 219			≥220
Heart Rate	≤40		41 - 50	51 - 90	91 - 110	111 - 130	≥131
Level of Consciousness				A			V, P, or U

Figure 6 Scoring system for NEWS (RCP, 2012).

The efficacy of the NEWS scoring system has been assessed through sensitivity and specificity testing. Sensitivity relates to a tool's ability to identify true positives and specificity relates to a tool's ability to identify a true negative. Changes to a tool's sensitivity or specificity will have a significant effect on clinical workload (with higher numbers of patients triggering a clinical response) and therefore is an important factor in their evaluation (Forster, *et al.*, 2018). Originally, when NEWS was compared to other warning systems in use, through AUROC (area under the receiver-operating characteristic) analyses, it performed better in terms of predicting cardiac arrest, ICU admission, death and any outcome (Smith *et al.*, 2013). Whilst NEWS performance was better than preceding tools, it continued to perform weakly in certain populations such as chronic lung patients who would falsely trigger due to low (but chronic) oxygen levels and also it did not take into account increasing oxygen requirements which is a significant clinical indicator of illness (RCP, 2017; Pimentel *et al.*, 2018). It should be noted that first iterations of NEWS were predominantly recorded on paper charts and

the use of electronic track and trigger systems have improved documentation (Hogan *et al.*, 2019).

1.2.3.3. National Early Warning Score (NEWS)2

In 2017, the Royal College of Physicians proposed an update with a refined NEWS2 model, which was endorsed by NHS England and NHS Improvement (RCP, 2017) (see Figure 7 and Figure 8).

Chart 1: The NEWS scoring system

Physiological parameter	Score 3	2	1	0	1	2	3
Respiration rate (per minute)	≤8		9–11	12–20		21–24	≥25
SpO_2 Scale 1 (%)	≤91	92–93	94–95	≥96			
SpO_2 Scale 2 (%)	≤83	84–85	86–87	88–92 ≥93 on air	93–94 on oxygen	95–96 on oxygen	≥97 on oxygen
Air or oxygen?		Oxygen		Air			
Systolic blood pressure (mmHg)	≤90	91–100	101–110	111–219			≥220
Pulse (per minute)	≤40		41–50	51–90	91–110	111–130	≥131
Consciousness				Alert			CVPU
Temperature (°C)	≤35.0		35.1–36.0	36.1–38.0	38.1–39.0	≥39.1	

Figure 7 Scoring system for NEWS2 with variable SpO2 scales for established respiratory failure patients (RCP, 2017).

Chart 4: Clinical response to the NEWS trigger thresholds

NEW score	Frequency of monitoring	Clinical response
0	Minimum 12 hourly	• Continue routine NEWS monitoring
Total 1–4	Minimum 4–6 hourly	• Inform registered nurse, who must assess the patient • Registered nurse decides whether increased frequency of monitoring and/or escalation of care is required
3 in single parameter	Minimum 1 hourly	• Registered nurse to inform medical team caring for the patient, who will review and decide whether escalation of care is necessary
Total 5 or more Urgent response threshold	Minimum 1 hourly	• Registered nurse to immediately inform the medical team caring for the patient • Registered nurse to request urgent assessment by a clinician or team with core competencies in the care of acutely ill patients • Provide clinical care in an environment with monitoring facilities
Total 7 or more Emergency response threshold	Continuous monitoring of vital signs	• Registered nurse to immediately inform the medical team caring for the patient – this should be at least at specialist registrar level • Emergency assessment by a team with critical care competencies, including practitioner(s) with advanced airway management skills • Consider transfer of care to a level 2 or 3 clinical care facility, ie higher-dependency unit or ICU • Clinical care in an environment with monitoring facilities

Figure 8 Clinical response to the NEWS trigger thresholds (Royal College of Physicians, 2017)

Specifically, the NEWS2 framework was introduced to improve identification of sepsis and to implement a dedicated SpO2 scoring scale (Scale 2) for use in patients with hypercapnic respiratory failure and the variable “new confusion” (RCP, 2017; Thorén *et al.*, 2022). Despite being developed to address concerns raised in the previous NEWS model, NEWS2 has a lower specificity for respiratory failure patients than the previous iteration (Pimentel *et al.*, 2018). A recent paper also indicates that NEWS2 may not be effective for patients admitted to hospital with Covid-19 infections, as the majority of their physiological parameters remain normal but with deranged SpO2 and oxygen requirements (Pimentel *et al.*, 2020).

1.2.4. Safety-II Approach in Patient Safety

The previous sections demonstrate an evolution of our understanding and care of patient deterioration events. However, healthcare organisational learning about FTR has employed a narrow lens (Sujan, 2018), with care reviews over the past two decades limited to adverse events analysis or mortality reviews (Vincent *et al.*, 2001; Hogan *et al.*, 2012). Whilst the NHS's Five Year Plan stresses the need to 'learn from patient deaths' (NHS England, 2017), traditionally used root cause analysis (RCA) has been suggested to hinder organisational safety understanding (Kellogg *et al.*, 2017). Focusing on deaths is a valuable approach to learning but, given that the healthcare system and processes are increasingly intractable, an absolute root cause for events may not be isolated.

Existing literature does not describe what can be learnt from rescue and how clinical staff create safety. Identifying how staff create safety successfully is integral to designing safer healthcare systems and processes. This is known as the Safety II perspective (Eurocontrol, 2013; Sujan, 2018). Learning from success is a complementary approach to learning from failure, highlighted in emerging patient safety theories and used in industry related high-reliability organisations (Eurocontrol, 2013; Sujan, 2018). Escalation occurs more frequently than not, but there have been limited studies exploring staff safety-related behaviours (such as problem anticipation or checking behaviours), rescue or how these behaviours create positive escalation outcomes (Ghaferi and Dimick, 2017).

1.3. Theoretical Framework-The System Initiative for Patient Safety (SEIPS)

Previous approaches to patient safety have not reaped huge rewards and this may be in part because of the lens applied to problems and solutions (Sujan *et al.*, 2016). A system approach is now the overarching philosophy in patient safety, Safety II realms, and is the foundation for the recent Patient Safety Incident Response Framework (North Bristol NHS Trust, 2020). Therefore, problems and potential solutions are identified and examined across a much broader landscape.

The SUFFICE study was designed to improve our understanding of the process of escalation and rescue, which are complex phenomena in a complex system. The design of the study drew heavily from complex interventions research (Richards, 2017) in order to comprehensively address the research focus. A complementary HF theoretical approach used in this study is based on the System Initiative for Patient Safety (SEIPS) framework that encourages 'systems thinking' (see Figure 9).

Applied Ergonomics 8

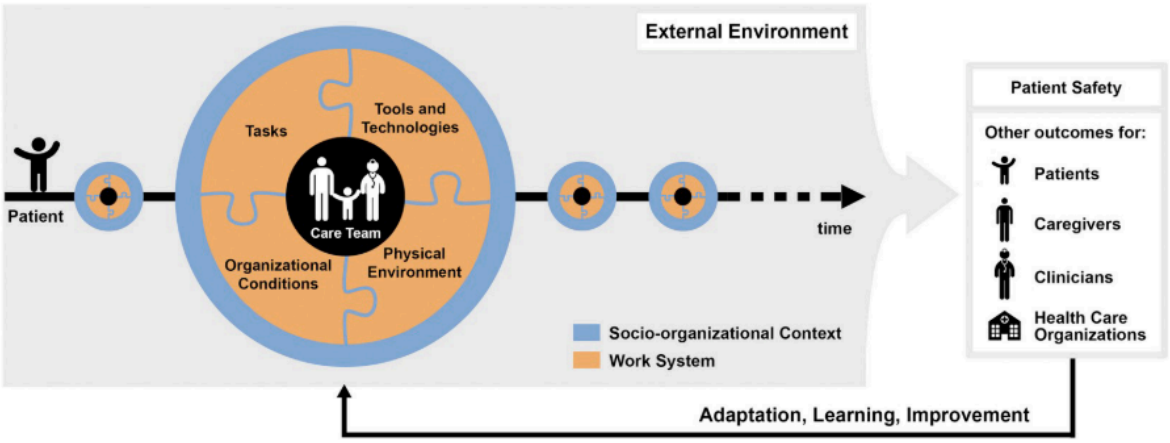


Figure 9 SEIPS Framework supporting the SUFFICE study. Permission to reproduce this image has been granted by Professor Carayon. Carayon, P., Wooldridge, A., Hoonakker, P., Hundt, A. S. and Kelly, M. M. (2020) 'SEIPS 3.0: Human-centered design of the patient journey for patient safety', Applied Ergonomics. Elsevier Ltd,

84(December 2018), p. 103033.

SEIPS was originally described as identifying domains of interest within a given system such as healthcare, and includes tools, technology, people, environment, tasks and organisation (Carayon, *et al.*, 2014), drawing on the seminal Donabedian Model (Donabedian, 1978). This framework has a strong precedence of being useful within healthcare studies (Carayon, 2006a; Lumley *et al.*, 2020; Ede *et al.*, 2021). It illustrates the core components of a system, how they interact and connect to give an understanding of outcomes (McNab *et al.*, 2020).

SEIPS supported each phase of the SUFFICE study (see Figure 10 study design flow diagram).

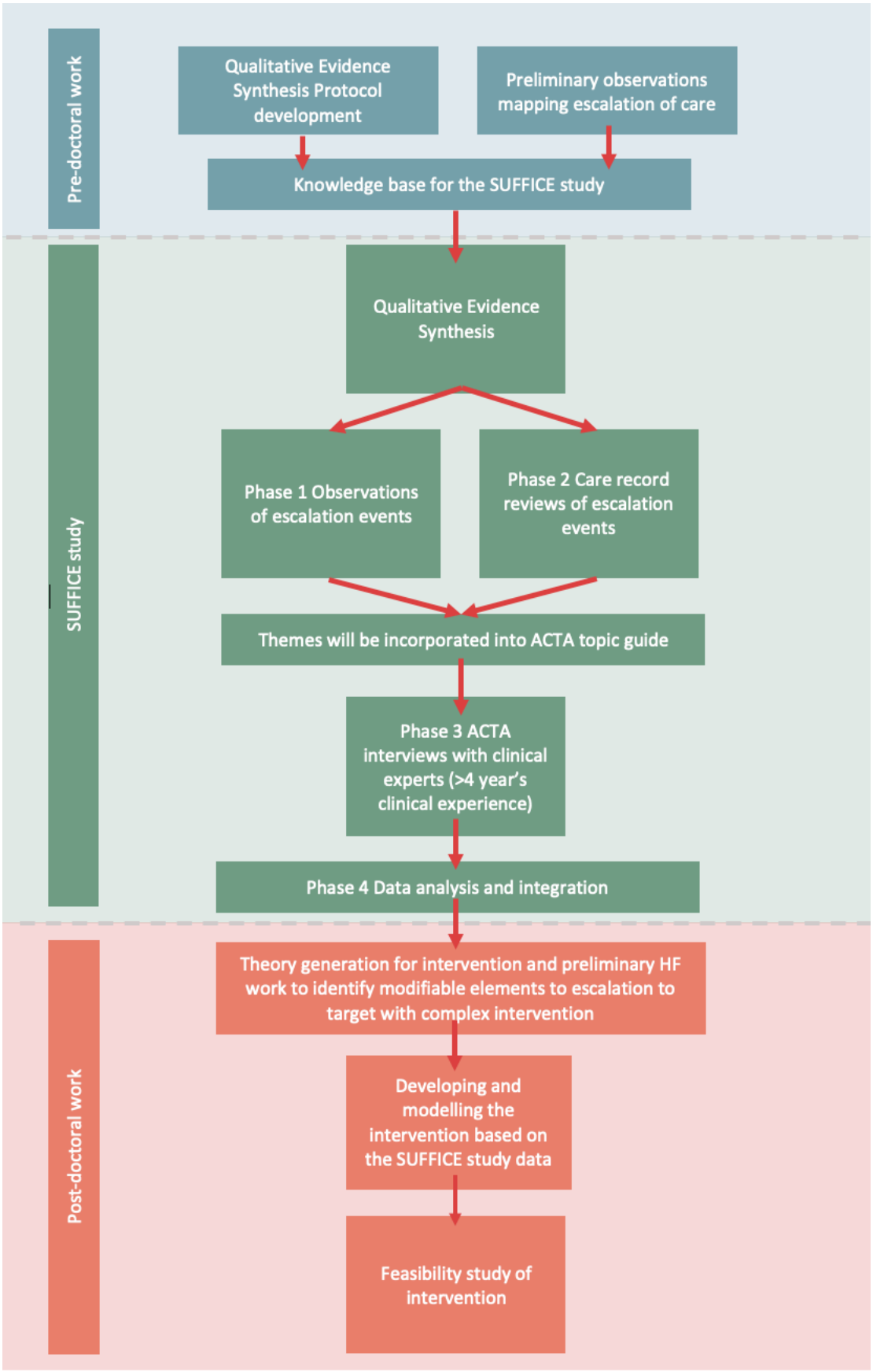


Figure 10 SUFFICE study design flow diagram

The primary aim of Phase 1 was to observe collaborative process of escalation and rescue. This was guided by SEIPS, ensuring observations explored all areas of the ward system, to identify how clinical staff interact with each other, EWS systems and their environment whilst trying to escalate a patient's care. The primary aim of Phase 2 was to explore success factors to rescue, identified from care record reviews. During analysis, SEIPS influenced the identification of system success factors that facilitate staff to escalate. Finally, the aim of Phase 3 was to understand how clinical staff rescue unwell ward patients through staff interviews. Again, this was supported with SEIPS during analysis, encouraging the research to focus on the people (clinical staff or patients) who interact with the task of escalating. Thus, a system thinking approach (supported by the SIEPS framework) has been pivotal in this study, impacting on the data collected, the conclusions drawn from the data and then ultimately clinical recommendations made.

1.4. Researcher's Background

The researcher is a senior critical care nurse with over 15 years' clinical, and 5 years' research, experience being an honorary critical care researcher for a large university in England. With an interest in Human Factors and Ergonomics (HFE) methods, and the shift in patient safety views, the researcher was keen to understand what can be learnt from successful events. The ethos behind this view is that it seems at odds to try and measure something (patient safety) by its absence. An appreciation that successful events are largely unrecorded and captured within most hospital processes has driven

the researcher to further understand how staff create safety and rescue patients from deterioration.

Whilst the researcher's background is certainly advantageous, there may be certain biases that come with this extent of clinical experience and knowledge. Rigorous inquiry requires a researcher to provide transparency to their research process including personal reflections and bias (Malinski and Welch, 2004). To ensure that methods within this study were as rigorous as possible the researcher undertook work that involved reflecting on any possible bias and mitigations for this (see Appendix 1).

1.5. Covid-19 pandemic

The Covid-19 pandemic has been the greatest challenge faced by the National Health Service (NHS) since its creation and was a prominent factor during this study. The severity of respiratory failure and high contagion index of SARS-Cov-2 resulted in unprecedented patient numbers requiring higher level care in either a High Dependency Unit (HDU) or ICU (*Italian Association of Respiratory Physiotherapists (ARIR)*, 2019). In response, the NHS increased bed capacity (NICE, 2020), utilised staffing models not seen before (NHS England, 2020) and changed medical strategies.

Important questions were raised as to how escalation of care, specifically deterioration detection, communication, and management (escalation processes), in patients with Covid-19, may differ or be similar, more effective, or less effective. A recent systematic review focusing on the use of EWS with Covid-19 positive patients (in primary care) suggested that further research is warranted (Greenhalgh *et al.*, 2020). Covid-19 patients also presented with an unpredictable trajectory in terms of physiological

stability, and it would be prudent to understand how hospital processes and staff mitigated this unpredictability, what safety mechanisms were implemented and how the process of rescue unfolded.

1.6. Research aims and objectives

The overarching focus of this research was to gain a greater understanding of the process of rescue by observing staff interactions during rescue events, review notes of patients who experienced a deterioration and understand success factors to escalation events as perceived by clinical experts. The goal was to answer the question,

What factors affect successful escalation of care and how can these be applied more effectively?

The objectives of each study phase were to:

i) To identify success factors to escalation by observing 200-400 escalation of care events in both Covid-19 positive and negative patients and develop a theoretical understanding of care escalation and rescue.

ii) To identify success factors to escalation by examining 200-400 care records of patients who clinically deteriorated (EWS $\geq$7) in the ward, avoided ICU and survived and compare with patients who deteriorated (EWS $\geq$7) in the ward, went to ICU and died.

iii) To understand factors that affect successful escalation of care from 30 expert staff interviews and identifying how these could be applied effectively across healthcare setting.

1.7. Significance of the study

Previous FTR and care escalation studies have focused on patient death or care escalation failure points (Andrews and Waterman, 2005; Shearer *et al.*, 2012; Astroth *et al.*, 2013; Ede *et al.*, 2019a), leading to a dearth of knowledge surrounding the process of rescue or successful escalation. The significance of this study is that it addresses this deficit in knowledge by exploring escalation and rescue events, ultimately filling both a research and clinical gap. This is the first study, to our knowledge, where the output is a framework of escalation success factors, to facilitate direct and measurable clinical improvements to patient outcomes. Targeted HF interventions, aiming to improve consistency of success factors during escalation, may reduce hospital mortality, morbidity, unnecessary ICU admissions or facilitate timely ICU admission (Johnston, *et al.*, 2015; Hogan *et al.*, 2019). This will be ethically significant by saving lives and financially beneficial to the NHS. Using data from two NHS sites makes results more generalisable to the wider NHS.

1.8. Overview of the research

This study explores behaviours, actions, tasks, communication, and the collaborative process of rescue through escalation. SUFFICE utilises a mixed methods approach, exploring escalation through deterioration event observations, care record reviews and in-depth interviewing of experienced staff and their experiences of rescue and escalation of care.

1.9. Thesis Structure

Chapter 1 provides the background to the phenomenon of interest, clarifies the aims and objectives of the study, and signposts to the structure of the thesis. In Chapter 2, the published Qualitative Evidence Synthesis is provided; this reviewed the current qualitative literature exploring care escalation in the acute ward setting. Specifically, this review identified that EWS were not suitable for all patients, particularly those who do not meet the escalation threshold. Gaps in the literature were identified and the review finally signposted to areas requiring further investigation. Chapter 3 includes the published study protocol, which explicitly details study methods, data collection and analysis. To supplement this published protocol, the rationale for the use of a pragmatist methodology is also provided. The study results are presented in three chapters (4, 5 and 6) and consist of one traditional thesis chapter and two submitted manuscripts: observations of escalation events (Chapter 4-submitted), Care Record Review of rescue events (Chapter 5) and the Applied Cognitive Task Analysis interviews (Chapter 6-submitted). Each results chapter also includes the implications of those results for the SUFFICE study.

Chapter 7 provides the published critical commentary describing the Patient and Public Involvement and Engagement work stream associated with the SUFFICE study. In Chapter 8, the results of all phases are discussed, and all the data are integrated to give a greater understanding of the process of rescue and escalation of care. Results are reviewed, drawing on current literature to further understanding whilst exploring the implications that the study findings may have for the care of unwell ward patients.

The Framework of Escalation Success Factors is presented as the discussion builds and limitations of the research are also described.

The conclusion Chapter (Chapter 9) highlights the original contribution to knowledge, presents answers to the original research question, and provides a summary conclusion.

1.10. Conclusion

It is possible that the care of the deteriorating ward patient may be further improved by understanding the care of patients who were successfully escalated or rescued. This chapter has provided a background to the study, outlined the aims and objectives of the study, and signposted to the structure of the thesis. The following chapter presents the findings of a Qualitative Evidence Synthesis detailing the human factors that affect escalation of care.

2. Chapter Two: Qualitative Evidence Synthesis

2.1. Introduction

Chapter 1 introduced the literature surrounding patient deterioration, FTR and escalation of care. This chapter presents a Qualitative Evidence Synthesis (QES) of studies that explore human factors affecting escalation of care in the acute ward setting. The review was registered with PROSPERO (CRD42018104745) and full methods protocol published (Open Access):

Ede, J. *et al.* (2019) 'How human factors affect escalation of care: a protocol for a qualitative evidence synthesis of studies', *BMJ Open*, 9(4), p. e025969.

The QES has been published in the *British Medical Journal (BMJ) Open Quality* journal (Open Access):

Ede, J. *et al.* (2021) 'Human factors in escalating acute ward care: a qualitative evidence synthesis.' *BMJ Open Quality*, 10(1).

This chapter includes the published manuscript and concludes by drawing together the key findings from the work and how this informed the SUFFICE Study.

2.2. Published QES Manuscript

Open access Systematic review

BMJ Open Quality

Human factors in escalating acute ward care: a qualitative evidence synthesis

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ABSTRACT

Background Identifying how human factors affect clinical staff recognition and managment of the deteriorating ward patient may inform process improvements. We systematically reviewed the literature to identify (1) how human factors affect ward care escalation (2) gaps in the current literature and (3) critique literature methodologies.

Methods We undertook a Qualitative Evidence Synthesis of care escalation studies. We searched MEDLINE, EMBASE and CINHAL from inception to September 2019. We used the Critical Appraisal Skills Programme and the Grading of Recommendations Assessment-Development and Evaluation and Confidence in Evidence from Reviews of Qualitative Research tool to assess study quality.

Results Our search identified 24 studies meeting the inclusion criteria. Confidence in findings was moderate (20 studies) to high (4 studies). In 16 studies, the ability to recognise changes in the patient's condition (soft signals), including skin colour/temperature, respiratory pattern, blood loss, personality change, patient complaint and fatigue, improved the ability to escalate patients. Soft signals were detected through patient assessment (looking/listening/feeling) and not Early Warning Scores (eight studies). In contrast, 13 studies found a high workload and low staffing levels reduced staff's ability to detect patient deterioration and escalate care. In eight studies quantifiable deterioration evidence (Early Warning Scores) facilitated escalation communication, particularly when referrer/referee were unfamiliar. Conversely, escalating concerning non-triggering patients was challenging but achieved by some clinical staff (three studies). Team decision making facilitated the clinical escalation (six studies).

Conclusions Early Warning Scores have clinical benefits but can sometimes impede escalation in patients not meeting the threshold. Staff use other factors (soft signals) not captured in Early Warning Scores to escalate care. The literature supports strategies that improve the escalation process such as good patient assessment skills.

PROSPERO registration number CRD42018104745.

INTRODUCTION

Failure to rescue

'Failure to rescue' (FTR), defined as mortality following complications during a hospital admission,[1] is common.[2] At least 11 000 hospital patients each year suffer preventable deaths[3] though other sources believe this number to be higher.[4] It is also recognised that patients who die following a cardiac arrest are likely to have preceding warning signs that are not adequately managed.[5] Though differences between hospital complication rates are small, patients can be three times more likely to die from complications depending on which hospital they are in.[2] Poor surveillance of these patients can be linked to inadequate monitoring of abnormal vital signs, poor fluid balance management or diagnostic errors.[3 6] Reports to the National Reporting and Learning System deomstrate that 7% were related to a failure to act or recognise patient deterioration.[7]

Escalation of care

Avoiding FTR requires successful escalation of care[8] whereby patients' deteriorations are detected, communicated and acted on.[8 9] Escalation interventions focus primarily on specialist clinical teams such as Critical Care Outreach or Rapid Response Teams (RRT).[10] These teams aim to target improvements to the initial detection and ward management of patient deterioration.[11] Other interventions target communication breakdowns.[12]

Human factors (HF) identified to positively or negatively affect care escalation include situational awareness, team working, communication, safety culture, workload, clinical experience, negative emotions and leadership.[6 9 13–15] However, research has historically focused on outcomes.[8] The aims of this qualitative evidence synthesis (QES) are to identify (1) how HF affect ward care escalation (2) gaps in the current literature and (3) critique literature methodologies.

METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was adhered to[16] (see online supplemental file 1). We undertook a QES of the literature exploring escalation of care. The research question was developed by the two authors (JE and VW) using the Population, Interest and Context framework.[17] A full protocol has been published in a peer-reviewed journal.[18]

The search strategy was assisted by a specialist librarian (TP). Searches were performed on three databases, MEDLINE, EMBASE and CINHAL. Dates searched were from database inception to September 2019. Medical Subject Headings terms were used and searched as free text (full search strategy is included in online supplemental file 2). Reference lists of all eligible studies were also checked, and incidental references included from these.

Eligibility criteria

This evidence synthesis includes qualitative studies reporting primary data. No limits on publication date or country were applied. We included studies that explored how HF affect FTR and care escalation from staff, patients or relative's perspective. Qualitative methods include (but are not limited to) ethnography, interviews, focus groups and HF methods. We defined HF as any human interaction affecting teamwork, tasks, equipment, workspace, culture or organisation.[19] Data analysis included, but has not been not limited to, thematic analysis, grounded theory and discourse analysis.

Inclusion

- Qualitative studies reporting primary data.
- Qualitative studies exploring how HF affect escalation of care of the in-hospital patient population.
- Studies employing qualitative data collection methods, for example, semistructured interviews, focus groups or observations.
- Observational studies relating to FTR or care escalation.
- Adult population.

Exclusion

- Systematic or literature reviews.
- Correspondence and short communications.
- Simulation studies.
- Studies written in any language other than English.
- Studies in the emergency department and maternity.

Eligible studies were entered into Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia. Available at www.covidence.org) and deduplicated. Study screening and selection was undertaken by two reviewers independently. The titles and abstracts were screened against the eligibility criteria. Disagreements between reviewers were resolved by third person mediation. Reasons for excluding studies were noted.

Quality assessment and confidence in synthesised findings (Critical Appraisal Skills Programme and Grading of Recommendations Assessment, Development and Evaluation-CERQual)

Two researchers (JE and VW) reached a consensus regarding which study quality assessment tools to use during the review. Two different quality assessments were conducted on all studies by both researchers. The Critical Appraisal Skills Programme (CASP) qualitative checklist was used to assess papers for credibility, confirmability, dependability and transferability.[20] This comprehensive framework tool is commonly used in qualitative study assessment.[21 22]

We assessed confidence in synthesised findings using the Grading of Recommendations Assessment-Development and Evaluation and Confidence in Evidence from Reviews of Qualitative Research (GRADE-CERQual) Criteria and associated guidance publications.[23–27] The four-stage assessment (methodological limitations, coherence, adequacy of data and relevance) examines each synthesised finding for confidence by critiquing contributing study rigour.[28] The output of this evaluation is a Summary of Qualitative Findings table detailing themes and papers contributing to this theme. This table promotes transparency in the synthesis methods. Themes from the data analysis are presented in order of highest to lowest confidence according to the GRADE-CERQual assessment.

Analysis

We undertook a thematic synthesis[22] using Thomas and Harden's framework to map how HF affect escalation of care.[29] This is a three-stage process. Initially, study findings are coded, these codes are then categorised into descriptive themes and finally these descriptive themes are categorised into analytical themes.[30] Stage 1 involves line-by-line coding of data, where each sentence is allocated a code. Stage 2 involves categorising each coded sentence into descriptive, broader themes. The final stage involves generating analytical themes, or 'going beyond' the findings of the initial study, which relate to the fixed or emerging research question (see table 1 for definitions of analytical themes). This framework supports data extraction from anywhere within the paper and is not confined to the results alone.

Data extraction tools were developed and piloted before the review took place to ensure consistency of data extraction. Study data were entered into an Excel spreadsheet (Windows, 2019. Microsoft Office) and study themes were analysed using NVivo software (NVivo qualitative data analysis Software; QSR International, V.10, 2014).

Patient and public involvement

Patient representative (TD) reviewed the original published protocol and aims of the review were discussed and deemed of patient importance.

RESULTS

The search identified 2404 papers which met the initial search criteria (refer to online supplemental file 3 for PRISMA diagram). After duplicates were removed, 1651 articles were screened. 1627 were excluded based on methodology, subject of interest or incorrect population. This resulted in 24 papers meeting the inclusion criteria and being reviewed in full. A full description of synthesised study characteristics are presented in table 2.

Table 1 Definitions of analytical themes

Analytical theme	Definitions and references
Information packaging	The use of quantifiable evidence of deterioration (such as vital signs) to initiate escalation of care.[15 33 34 40 41]
Flattened hierarchy	Escalation of care can be initiated from any staff member to any staff member.[15 31 35 41–45]
Situational awareness	The comprehension of clinical elements and projection of their status in the future.[73]
Team functioning	Fragmented team-working with sequential rather than concurrent task completion and poor relationships.[35 36 41–45 47 48]
Soft signals of deterioration	Non-numerical deterioration cues attained from observation rather than instrumentation.[15 31 35–37 41 49 50 54 55]
Decision making	Clinical reasoning surrounding detection, communication and management of escalation of care.
Clinical experience	As staff became familiar with deteriorating patients, they were better able to detect and predict impending illness.[15 36 38 42 43 46 49 50 54 55]
Clinical assessment	Involves staff looking, listening and feeling the patient to identify respiratory, skin, neurological or physiological abnormalities.[15 49 51 55 57]

Quality assessment results

Critical Appraisal Skills Programme

Studies were assessed to be of moderate to high quality and no studies were excluded based on this assessment (table 3). Two studies[31 32] used surveys to understand nurses' perceptions of caring for deteriorating patients and were scored poorly for choice of methodology. These studies were still included as open ended free-text questions were used and it was felt that this could still contribute to answering the research question, while acknowledging data from these studies are unlikely to be rich and is therefore a limitation of the method.

Grading of Recommendations Assessment, Development and Evaluation-CERQual

Following the CASP assessment all studies were evaluated against the GRADE-CERQual criteria. A Summary of Qualitative Findings table (table 4) is presented which promotes transparency in this synthesis' findings and methods. The table includes documented rationale for grading judgements.

THEME RESULTS

Themes presented are ranked from the highest to lowest confidence in synthesised findings. Data extracted mostly related to organisational and patient assessment factors affecting escalation of care. Organisational factors could be classified into Information Packaging and Communication Credibility, Flattened Hierarchy, Workload, Staffing and Situational Awareness and Team Functioning. We found patient assessment Themes of 'Soft Signals of Patient Deterioration' and Early Warning Scores (EWS), Decision Making and Clinical Assessment Skills and Experience.

Information packaging and communication credibility (high GRADE-CERQual evidence)

Eight studies identified that information packaging during escalation of care was a facilitator to success.[15 33–39] Packaging involved using quantifiable evidence of patient deterioration such as vital signs[15 33 34 40 41] to initiate escalation of care. This removed ambiguity,[39] provided numerical evidence of deterioration[15] and was a common language[34] for clinical staff. This was particularly important when staff were unfamiliar to each other.[34] Conversely, staff felt communication credibility was questioned when referrals were made using non-medical language[33] or delivered in an unsystematic way.[34] This made an escalation referral difficult to understand and prioritise, with medics often having to question further to gain more information to facilitate decision making.[35]

Flattened hierarchy (high GRADE-CERQual evidence)

A common organisational facilitator to escalation of care was a flattened hierarchy meaning that escalation is accepted from anyone to anyone.[15 31 35 41–45] This created a confidence in staff to raise concerns regarding a patient's clinical condition, opening channels of communication. Staff also felt that electronic vital signs systems increased the accountability of patient illness[32 35 42 46] with acutely unwell patients being everyone's responsibility. However, it was also acknowledged identifying who is accountable for an unwell patient was sometime a challenging. Synthesised studies demonstrated instances of lack of deteriorating patient ownership[32] or passing on of the problem[54] by clinical staff to another team or colleague.

Workload, staffing and situational awareness (high GRADE-CERQual evidence)

Several studies described resources as a significant factor affecting care escalation. Three studies identified a lack of skilled staff as limiting the ability to escalate the deteriorating patient.[15 35 47] During high workload or low staffing periods staff felt their awareness of patient deterioration reduced due to sensory overload and suboptimal monitoring due to competing demands.[15 32 34 36 41 42 45 47–52] Staff believed continuity of care improved situational

Table 2 Synthesised studies summary table

Study ID	Study design	Name of journal	Methods	Sample size (N/hours)	Population	Data collection date	Data analysis method
Andrews[33] 2005	Qualitative Design	Issues and Innovation in Nursing Practice	Interviews Observations	44 Not avail	Nurses, doctors, AHPs and CSWs	2002	Grounded Theory
Astroth[45] 2013	Qualitative Design	Journal of Clinical Nursing	Interviews	15	Nurses	Not avail	Concept Analysis
Braaten[51] 2015	Descriptive Qualitative	American Journal of Nursing	Interviews	12	Nurses	2012	Content Analysis
Brady[42] 2014	Qualitative Design	BMJ Quality and Safety	Focus Groups	31	Nurses, respiratory therapists, physicians	2009	Constant comparison
Bunkenbor[55] 2013	Descriptive Qualitative	Journal of Advanced Nursing	Interviews Observations	13, 70 hours	Nurses	2009	Content Analysis
Burns[46] 2017	Qualitative Design	Journal of Advanced Nursing	Interviews	25	Nurses	2015	Thematic Analysis
Chua[49] 2013	Qualitative Exploratory Descriptive	International Nursing Review	Interviews	15	Nurses	2011	Content Analysis
Chua[52] 2019	Qualitative Exploratory Descriptive	International Journal of Nursing Studies	Interviews	22	Nurses	2016–17	Thematic Analysis
Currey[32] 2017	Descriptive exploratory	Australian Critical Care	Survey	207	Nurses, Doctors, Care Support Workers,	2014	Content Analysis
Donohue[15] 2010	Qualitative Design	Intensive and Critical Care Nursing	Interviews	9	Nurses	2006	Thematic Analysis
Elmufudi[43] 2017	Qualitative Design	American Journal of Medical Quality	Interviews	40	Doctors	2014	Thematic Analysis
Foley[56] 2018	Qualitative Design	Journal of Clinical Nursing	Interviews Observations	8	Nurses, CSWs		Systematic Text Condensation
Hart[40] 2016	Descriptive Qualitative	Journal of Clinical Nursing	Interviews	28	Nurses	2015	Constant Comparison
Mohammmed Iddrisu[54] 2018	Qualitative Design	Journal of Clinical Nursing	Focus Groups	14	Nurses	2014	Thematic Analysis
James/[31] 2010	Qualitative Design	Journal of Nursing Management	Survey	131	Care Support Workers	Not avail	Content Analysis
Johnston[8] 2015	Qualitative Design	Annals of Surgery	Observations	42 hours	Surgical wards	2013	Grounded theory

Continued

Table 2 Continued

Study ID	Study design	Name of journal	Methods	Sample size (N/hours)	Population	Data collection date	Data analysis method
King 2019[72]	Qualitative Design	Health Expectations	Focus Groups	26	Patients and families	2014–2017	Thematic Analysis
Searle Leach[38] 2010	Qualitative Design	Quality and Safety Healthcare	Interviews	50	Nurses	Not avail	Grounded Theory
Mackintosh[34] 2012	Comparative case study	Postgraduate Medicine Journal	Interviews Observations	35 150 hours	Doctors, nurses, critical care nurses,	2009	Thematic Analysis
Mackintosh[41] 2014	Qualitative Design	Social Science and Medicine	Interviews Observations	35 180 hours	Doctors, nurses, critical care nurses,	2009	Thematic Analysis
Massey[44] 2014	Qualitative Design	Australian Critical Care	Interviews	15	Nurses	2011	Thematic Analysis
Martland[47] 2016	Qualitative Design	Australian Health Review	Focus Groups	43	Doctors and nurses	2007	Grounded Theory
Peebles[48] 2012	Service evaluation	Resuscitation	Observationsnotes review	17 care episodes	RRT episodes	Not avail	Thematic Analysis
Petersen[50] 2017	Qualitative Design	BioMedical Central	Focus Groups	18	Nurse	Not avail	Content Analysis

RRT, rapid response team.

Table 3 CASP quality assessment for synthesised studies

Study ID	Was there a clear statement of the aims of the research?	Was the research design appropriate to address the aims of the research?	Was the recruitment strategy appropriate to the aims of the research?	Was the data collected in a way that addresses the research issue?	Was the data analysis sufficiently rigorous?	Is there a clear statement of findings?	Is a qualitative methodology appropriate?	How valuable is the research?	Have ethical issues been taken into consideration?	Has the relationship between researcher and participants been adequately considered?
Andrews[33] 2005	Low	Low	Unclear	Low	Low	Unclear	Low	Low	Low	high
Astroth[45] 2013	Low	Low	Low	Low	Low	Low	Low	Low	Low	high
Braaten[51] 2015	Low	Low	Low	Low	Low	Low	Low	Low	Low	high
Brady[42] 2014	Low	Low	Low	Low	Low	Unclear	Low	Low	Low	high
Bunkenborg[25] 2013	Low	Unclear	High	Low	Unclear	Low	Low	Low	Low	high
Burns[46] 2017	Low	Unclear	Unclear	Unclear	Low	Unclear	Low	Low	Low	high
Chua[48] 2013	Low	Low	Low	Low	Low	Low	Low	Low	Unclear	high
Chua[52] 2019	Low	Low	Low	Low	Low	Low	Low	Low	Low	low
Currey[32] 2017	Low	Low	Low	Unclear	Unclear	Unclear	Low	Low	Low	high
Donohue[15] 2010	Low	Low	Low	Low	Low	Low	Low	Low	Unclear	Unclear
Elmufdi[43] 2017	Low	Low	Low	Low	Low	High	Low	Unclear	Low	high
Foley[56] 2018	Low	Low	Low	Low	Low	Low	Low	Low	Low	high
Hart[40] 2016	Low	Low	Low	Low	Low	Low	Low	Low	Low	low
Iddrisu[54] 2018	Low	Low	Unclear	Low	Low	Low	Low	Low	Low	high
James[31] 2010	Low	Low	Low	Low	Low	Low	Low	Low	Low	high
Johnston[8] 2015	Low	Unclear	Low	Low	Low	Low	Low	Low	Low	high
King 2019[72]	Low	Low	Low	Low	Low	Low	Low	Low	Low	High
Leach[38] 2010	Low	Low	Unclear	Low	Low	Low	Low	Low	Low	high
Mackintosh[34] 2012	Low	Low	Low	Low	Low	Low	Low	Low	Low	high
Mackintosh[41] 2014	Low	Low	Low	Low	Low	Low	Low	High	Low	high
Martland[47] 2016	Low	Low	Unclear	Low	High	Low	Low	Low	Low	high
Massey[44] 2014	Low	Low	Low	Low	Unclear	Low	Low	Low	Low	low
Peebles[48] 2012	Low	Low	Low	Low	Unclear	Low	Low	Low	Unclear	high
Petersen[50] 2017	Low	Low	High	High	Low	Low	Low	Low	Low	high

CASP, Critical Appraisal Skills Programme.

Table 4 Confidence in synthesised findings using the GRADE-CERQual framework

Summary of review finding	Studies contributing to the finding	Methodological limitations	Coherence	Adequacy	Relevance	CERQual confidence assessment	Explanation of the CERQual evidence
Information packaging (using quantifiable evidence of patient deterioration) affected perceived **communication credibility**	[15 32–39]	Low concerns regarding study methodology	Low concerns about coherence	Low concerns about adequacy	Low concerns about relevance	High Confidence	All studies, demonstrated good methodology, data were considered moderately thick with high numbers of participants and methods, a high no of studies contributed to review finding.
Flattened hierarchy and were organisational components affecting escalation of care	[15 31 32 34 35 41–46]	Low concerns regarding methodology	Low concerns about coherence	Low concerns about adequacy	Low concerns about relevance	High Confidence	One study with minor concerns regarding methodology (survey), high no of studies contributing to finding, data were considered moderately thick with high numbers of participants and methods
Workload and **staffing** were factors considered by clinical staff to affect their **Situational awareness** of patient deterioration.	[15 32 34–38 41 42 45–47–52]	Minor concerns regarding methodology	Low concerns about coherence	Low concerns about adequacy	Low concerns about relevance	High confidence	Two studies with minor methodological concerns with one study where using a survey, and another study using participants for a focus group put forward by head nurse, high no of studies contributing to review finding, rich data sources and multiple methods of data collection, data were considered moderately thick with high numbers of participants and methods
Team functioning caused problems or **facilitated care during escalation**	[15 32 33 35 39 41–45–47–51]	Minor concerns regarding methodology	Low concerns about coherence	Low concerns about adequacy	Low concerns about relevance	High confidence	Two studies with methodological concerns, one study where using a survey, and another study using participants for a focus group put forward by head nurse, all other studies demonstrate good methodology, high no of studies contributing to review finding, data were considered moderately thick with high numbers of participants and methods
Soft signal of patient deterioration used by clinical staff indicating a patient's worsening condition, not adequately represented in **Early Warning Score**	[15 31 33 35 36 38 41 42 44 48 49–51 53–54]	Moderate concerns regarding methodology	Low concerns about coherence	Moderate concerns about adequacy	Low concerns about relevance	Moderate Confidence	Three studies had methodological concerns. One utilising a survey methodology with open ended-questions, the other was being observed by the implementer of the local Medical Emergency Team (MET), the last one using participants for a focus group put forward by head nurse, large no of studies contributing to synthesis finding.
Clinician confidence affected **decision making** during escalation of care	[31–36 38 43–45 47 49–52 55]	Moderate concerns about methodology	Low concerns about coherence	Moderate concerns about adequacy	Low concerns about relevance	Moderate confidence	Four studies had methodological concerns, two studies utilised a survey methodology with open ended-questions, the other study had a focus group where participants were selected by head nurse, the other had observation completed by the implementer of the local RRT, data were considered moderately thick with high numbers of participants and different methods, large no of studies contributing to synthesis finding

Continued

Table 4 Continued

Summary of review finding	Studies contributing to the finding	Methodological limitations	Coherence	Adequacy	Relevance	CERQual confidence assessment	Explanation of the CERQual evidence
Clinical Assessment skills relating to **patient assessment** and staff experience positively or negatively affected deterioration detection by clinical staff	[15 35 38 39 42 43 46 49–51 54 56]	Moderate concerns regarding methodology	Low concerns about coherence	Moderate concerns about adequacy	Low concerns about relevance	**Moderate** Confidence	Two studies with methodological concerns. One had observations completed by the implementer of the local RRT, the other study had a focus group where participants were selected by head nurse, data were considered moderately thick

GRADE, Grading of Recommendations Assessment, Development and Evaluation; RRT, rapid response team.

awareness.[36 41 42 49 51] Staff felt that a benchmark 'baseline', meant they could identify any significant changes to patient illness. It was not uncommon for staff to employ workarounds during the periods of system pressure such as escalating to the RRT. This was done (rightly or wrongly) to supplement care escalation when medical support was scarce.[15 47]

Team functioning (high GRADE-CERQual evidence)

Seven studies found poor team relationships were a barrier to escalating patient care, resulting in significant delays.[15 32 33 35 42 45 50] Poor team working was presented as tasks being done sequentially rather than concurrently, or where there was a lack of role definition.[35 36 41–45 47 48] Staff believed a lack of understanding of team roles and the care individuals could provide contributed to uncertainty about to whom patients should be escalated.[35 41 44 45] Poor team functioning meant staff felt deterred from escalating care due to negative emotions such as fear of reprimand, fear of being wrong, intimidation and retribution.[32 35 42 45 49–51 55] Escalation to outside resources, such as the RRT, was sometimes perceived to be negative[15 43 45] with staff reporting that they preferred to cope with a patient deterioration.

Soft signals of patient deterioration and EWS (moderate GRADE-CERQual evidence)

Staff at times overruled the EWS derived escalation pathways using other patient related factors in their decision-making process when considering escalation.[15 31 33 35 36 38 41 42 44 46 49–51 54–56] They identified factors additional to standard EWS variables which caused them concern about a patient's condition (see online supplemental file 4). These patient factors or 'soft signals of deterioration', were (from most to least common finding in studies); pale skin,[15 31 41 49 50] respiratory pattern (as distinct from respiratory rate),[15 35 37] blood loss,[36 49] personality change,[36 49] patient complaint,[50 54] skin temperature[50] and patient fatigue (observed or reported).[15] Nine studies found patient assessment was integral to detecting the 'soft signals of deterioration' including the early signs of worsening illness before a triggering EWS was evident.[15 35 36 38 39 46 49 50 55] Two papers described how staff felt that EWS protocols could place barriers to escalation when patients did not meet the trigger threshold but nurses felt they required an increase in care surveillance.[33 50] In some instances staff felt they had to wait for a deterioration to occur before being able to escalate[33] but in others they continued to escalate despite normal EWS.[46 49 51]

Decision making (moderate GRADE-CERQual evidence)

Escalation decision making involved clinical reasoning surrounding the detection, communication and management of escalation of care. Seven papers found that clinician confidence is a facilitator to decision making during patient deterioration management.[31–33 35 36 44 50] Confidence can be derived from staff providing peer support to

one another, training or education level. Shared team decisions were sometimes an escalation facilitator.[38 44 45 47 49 51] However, a lack of consensus in decision making particularly for end of life care,[32] was seen as problematic[34 43 49 55] often leading to deviation from guidelines or escalation protocols. Lack of consistency in decisions meant escalation of care demonstrated response variability,[34] leading to differing and unpredictable priorities.[47] There was also evidence of clinicians assuming physiology changes were not significant and waiting for confirmation of deterioration before responding meaningfully.[45]

Clinical assessment skills and clinical experience (moderate GRADE-CERQual evidence)

Clinical assessment involved looking, listening and touching the patient to identify respiratory, skin, neurological or physiological abnormalities.[15 49 51 55 57] The ability to clinically assess patients well enabled staff to make better escalation of care decisions,[35 36 38 45 49–51 55] particularly as the ability to detect 'soft signs' was seen as key. Conversely, undertaking a poor patient clinical assessment posed barriers to illness detection.[15] Many studies found that as staff gained experience of deteriorating patients they were better able to detect and predict impending illness.[15 36 38 42 43 46 49 50 54 55]

DISCUSSION

We identified 24 qualitative studies of moderate to high methodological quality that identify how HF affect escalation of care. Our evidence synthesis has contributed to escalation of care literature and themes derived from analysis are pertinent to clinical practice.

The studies within this synthesis demonstrated that EWS provide staff with a tool that facilitates communication of concerns and assists workload prioritisation.[35] Studies reported successful escalation of care was best facilitated when a patient's deterioration packaged neatly with quantifiable evidence. However, some staff in the synthesised studies felt able to escalate non-triggering patients requiring medical attention, although this process was acknowledged to be challenging. It was also suggested that some staff can anticipate clinical deterioration before a triggering EWS[58] and that there are soft signals (fatigue, skin temp/colour, patient complaint, personality change, blood loss, respiratory pattern), of deterioration recognised by nurses but are not adequately captured by EWS in their current format. Many studies also found that as staff gained experience of deteriorating patients, they were better able to predict deterioration patterns and anticipate problems. It seems that the EWS alone may not maximise improvements to patient outcomes.[59 60] Evidence suggests that organisations should facilitate good patient assessment, as this was key to detecting soft signals that would otherwise go undetected through an alerting system. Research should also aim to identify how clinical staff anticipate problems in certain patient groups and how they recognise and respond to these to ultimately create safety.[61] It is evident that the literature does not fully report good escalation catches[62] such as rescued non-triggering sick patients. This event is in effect invisible and not measured in current healthcare evaluation systems or metrics. Incorporating this tacit knowledge into education programmes or simulation training and scenarios, may be a feasible strategy to improve care escalation.

A flattened hierarchy[63] was implemented in the aviation industry when it was discovered that a number of flight incidents may have been avoided had the copilot been empowered to challenge the pilot.[64] Synthesised studies identified that a Flattened Hierarchy was felt by healthcare staff to be a positive strategy for escalating care of deteriorating patients (escalation can be initiated from anyone). However, the effectiveness of a flattened hierarchy may be influenced by poor team functioning. Poor team working was a common barrier to escalation of care identified in this evidence synthesis. This finding is corroborated by a retrospective case records review of preventable hospital deaths[3] and a literature review on FTR following surgery.[65] In both publications, the authors isolated several contributory factors such as poor team communication, leadership and decision making. Without adequate team communication, the benefits of a flattened hierarchy and team decision making may be lost. If organisations wish to implement a flattened hierarchy escalation system this must also be complemented with an emphasis on non-technical skills and training[66] before evidence of full patient benefit.

A clinically significant theme to emerge from the synthesised findings was that the greater the workload, the less staff felt they were able to keep track of patient illness or monitor their patients. This sometimes resulted in staff undermonitoring their patients causing some triggering patient deterioration to go unnoticed.[30] This finding is supported by a recent study demonstrating that lower numbers of registered nurses led to a higher rate of missed vital signs observation.[67] Organisations could focus on reducing workload, (an unlikely solution), or improving vital signs monitoring processes. A recent option is utilising wearable continuous monitoring that may reduce the nursing workload spent performing regular vital signs observation rounds.[68]

Other significant clinical effects of high workloads may be a reduction in staff ability to detect deterioration in patients who are not triggering, losing the human safety net for false negative (non-triggering) patients. When mental capacity is limited with reduced team resources, this will directly affect an individual's situational awareness of the environment as mental resources reduce as cognitive demands increase.[69] A recent study found the risk of death increased by 3% for every day a patient experienced nurse staffing levels below ward mean.[70] Poor situational awareness, reduced ability to detect soft signals of deterioration and undermonitoring may explain these results. Conversely, staff described improved situational awareness when there was continuity to their patient care.

This was felt to facilitate staff in detecting often nuanced clinical changes or soft signals and also bridged the care elements through a patients illness.[71] A strong local emphasis on nursing continuity should be encouraged as the evidence suggests that this may improve detection of deterioration and care escalation.

Our study has some limitations. Synthesised studies were assessed for their methodological robustness using the GRADE-CERqual and CASP guidelines. This enabled us to present themes with the highest confidence of good quality evidence first, but results may be limited by the data quality or analysis. within the studies themselves. Publication bis may also affect results that were included. Broadly, studies were methodologically sound but consistently failed to explore the relationship of the researcher to the participants, or this was not explicitly documented. There was also only one study identified that used patients and relatives as study participants.[72]

Conclusion

This evidence synthesis has identified HF that affect escalation of care. EWS have clinical benefits but can sometime impede escalation in patients not meeting the escalation threshold. Staff use other factors (soft signals) not captured in EWS to escalate care. The literature supports strategies that improve the escalation process such as good patient assessment skills. An organisational emphasis on non-technical skills and team cohesion should be synonymous with a flattened hierarchy to enable effective care escalation.

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2.3. Implications for the study

The discussion and conclusions from the published QES have provided a foundation on which to base the empirical data collection for the SUFFICE study. Each finding from the QES is summarised below and linked to the study aims and methods.

Firstly, the literature suggests that escalating care is effective when patients meet quantifiable escalation thresholds but can be impeded when patients don't meet this but are clinically concerning (Ede, *et al.*, 2021). This indicates a disconnect between work as imagined (WAI), which is represented by Standard Operating Procedures (SOPS), and work as done (WAD), which includes everyday clinical work, trade-offs and workarounds (Righi *et al.*, 2017). Phase 1 of SUFFICE data collection bridges this gap by observing and documenting escalation events and Phase 3, through interviewing staff, explores cognitive elements of escalation using a critical decision method (Militello and Hutton, 1998) to understanding how escalation occurs (WAD) and what the success factors are to this process.

Secondly, rescue metrics in healthcare are poorly documented and literature has focused on FTR (Ede, Petrinic, *et al.*, 2021). Rescue of the deteriorating patient has not been fully investigated and SUFFICE addresses this knowledge gap by focusing on the care of unwell and deteriorating patients. In Phase 2 of SUFFICE, care records were reviewed for patients who triggered a EWS of $\geq$7; a trigger threshold that would indicate a high probability of an ICU admission (Gidari *et al.*, 2020), but who have avoided this event. Rather than these patients being labelled a false-negative (high triggering EWS but no event) this study will examine if there was a rescue event, which mitigated this threat through good care and timely intervention.

2.4. Summary

To summarise, 24 studies were included in this review. Quality assessment of these indicated moderate to high confidence in methods and results. Overall, the synthesised findings indicate that escalating care is effective when patients meet quantifiable escalation thresholds but are clinically concerning. Importantly, rescue metrics in healthcare are poorly documented and literature has focused on failure to rescue

3. Chapter Three: Methodology and Methods

3.1. Introduction

This SUFFICE study was designed to answer the research question "What are the success factors to escalation of care and how can these be applied more effectively?", therefore, the phenomenon of interest was escalation of care and the process of rescue in the acutely deteriorating ward patent. In this chapter, the key aims and objectives of the SUFFICE study are described along with the concept of research paradigms. Finally, the rationale for mixed methods research is presented, leading onto a clear description of study design, setting, sampling methods and participants, which is presented as a published protocol and steps taken to ensure study rigor.

3.2. Study Aims and Objectives

The focus of this study was to develop a Framework of Escalation Success Factors that can be developed into a multi-faceted intervention to improve outcomes for deteriorating patients. This was addressed through the following objectives:

i) To identify success factors to escalation by observing 200-400 escalation of care events in both Covid-19 positive and negative patients and develop a theoretical understanding of care escalation and rescue.

ii) To identify success factors to escalation by examining 200-400 care records of patients who clinically deteriorated (EWS $\geq$7) in the ward, avoided ICU and survived and compare with patients who deteriorated (EWS $\geq$7) in the ward, went to ICU and died.

iii) To understand factors that affect successful escalation of care from 30 expert staff interviews and identifying how these could be applied effectively across healthcare setting.

3.3. Research Paradigms

A research paradigm is a set of beliefs or a worldview, which describes the approach to scientific inquiry (Guba and Lincoln, 1994; Morgan, 2007; Shannon-Baker, 2016) (see Figure 11).

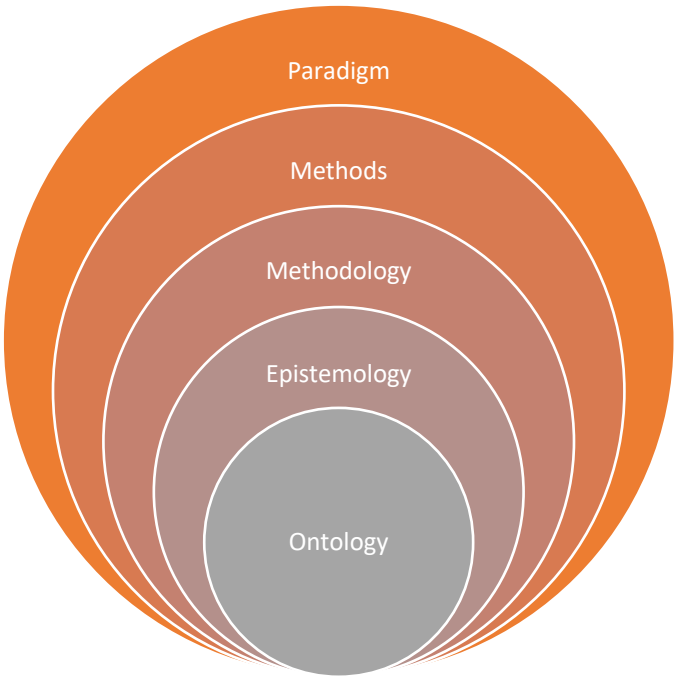

Figure 11 Paradigm concept diagram

An absolute paradigm definition has been debated within academic circles (Shannon-Baker, 2016) with an early and simple definition being that a paradigm is a philosophical underpinning from which a scientific research approach flows (Weaver and Olson, 2006). These worldview beliefs are often shared by communities of researchers, and regulate

the approaches of scientific enquiry, such as the research methods utilised (Weaver and Olson, 2006). For this thesis, paradigms will be referencing the early Weaver and Olsen (2006) definition.

Barriers to the widespread identification of paradigms within research may stem from the difficulty that many students face in translating philosophical underpinnings into tangible research approaches that practically guide and inform their area of interest. Perhaps, up until recently, there had been no paradigm that fitted into the broader nursing body consciousness, which the profession felt wholly complimented their view and approach to scientific enquiry and that balanced both the science and art of nursing. It is important for a researcher to explore how they believe reality to exist (Ontology), how this may be interrogated and understood (Epistemology), and what their adopted paradigm may be, which will then inform their approach to research methods.

3.3.1. Ontology, Epistemology and Methodology

A paradigm is a collection of four key facets: ontology, epistemology, methodology and methods (see Figure 11). Ontology stems from the Greek word *'Ont'* which translates to being. Ontology is the belief of what reality is (Schwandt, 2015) and what can be known about it (Guba and Lincoln, 1994). For example, one researcher may believe that there is a singular reality whereas another may believe that reality is constructed. Epistemology has in origins in the from Greek word *epistēmē* which translates to 'knowledge'. Epistemology logically then relates to how we can know reality and investigate it (Guba and Lincoln, 1994; Waring *et al.*, 2015). Again, some believe that reality can be measured whereas others believe reality may be interpreted based on your own beliefs. There is often confusion about Methodology and Method, but there is a distinction, which

requires further expansion. Methods refer to the tools by which data are collected to answer a research question and these can include interviews, surveys, observations, data-base interrogation etc (Halcomb, 2019). Methodology provides guidance throughout a research study, offering one approach that links the goal of the study to the unit of analysis (Viergever, 2019). Normally, the methodology is either empirical (scientific), interpretive (humanistic) and critical (emancipated) (McGregor and Murnane, 2010). A research paradigm informs how one goes about interrogating a phenomenon of interest and the methods utilised and reflects the philosophical underpinnings. The commonest paradigmatic models, positivism, constructivism, and pragmatism (Lincoln and Guba, 1985), are discussed below in the context of the SUFFICE study (see Table 3).

Table 3 Summary table of research paradigms and researcher reflections in relation to the SUFFICE study

Methodology	Ontology *(what is the nature of reality?)*	Epistemology *(How can you know reality?)*	Methods *(How can we measure reality?)*	Researcher reflections (supporting or opposing beliefs in relation to the SUFFICE study)
Positivism (received view)	There is a single reality that can be known, it is independent of the researcher	Reality can be objectively measured (Quantitative),	Experimental research, quantitative, threats to validity (bias) must be eliminated, testing a theory	Certain elements of the world can be measured, but this gives a very finite view. Confounding variables will never be fully eliminated and therefore should be acknowledged. I have no testable hypothesis about care escalation success factors.
Constructivism (constructed reality)	Multiple realities are created by individuals, the physical world is known by individuals	Interactive link between reality and observer	Qualitative, hermeneutical, building a theory	Reality is at least in part interpreted, but there remain elements that can be absolute and measured such as failure to escalate metrics.
Pragmatism (problem centred)	Reality is renegotiated, debated, and interpreted	The best method is the one that solves the research question	Mixed methods-match methods to research question	Pragmatism is a method that sits well with the researcher's critiques of other paradigms.

3.3.2. Positivism, Constructivism and Pragmatism

Positivism holds the belief that there is a true reality which is ***received*** by the researcher (Schwandt, 2015). It is independent of the scientist and therefore reality may be measured with contextual variables being heavily controlled (Weaver and Olson, 2006). This description leads to the method of measurement, which is predominately quantitative and experimental in origin (Schwandt, 2015). Positivism is not without its criticisms and has been suggested to rule out an understanding about the world derived from patient experiences and interpretation (Given, 2012). The phenomena of interest for SUFFICE is the complex issue of escalation and rescue, which is affected by multiple system factors, both human and organisational. This cannot be reduced and measured in its entirety, and there is a richness of the human experience that is required to fully understand, explore, and enlighten this phenomenon. Therefore, SUFFICE does not lend itself to a purely positivist paradigm (see Table 3).

Constructivism is an approach favoured by Guba and colleagues and is also known as naturalistic inquiry (Guba and Lincoln, 1994). This paradigm advocates that realities are experientially based, shared among many individuals and are alterable (Guba and Lincoln, 1994). Constructivism is the view that reality is a construct of communities and that the researcher has a direct link to this reality (the findings are created as the study proceeds) (Schwandt, 2015). It is commonly used to research the human experience and is subjective (Doyle *et al.*, 2009). Constructivism has been criticised due to bias and replicability, given the varying conditions of the human experience. This paradigm lends itself to qualitative

research methods such as interviewing and observations (Lee, 2012). Broadly, constructivism is an approach that certainly sits neatly within Phase 3 of the SUFFICE study, seeking to understand the experiences of staff during an escalation of care and rescue event through interviews. But there are other elements required within this study, particularly in Phase 1 and 2, such prevalence of deterioration, acuity data and EWS, which are better represented when measured with quantitative methods. These quantitative data add depth to the qualitative narrative obtained through the notes reviews and observations by employing mixed methods data collection. Criticisms of the notes review methodology are that it gives no indication of wider contextual and organisational understanding but focuses on the patient alone (Hogan *et al.*, 2015; Vollam *et al.*, 2020). Complementing the notes review and observation methodology with quantitative data gives wider breath and understanding to events. Therefore, SUFFICE does not lend itself to a purely constructivist paradigm.

Pragmatism allows the researcher to engage a pluralistic stance about what reality is and how we can know that reality (Clarke, 2007). Pragmatism accepts that there can be singular or multiple truths and that a researcher can combine both inductive or deductive reasoning (Creswell and Plano Clark, 2011). If SUFFICE was linked to positivism or constructivism, certain elements of the research question would remain unanswered, dramatically reducing the value and contribution of the study data. The complex issue of escalation and rescue requires multiple methods (mixed methods) to generate multiple data types. Thus, pragmatism is the most suitable paradigm to inform SUFFICE, allowing the researcher to be both subjective in their

reflections and objective during data collection and aligns well with Mixed Methods Research (MMR) (Shannon-Baker, 2016).

3.4. Mixed Methods Research (MMR)

MMR was originally defined as studies that consist of qualitative and quantitative data strands, where neither method is linked to a particular research paradigm (Creswell and Plano Clark, 2011). This has evolved further with the concept that this may also be two or more qualitative strands or two or more quantitative strands (Cresswell, 2015). MMR is often confused with multiple methods studies, which utilise multiple qualitative and quantitative data collection strategies, but do not integrate the findings (Harrison *et al.*, 2020). MMR research intentionally mixes data strands from multiple methods at a data collection or analysis stage (Shannon-Baker, 2016). The philosophical underpinnings of each of these data collection methods have been described earlier in this chapter but closely relate to pluralism (multiple research paradigms can be adopted) (Tashakkori *et al.*, 2015). This means that MMR is not ruled by one paradigm or another and results in heavy debate (paradigm wars) (Bryman, 2006).

Scholars can argue either for or against the merging of quantitative and qualitative paradigms (Bryman, 2006; Clarke, 2007). Opposing beliefs, based on the ontology, are the drivers for historical philosophical debates (qualitative and quantitative) about whether these methods can be mixed (Bryman, 2006; Johnson and Onwuegbuzie, 2007). Despite this, the number of MMR studies has increased significantly between the 1990s (17%) to the early 2000s (30%) (O'Cathain *et al.*,

2007) and continues to increase (Leech and Onwuegbuzie, 2009; Doyle *et al.*, 2016).

Early advantages to MMR were described, including offsetting some of the weaknesses associated with a singular method (Moffatt *et al.*, 2006) and offers validation and convergence of findings (O'Cathain *et al.*, 2007). They may generate more evidence in order to answer a research question than a singular approach (Creswell and Plano Clark, 2011). Early captured examples of this include the rich yield that arises from combining RCTs with a qualitative strand to explore acceptability or adherence to treatments being tested (O'Cathain *et al.*, 2007). The advancing medical requirements of the patient population also require that research movements and philosophies meet this demand. Indeed, complex interventions, such as organisational deterioration and escalation strategies, require a full system approach to evaluation and it could be argued that singular approaches are almost redundant in this field of health research (Carayon *et al.*, 2015). MMR is grounded in the need to engage with real world problems and research environments with increasing system complexity (Dawadi *et al.*, 2021). MMR brings scholars, and most importantly clinical researchers together from different backgrounds and approaches and its acceptance is now so wide that there is an international journal specialising in publishing mixed methods research (Tashakkori and Creswell, 2007; Fàbregues *et al.*, 2021).

3.5. Mixed Methods Design Decisions

Founding work described how MMR studies require design justifications, which include i) level of interaction ii) emphasis or weighting of each data strand and iii)

MMR study design. Each of these dictate strand collection timings and when strands are mixed (Creswell and Plano Clark, 2011). The level of interaction refers to the dependence (interaction) or interdependence (distinct) of each strand (Halcomb, 2019). It has also been suggested that each strand can be used for more than one purpose, being independent (explore an issue in its own right) or dependent (used to develop a questionnaire) (O'Cathain *et al.*, 2007). Data strands in SUFFICE are interactive as results from the first two phases are explored in more depth within the interviews (Phase 3).

The priority of the data strands refers to the weighting of data. Some studies may have a greater quantitative emphasis than qualitative data (expressed as QUAN qual) and vice versa (QUAL quan), or both strands can be given equal priority (Clarke, 2007). In MMR research, quantitative data is often used to describe a phenomenon, test the effectiveness of an intervention and explain variability (O'Cathain *et al.*, 2007; McKim, 2017). Qualitative data can be collected for exploratory purposes such as describing a context, giving greater definition to a problem or giving results real-world meaning (O'Cathain *et al.*, 2007; McKim, 2017). In SUFFICE, the data priority is QUAL quan.

Originally, there were over 30 different MMR designs available (Leech and Onwuegbuzie, 2009) and it is important to understand the options and application of each design. Design specifically guides the timing of data collection and at what point in the study the data are mixed. Key MMR designs proposed by Cresswell (2015) include the Convergent parallel, Explanatory sequential and Exploratory

sequential, Embedded, and Multiphase designs (Cresswell, 2015). The key characteristics for each design are described in Table 4.

Table 4 Mixed methods designs summary adapted from Cresswell (2015)

Design	Characteristics
Convergent parallel	• Concurrent quant and qual (strand) data collection • Equal strand prioritisation QUAN+QUAL • Independent during analysis • Analysed data mixed at the end
Explanatory Sequential	• Starts with collection and analysis of Quant data • Strand priority sits with Quant data QUANT qual • Data is analysed sequentially and builds upon the next phase
Exploratory Sequential	• Starts with collection and analysis of Qual data • Strand priority sits with Qual data • Data is analysed sequentially and builds upon the next phase
Embedded	• A qualitative phase is imbedded usually within a quantitative study (RCT) • Strand priority sits with Quan data • Data is analysed sequentially
Multi-phase	• Multiple phases of data collection each building upon the data from the last • Priority sits equally • Data is analysed sequentially

To summarise, key MMR decisions for SUFFICE are:

- Data interactivity: ***INTERACTIVE***
- Data priority: ***QUAL quan***
- MMR design: ***EXPLORATORY SEQUENTIAL***

3.6. Limitations to MMR

Limitations to MMR include volume of data management, the generation of conflicting data, and the requirement for the researcher/research team to have expertise in multiple methods. MMR generates in-depth data that often requires a large resource to collect, manage and analyse (Halcomb, 2019). Pragmatic MMR considerations include a requirement for a significant level of skill and knowledge to be able to utilise several data collection research methods rigorously. Also, the amount of data collection required for MMR may be more than a single researcher is able to accommodate. These limitations are not insurmountable but require addressing at the design stage. In the SUFFICE study, a Framework Analysis was chosen to account for the large amount of data collected, allowing the researcher to efficiently organise and visualise the data from multiple phases (Gale *et al.*, 2013).

3.7. Published Study Protocol (Open Access)

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Protocol for a mixed methods exploratory study of success factors to escalation of care: the SUFFICE study

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Abstract

Background: In the United Kingdom, hospital patients suffer preventable deaths (*failure to rescue*) and delayed admission to the Intensive Care Unit because of poor illness recognition. This problem has consistently been identified in care reviews. Strategies to improve deteriorating ward patient care, such as early warning systems and specialist care teams (Critical Care Outreach or Rapid Response), have not reliably demonstrated reductions to patient deaths. Current research focuses on *failure to rescue*, but further reductions to patient deaths are possible, by examining care of unwell hospital patients who are rescued (successfully treated). Our primary objective is to develop a framework of care escalation success factors that can be developed into a complex intervention to reduce patient mortality and unnecessary admissions to the Intensive Care Unit (ICU).

Methods and Analysis: SUFFICE is a multicentre mixed-methods, exploratory sequential study examining rescue events in the acutely unwell ward patient in two National Health Service Trusts with Teaching Hospital status. The study will constitute four key phases. Firstly, we will observe ward care escalation events to generate a theoretical understanding of the process of rescue. Secondly, we will review care records from unwell ward patients in whom an ICU admission was avoided to identify care success factors. Thirdly, we will conduct staff interviews with expert doctors, nurses, and Allied Health Professionals to identify how rescue is achieved and further explore care escalation *success factors* identified in the first two study phases. The final phase involves integrating the study data to generate the theoretical basis for the framework of care escalation success factors.

Ethics and Dissemination: Ethical approval has been obtained through the Queen Square London Research and Ethics committee (REC Ref 20/HRA/3828; CAG-20CAG0106). Study results will be of interest to critical care, nursing and medical professions and results will be disseminated at national and international conferences.

Introduction

It has been estimated that there are up to 11,000 preventable deaths in England National Healthcare Services (NHS) Trusts each year (1). Patient deaths, resulting from reversible in-hospital complications, are classified as a Failure to Rescue (FTR) (2,3). FTR is a common theme to National Confidential Enquiry into Patient Outcomes and Death (NCEPOD) reports(4–6). Evidence suggests complication rates do not differ significantly between hospitals, but some patients can be 3 times more likely to die in certain Trusts compared to others (7), implying organisational differences accounting for mortality rates.

Background

The appropriate use of Intensive Care Unit (ICU) resources is high on the NHS agenda (8). During the Covid-19 pandemic a key focus of the NHS was the optimisation of vital critical care capacity to provide for the surge of patients who would ultimately need advanced level care in a High Dependency Unit (HDU) or ICU (9). Optimisation has two key elements: reducing unnecessary ICU admissions and facilitating timely admissions. Poor recognition of patient deterioration increases patient mortality and morbidity (10) by delaying admission to the ICU. Delays cause worsening patient outcomes (11) including longer ICU and hospital length of stays (12). In order to avoid FTR and maximise ICU treatment efficacy, a successful and timely escalation of care is required (13). Timeliness of a patients' deterioration detection, communication and management (4,13) (escalation of care) can be influenced by organisational or human factors (system influences affecting human performance). Organisational factors include hospital volume (number of similar procedures completed such as oesophagostomy surgery) (14), nursing ratios, number of critical care beds and the number of operating theatres (15). Human factors attributed to influencing FTR/care escalation include situational awareness, poor clinical monitoring, team working, communication, safety culture, workload, clinical experience, negative emotions and leadership (4,16–20).

Interventions to reduce FTR by optimising care escalation include specialist teams and early warning scores (EWS) (13). Specialist clinical teams, such as Critical Care Outreach or Rapid Response Teams, target improvements to the initial detection and ward management of

patient deterioration (21). Unfortunately, evaluations of this intervention conclude a lack of strong evidence of improved outcomes (21,22), such as cardiac arrest rates. Similarly, a recent systematic review on EWS, showed that many tools have methodological weaknesses and may not perform as well as expected (23). Key weakness in EWS, are that they don't entirely complement the ways in which clinicians escalate care , for example EWS do not integrate soft clinical signals of deterioration (24) often used to escalate a patients care prior to significant illness. Despite these targeted interventions, preventable patient deaths remains problematic (6).

Patient deterioration literature has primarily focused on failure. In the deteriorating ward patient, further reductions to patient mortality and improvements to patient morbidity may be seen by examining the process of rescue and identifying success factors to this. SUFFICE forms part of a full-time doctoral study and aims to systematically address gaps in understanding about the process of rescue.

METHODS

Aims and Objectives

Our primary aim is to develop a framework of care escalation success factors that can be developed into a complex intervention to reduce patient mortality and unnecessary ICU admissions. Rescue event analysis will be achieved through five key objectives:

- To observe between 200-400 patient escalation events in representative areas
- To review between 200-400 care record reviews of deteriorating patients who avoided an ICU admission
- To interview 30 expert clinical staff to identify success factors and how to apply them effectively
- To describe the patient population in whom escalations occur
- To describe rescue events in Covid-19 negative and positive patients

Patient and Public involvement (PPI)

This study has been developed and supported by several Patient and Public Involvement (PPI) representatives (CT, IT, MC) that form the SUFFICE PPI group. This group has been consulted at major study milestones including study development and have fed back on study protocol, study design and ethics applications. These representatives are both patient and public, who give a rich insight into the patient experience.

Study Design

SUFFICE (Success Factors Facilitating Care during Escalation) is a multicentre, mixed-methods, exploratory sequential study aiming to identify the success factors to care escalation (rescue), resulting in a framework development. There are four key study phases; observations of escalation events, a retrospective care records review of ward patients who became unwell but did not require an ICU admission, clinical staff interviews and a data integration phase (see Figure 1. SUFFICE study design flow diagram).

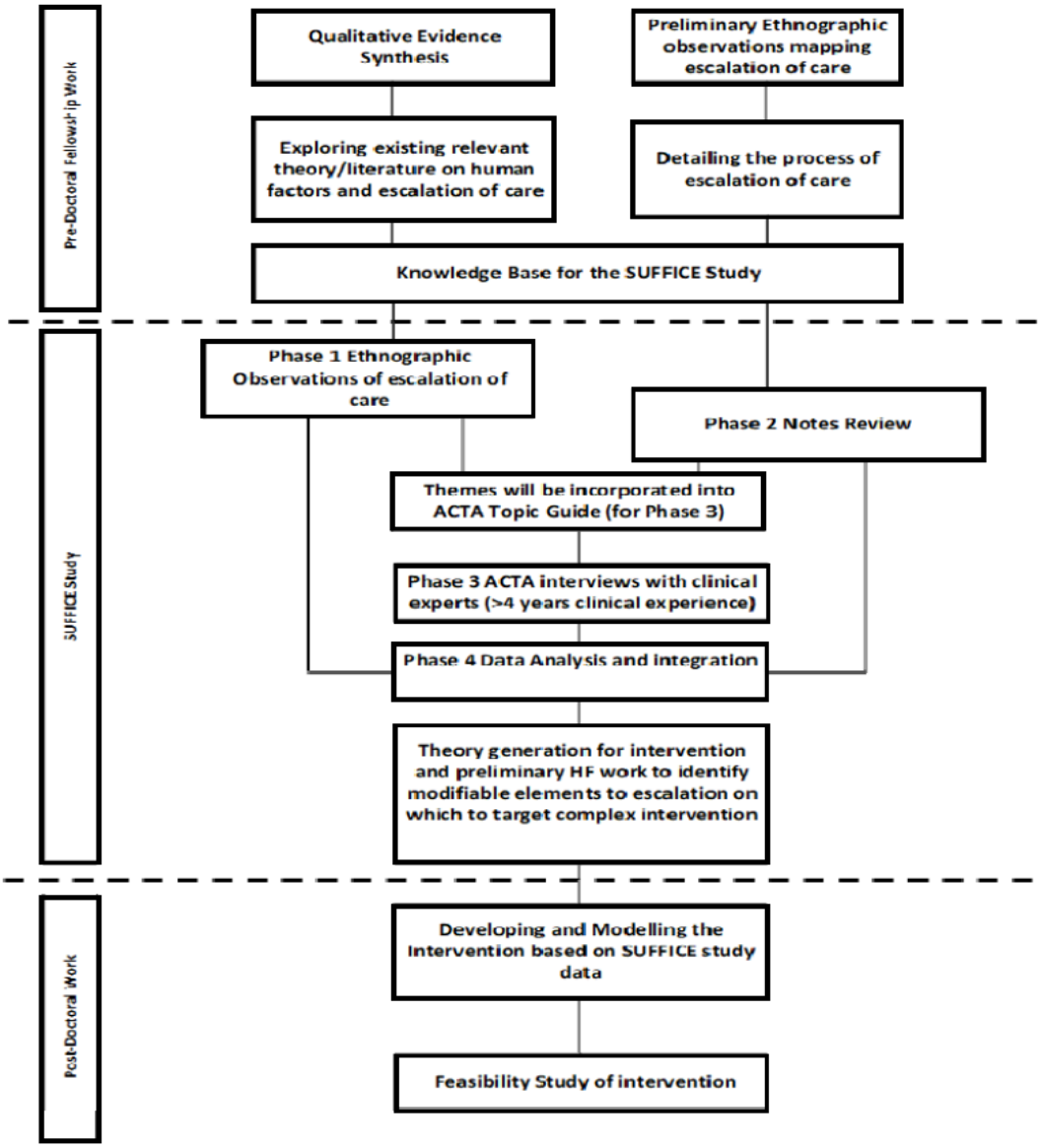

Figure 1. SUFFICE study design flow diagram

Phase 1: Escalation event observations

Between 200-400 escalation events will be observed to develop a theoretical understanding of the process of rescue. We are defining an escalation of care as any communication relating to the recognition of patient deterioration (13). Non-participant observations (25) will be conducted by the researcher in the clinical ward environment. For the purposes of SUFFICE, observation rather than Ethnography was chosen to ensure an appropriate

representation of data collection, which is likely to be short periods of intense fieldwork (26). This will be achieved by shadowing clinical staff and observing their interactions with other staff groups ensuring the collaborative process of rescue is captured. Observations will be conducted in 4-hour sessions within clinical areas, and participants may be observed during multiple observation sessions.

Informal interviews will supplement observations, probing events, staffing levels, or actions, this being an accepted method in observation research (27). Data collected will include patient factors (age, admission type), escalation factors (escalation triggers, EWS), and contextual ward factors (staffing levels). Shelford Safer Care Nursing Tool (SNCT) data, giving an indication of ward staffing levels and ward acuity or dependency (28), may be collected for wards where an escalation event is witnessed. This data collectively will contribute a theoretical understanding of situations that lead to an escalation of care.

Phase 2: Retrospective Care Records Review (RCRR)

We will review 350 medical, surgical or trauma patient care records to understand why some clinically unwell patients deteriorate to the point where their condition would trigger an intensive care review (a trigger event) but avoid an ICU admission (rescued). We have defined clinically unwell as a EWS score of =>7 which would warrant an ICU review or an admission (29). We have also defined rescue as a resolution of a trigger event without requiring an ICU admission. Care data will be reviewed specifically around periods of care, centred around the patient's EWS trigger event:

- 24 hours pre-trigger
- 24 hours post-trigger
- >24 hours post-trigger (subsequent care period until 3 subsequent triggers of <3 is documented indicating stability)

A further 50 notes (giving a total of up to 400 care records) will be reviewed from participants who became unwell on the ward were admitted to ICU and died. Records will be reviewed using the Structured Judgement Review (SJR) method (30,31) and will consider all aspects of the patients care by examining records from nursing, Allied Health

Professionals, doctors, drugs charts and diagnostic test results (1). Care records reviews are a prime method to assess quality of care (32).

The review process is conducted in three stages: Level 1 and Level 2 (in-depth) reviews:

- Level 1, care records will be reviewed and given quality of care scores before, during and after the trigger event. Quality of care is graded by the reviewer, from 1-5 (1-Very poor care, 2-Poor care, 3-Adequate care, 4 Good care, and 5-Excellent care) in each care period. A small vignette will be documented for each phase justifying rationale of each quality-of-care grade. A modified Case Report Form (CRF) tool will be used to collect the data based on the Structure Judgment Tool (30) used within NHS mortality reviews and has been included within the associated documents. Other data collected will include patient factors; age, length of hospital stay, Clinical Frailty Scale and Charlson Co-morbidity scores, Safer Nursing Care Tool (SNCT) data.
- Level 2 reviews will be conducted on care records that have been graded scores of 4-5 (indicating Good to Excellent care). From these records, a rich qualitative narrative of care factors will be extracted giving a chronology of care pre- and post-trigger. Themes from care reviews may also be explored in Phase 3.
- Validation will consist of a random pragmatic proportion of Level 1 (10%) and Level 2 (n=5) care record reviews being conducted by a second researcher to assess care judgements scores (1-5). A Kappa Coefficient (for interrater reliability) calculated (1) and significant agreement will be assumed with a result of >0.64 (20).The second researcher is likely to be one of the research team (listed as contributors) or a clinical/research colleague with suitable expertise, training and trust clearances.

Phase 3: Staff Applied Cognitive Task Analysis (ACTA) interviews

We will interview up to 30 nursing and medical experts with at least 4 years' clinical experience, to understand factors affecting successful care escalation and identify how these could be applied effectively across healthcare settings. This may be staff who also participated in Phase 1. Interviews will be guided by a piloted interview developed using the Applied Cognitive Task Analysis (ACTA) interviewing methodology. ACTA is a cognitive interviewing technique, not requiring specialist cognitive training, and centres on eliciting

expert knowledge used to perform key tasks (33). Expert participants will describe how they manage patient deterioration and care escalation (34), articulating their knowledge through posed escalation scenarios. The focus of the interviews is to identify escalation success factors, identified by healthcare experts.

The broad ACTA interview schedule is as follows:

Task diagram: Asks participants to list six key escalation tasks. Aims to get the interviewee focussed on escalation tasks and creates a process map (ordered diagram of escalation).

Knowledge Audit: Identifies how expertise is utilised during escalation. Escalation questions are organised around expertise categories: diagnosing, predicting, situational awareness, perceptual skills, workarounds, improvising, meta cognition and recognizing anomalies.

Simulation Interview: Interviewee is posed an escalation simulation prompting expertise which may not have already developed from the knowledge audit.

To maximise opportunities to collect this specific information, an experience cut-off for participant selection has been given. Participant interviews (over the telephone or face to face) will last no longer than 90 minutes (60-90 minutes), will be digitally recorded on an encrypted device and transcribed.

Phase 4: Data Analysis and Integration

A full study data analysis plan is outlined in the analysis section.

Setting

This study is taking place in two separate United Kingdom NHS Trusts. These are two contrasting Trusts, one being a large teaching hospital and the other being a smaller DGH. Trust A is a group of three tertiary referral hospitals and one district general hospital. In total, the organisation has approximately 1,465 beds, and serves a population of around 655,000. The intensive care capacity within this trust comprises on three specialist units, Neuro, Cardiac and General. The total Trust ICU bed capacity is approximately 48 beds with no established Critical Care Outreach Team. Trust B is the main provider of acute hospital services for the population of approximately 500,000 people. The hospital has

approximately 813 inpatient beds of which 627 are acute bed, 66 for children and young people 75 maternity. This trust has a well-established, nurse-led critical care outreach team and an ICU capacity of 16 beds.

Participant Selection

Phase 1: Escalation event observations

Clinical staff who receive or make escalation referrals will be approached and consented for observations. Staff will be purposively selected to ensure a variety of specialities (surgical, trauma, medical) and clinical grades. Participants should be over the age of 18 and be willing to give informed consent. Observations will cease when a full data set (of 200-400 witnessed escalation events) is completed. Staff will be recruited through posters, word of mouth and invitation emails endorsed by key ward stakeholders.

Phase 2: Retrospective Care Records Review (RCRR)

Our focus is to identify acutely unwell medical, surgical or trauma patients in whom a ward rescue event has occurred without needing an ICU admission. We have defined acutely unwell as a EWS =>7 (35). A EWS score of =>7 has a higher specificity, predictive value, positive likelihood ratio and positive predictive value of an ICU admission than a threshold of 5, and therefore these patients have a high probability of an ICU admission (36). The aim of this analysis is to identify why these patients (with a high probability of needing an ICU admission) avoid this event and if and how they are rescued. This trigger value was also supported through study team consensus as this physiological derangement would be unlikely to spontaneously resolve without intervention. Patients who meet the inclusion criteria will be identified from the local electronic patient record (EPR). The most recent patients who meet the inclusion criteria will be identified and their care records retrieved.

Record reviews survivors

- Medical, surgical or trauma patients who have had an EWS=>7
- Have not been admitted to ICU
- Survived their hospital admission (discharged to normal place of residence)
- Have Covid-19 and non-Covid-19 infections

Record reviews deceased

- Medical, surgical or trauma patients have triggered a=>7 EWS score
- Have been admitted to ICU
- Died
- Have Covid-19 and non-Covid-19 infections

Records will be sampled from varying timepoints within the year to ensure seasonal variation is captured. If notes are incomplete, these will be excluded until 400 usable datasets are completed. Confidentiality Advisory Group (CAG) (CAG-20CAG0106) support was obtained for this study (see ethics section).

Phase 3: Staff Applied Cognitive Task Analysis (ACTA) interviews

Any staff member who has experience of escalating or receiving a care escalation and has 4 years or greater clinical experience are eligible to take part in the interview. To maximise opportunities to elicit expertise utilised during escalation of care, an experience cut-off for participant selection has been given. For the purposes of this study, 'expert' is defined as greater than 4 years clinical experience (37,38). Pilot interviews have been conducted exploring care escalation. Participants will be chosen for representativeness in terms of gender, age and clinical role, ensuring varied responses. Staff will be over the age of 18 and are willing to give informed consent. If a staff member withdraws from the study, they will be replaced to ensure a full dataset is collected. Staff will be recruited through posters, word of mouth and invitation emails endorsed by key ward stakeholders.

Phase 4: Data Analysis and Integration

n/a

Sample Size

Phase 1: Escalation event observations

Observations will be undertaken in four-hour time slots, at varied times of day but with a maximum of one time slot per day. Data collection will continue for 6-12 months; estimates

(from preliminary observation work) are that between 8-10 care escalations will be captured per observation session, generating between 200-400 escalation episodes in total. Saturation of data themes will be used as an indicator of sample size (39).

Phase 2: Retrospective Care Records Review (RCRR)

This sample size (400 care record reviews) is a pragmatic choice with each Level 1 review estimated to take 1 hour to complete. Each in-depth Level 2 review may take up to four hours to complete. Based on other studies using this method (31,40) between 200-400 notes were a large enough number that the data will be sufficiently rich, and saturation is likely to be achievable.

Phase 3: Staff Applied Cognitive Task Analysis (ACTA) interviews

For qualitative interviewing it is accepted that 12 interviews are likely to generate data saturation (41). We chose not to dilute the number of interviews as participants will be selected from two participating NHS sites. It was felt that 15 interviews from each site would generate a rich data set. Interviews will continue until the full 30, or until data saturation is achieved.

Phase 4: Data Analysis and Integration

n/a

Data storage

All data will be stored as per the General Data Protection Regulations (GDPR). All electronic data will be stored on a secure NHS server that was password protected. All paper documentation will be stored in a locked NHS or research facility and appropriately archived once the study has been completed.

Data Analysis

Phase 1: Escalation event observations

Statistical analysis will be mostly descriptive and may include (but not limited to) patient factors collected using the Charlson Comorbidity Index (CCI) tool and the Clinical Frailty

Scale (CFS). For continuous data (includes but not limited to) triggering patient factors, escalation data and contextual organisational factors, mean and standard deviation will be calculated. For categorical data (includes but not limited to) escalation type, organisational data, number and percentage will be reported. This will provide context with which to analyse the qualitative data and identify patterns within and across data collection settings. Statistical advice will be sought for this study.

For qualitative data, a Framework Analysis method was chosen as it provides a clear structured output in the form of a Coding Matrix (42). There are 5 key steps to be taken within a Framework Analysis (43) which include:

- Familiarisation
- Identifying a thematic framework
- Indexing (selecting the interesting fragments-coding)
- Charting/Summarising (key difference between this and content analysis) Tell the story of those fragments
- Interpretation

Phase 2: Retrospective Care Records Review (RCRR)

Our primary objective is to identify care escalation success factors. To generate an in-depth understanding of this, hospital factors will be explored against care scores generated through notes reviews. Care records data will be extracted using the SJR forms designed by the Royal College of Physicians (RCP) (44) (see methods for full details). Care record review data collected will consist of ordinal (care scores, CFS) and continuous variables (agency usage, bed occupancy rates, staffing ratios). Continuous variables will be described with means, standard deviations, medians, and inter-quartile ranges. Categorical (ordinal) variables will have number and percentages. If the data obtained do not violate any statistical principles, we may model the association of care scores with other ward-level variables such as agency usage, bed occupancy and staffing levels using an Ordinal Regression. All tests will be performed in SPSS. P-values will be considered statistically significant when less than 0.05.

A Kappa Co-efficient will also be calculated using SPSS to indicate the level of interrater agreement between quality of care judgement scores (1) from both reviewers completing care record reviews. If data indicates poor interrater agreement, joint reviews will be undertaken to ensure consistency of methods and explanations for scores will be documented within a study audit trail.

For qualitative data, a rich narrative of care will be obtained from notes reviews using a piloted data collection form and will be thematically coded (45). This includes duplicate data extraction (by two researchers or a coding buddy) for up to 40 Level 1 care reviews and 5 Level 2 care reviews.

Phase 3: Applied Cognitive Task Analysis (ACTA) Interviews

Interview transcript data will be coded using Thematic Analysis (45) and inserted into a Knowledge Audit Table and Cognitive Demands Tables (similar to a framework analysis) using the headings from the original ACTA methodology (33) (see methods section of interview structure). The aim of this table (as with Framework Analysis) is to help the researcher identify common themes or conflicting information. A second researcher will cross-analyse up to 3 interviews to ensure coding rigor and theme identification. However, the coding process will be subject to strict collaboration between the research team. To strengthen rigor and credibility, a coding audit trail will be completed detailing coding decisions. Data will be analysed in a coding software package such as NVivo.

Phase 4: Data Analysis and Integration

In this final phase, study data will be analysed, linked and compared (viewed as a whole or mixed) (46) enabling the research team to generate a framework of care escalation success factors. Full study data will be analysed together after initial analysis (in each of the phases), defining areas of data convergence or divergence (47). Following data tabulation, success factors to escalation will be identified (intervention framework). Work will be undertaken by the study team, a Human Factors scientist, and the stakeholder group, using knowledge from SUFFICE and the existing body of escalation literature, to develop this framework.

The framework of success factors may include:

- Success factor (description of the factor)
- Outcome (what outcome that factor facilitates)
- Context (what is the context to that factor such as ward, patient)
- Knowledge base (what is understood about that factor already in the literature)
- Balancing measure (could there be any negative system outcomes if that factor were implemented)

ETHICS AND DISSEMINATION

Ethics

This study gained ethical approval from the Queens Square London Research Ethics Committee (HRA-20HRA/3828; CAG-20CAG0106). The Oxford University Hospital Foundation NHS Foundation Trust will act as sponsor. The study has been developed with the support of the SUFFICE PPI group. This paper reports SUFFICE Protocol Version 2.1 and has been written with reference to the SPIRIT (Standard Protocol Items: Recommendations for International Trials) checklist (48) (see Supplementary File 1). This protocol paper has been independently peer reviewed by an expert (CS) within the field of patient deterioration and Critical Care.

Phase 1 and Phase 3

Informed consent will be obtained from participants by trained researchers. This study has been developed with the help of the Trust's clinical psychology department and staff wellbeing has been carefully considered. If there is distress caused by participating in this study, then staff will be referred to the Trust's occupational departments and the study team will again review the methods with a clinical psychologist. This study is about identifying effective patient care, but in very rare circumstances this may identify poor care which may require escalation through the local clinical governance channels.

Phase 2

CAG (CAG-20CAG0106) supports the study team to screen hospital patient lists (including name, DOB and Hospital number) for eligible patients under Section 251 of the NHS Act

2006. The report of patients meeting the inclusion criteria will be generated by the hospital information team and will not be extraneous to the purpose of the study and only allow for eligibility assessment. From this report, the researcher (ICU nurse and another suitable clinician) will access patient notes to perform the Retrospective Care Records Review (as detailed in methods). The Trust generated data report will be held within an NHS network. Only a researcher with a clinical background will use this report and similarly patient electronic records. Once the record reviews have been conducted, the identifiable data will be destroyed.

Phase 4

n/a

Dissemination

Results from this study will be disseminated at regional and international conferences. These conferences will be attended by one of the SUFFICE PPI representatives should they choose. Papers generated will be published in peer reviewed medical and nursing journals.

Trial Registration Number

ISRCTN 38850

Competing interests: PW reports significant grants from the National Institute of Health Research (NIHR), UK and the NIHR Biomedical Research Centre, Oxford, during the conduct of the study. All other authors declare no conflict of interest.

Contributor statement: JE designed and led the project. RE and PW have substantially contributed to this work, provided expertise and PhD supervision, and have agreed the final manuscript.

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3.8. Patient and Public Involvement and Engagement (PPIE)

This study has been developed and supported by several Patient and Public Involvement and Engagement (PPIE) representatives (CT, IT, MC) who form the SUFFICE PPIE group. This group has been consulted at major study milestones, including study development, and have fed back on study protocol, study design and ethics applications. These representatives reflect both patient and public perspectives, thereby giving a rich insight into the patient experience. A full published commentary on the PPIE process for this study is detailed in Chapter 7.

3.9. Data collection tools

Three data collection tools were developed for each phase of data collection (two Case Report Forms and one Interview Topic Guide) to fulfil the research aims of the study. The bespoke tools ensured appropriate and replicable data collection methods for each of the study phases (see Appendix 2 for Examples of populated Case Report Forms and submitted interview paper in Chapter 6). These are now described in full, and the design rationale provided.

3.9.1. Phase 1 Escalation Event Observations Case Report Form

The aim of the first phase of data collection was to identify success factors to escalation by observing escalation of care events in ward patients. Escalation event observation data included both quantitative data (patient age, trigger score) and qualitative data (field notes, ad hoc question responses). Pre-defined variables were

developed during supervision sessions, through previous escalation of care ethnography work and drawn from the Qualitative Evidence Synthesis (Chapter 2) (soft signals of patient deterioration). The electronic data collection tool was specifically developed in an Excel® spreadsheet (Microsoft Corporation, 2018. *Microsoft Excel*, Available at: https://office.microsoft.com/excel). It was user tested prior to the formal data collection process and iterated by adding some quick drop-down menus, categorising certain anticipated qualitative data e.g., NtN (Nurse to Nurse) referral, NtD (Nurse to Doctor), and removing extraneous information.

Where possible, scores that contributed to a larger score such as EWS were collected at an individual level. Data inserted into the e-CRF were anonymised at the point of capture. To obtain rich qualitative data, free text field notes were also collected in another spreadsheet tab, which included a narrative of events, such as context, environment, tools, tasks, technology, people, and organisation, as well as documentation of any discussions with clinical staff. Free text data were captured during the escalation event or following, when the researcher had allocated time at the end of each observation session for reflections, critical thoughts, and questions.

3.9.2. Phase 2 Retrospective Care Record Review Case Report Form

The aim of this phase was to i) identify success factors to escalation documented in care records of patients who triggered a EWS ≥7 in the ward, avoided ICU and survived and ii) compare with ward patients who triggered a EWS ≥7, went to ICU and died. The RCRR tool was adapted from the Structured Judgement Review (SJR) used for mortality NHS reviews and was developed by the Royal College of Physicians

(RCP) (Gibson, 2016). The original SJR form consisted of time periods, care scores and sections for free text. The Phase 2 tool was adapted from this, and used to collect a broader range of patient, illness, demographic data with further escalation metrics also included. Patient care data were reviewed and collected, focusing on the patient's EWS trigger event:

- 24 hours pre-trigger
- 24 hours post-trigger
- >24 hours post-trigger (subsequent care period until 3 subsequent triggers of <3)

As with the previous data collection tool, this was also piloted and adapted by two researchers (the second researcher was previously naive to the tool) who gave feedback about terms used. In anticipation of the breadth and potential complexity of data collected during this phase, two key governance methods were developed: a data dictionary and a screening Standard Operating Procedure (SOP). The purpose of the data dictionary was to give clear definitions to variables and units of measurement to be extracted such as heart rate (beats per minute) and blood pressure (Millilitres of Mercury) (see Table 5). This document also ensured consistency between both researchers and any measure/variable ambiguity was mediated through minor word changes or descriptions within the CRF columns.

Table 5 Quantitative Data Dictionary

VARIABLE	MEASURE	ABBREVIATION
Heart rate	beats per minute	Bpm
Blood pressure	Millilitres of mercury	mmHg
Clinical Frailty Scale	1-9	n/a This should be a measurement of the patient's pre-morbid state. When used in the context of an acute illness or admission to hospital, it is recommended that the CFS score be based on the patient's premorbid status two weeks prior to the acute change rather than their presentation at the time of assessment (AIMS Research Group at the Ottawa Hospital, no date). Subject to inter-rater bias (see website for further details-excellent critique)
Charlston Co-morbidity Index (total 37)	Calculated from medical history. Refer to CCI calculator	n/a
Date of admission	Day/month/year format	Xx/xx/2020
Time to referral	(hh:mm)	n/a
Ward Type	Medical/Surgical/ Trauma	Med/Surg/Trau
Gender	Male/Female	M/F

An SOP was developed to signpost where to extract care record review data (see Appendix 3) based on the variables above. See Appendix 4 for care record reviews data extraction rules.

3.9.3. Phase 3 Interview Topic Guide

The aim of this phase of study was to understand the factors that affect successful escalation of care and identify how these could be applied effectively across healthcare settings. To identify success factors, it was important to understand expertise within the escalation process; the ACTA methodology provided a

framework with which to do this. To ensure consistency between interviews, an interview topic guide was developed with Robert Hutton M. S. Human Factors & I/O Psychology; B. A. (Hons) Psychology who co-developed Applied Cognitive Task Analysis (ACTA) interviewing methodology (Militello and Hutton, 1998). Overall, the interview schedule remained true to the original methodology, but also allowed enough flexibility to probe escalation of care. This topic guide was piloted and adapted to the requirements of the SUFFICE study (see Chapter 6 Published ACTA Manuscript). The content of early ACTA interviews was reviewed by both JE and RH, and minor changes made such as probing a single event more thoroughly and not aiming to use all the ACTA prompts if data yield was better with certain questions based on researcher judgment during the interview.

3.10. Preparing data for Analysis

Both the quantitative and qualitative data generated from this study were prepared in different ways.

3.10.1. Quantitative Data Preparation

Quantitative data were entered directly into an excel spreadsheet. The data included categorical data (such as gender, admission type and trigger cause), and numerical data (such as vital signs data and age). Data were 'cleaned' ready for analysis, such as removing any unnecessary data columns and identifying data entry errors. A missing data frequency query was run to identify data sets with missing values. If any values were missing, the initial response was to revisit the source data to extract the missing information. If this method was unsuccessful,

data remained blank and reported in any final statistics. The spreadsheet was locked and imported into SPSS. Once in SPSS, the data were assessed for distribution of normality for certain variables, such as care scores. Expert statistical consultation was sought to clarify the appropriateness of statistical tests that have been described in detail in the published protocol. A data analysis decision tree was developed to illustrate key analysis decisions made (see Figure 12).

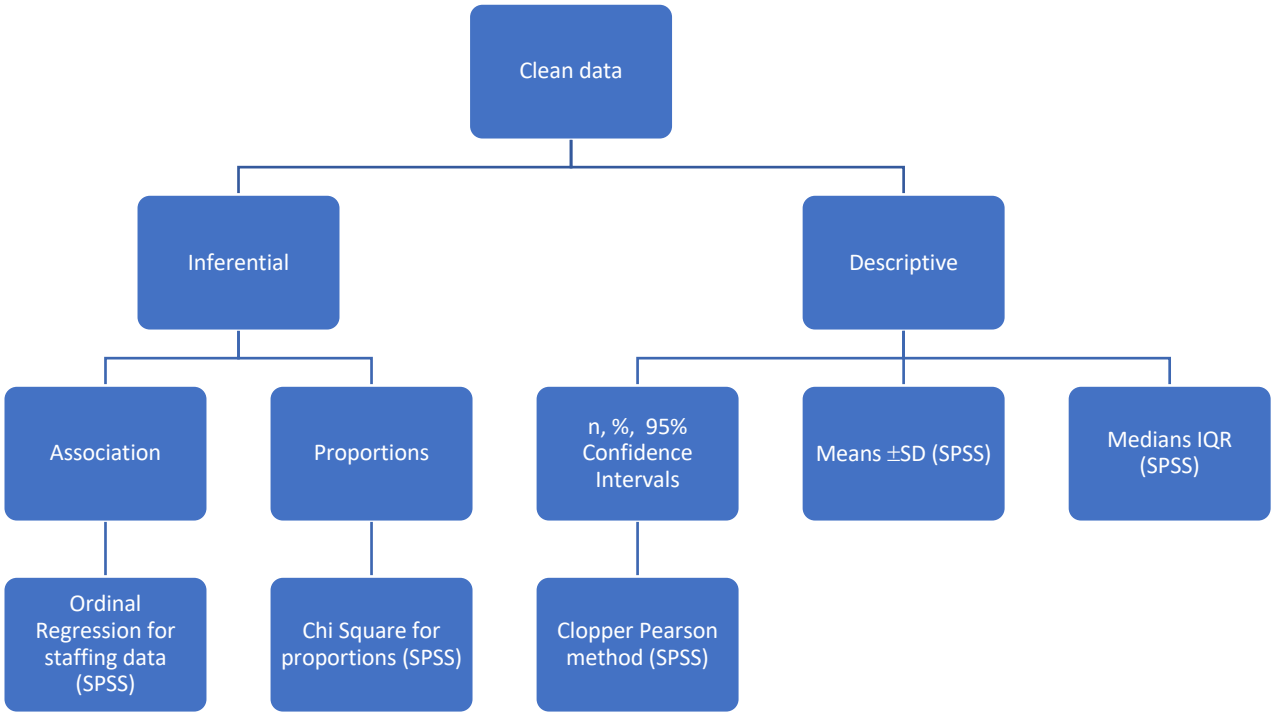

Figure 12 Data analysis decision tree

3.10.2. Reliability of Organisational Staffing Data

The published protocol stated that organisational staffing data would be collected to give a contextual understanding of rescue events within the ward setting. However, during the Covid-19 pandemic, staffing data were unreliable and deemed too risky to include within the analysis of this work. Firstly, staff were regularly deployed to other clinical areas within the Trust, and this was not reflected within the staffing documentation due to the urgency of the pandemic response. One Trust continued to use manual data collection for staffing which, by their own admission, was prone to error. In the Trust that did utilise electronic staffing data through a rostering system, this frequently did not have the responsiveness nor the organisational processes in place to adequately capture staff redeployment. Secondly, there were staffing data gaps of several months, particularly between April and September 2020, when normal data collection processes were severely weakened. Finally, there were key differences between the ways in which both Trusts documented their staffing data and how they judged a clinical area to either be adequately staffed or short. One Trust did this through local experience of required numbers, whilst the other Trust did this through the calculation of Care Hours Per Patient Days in Safe Staffing (CHPPD).

3.10.3. Qualitative Data Preparation

Audio files of staff interviews were saved onto a secure NHS network and given a unique identifier, as well as the date of the interview and site code. The use of names and identifying information were avoided throughout the interview. The

files were transcribed by a professional transcriber and returned to the research team. The interviews were read shortly after each interview to maximise recall of the researcher and interviews transcriptions were assessed for accuracy. Periodically, the interviews audio files were listened to again and compared to the transcription to judge fidelity. Qualitative data were derived from observations included in field notes, care narratives (from eCRF) and researcher reflections (research diary) and combined within a word document and assigned a unique identifying code. Vignettes from the record reviews were also allocated a study identifier (linked to the quantitative data) and transferred to Nvivo® software.

3.11. Data Integration

This mixed methods study will utilise multiple analysis techniques on both qualitative and quantitative data. Data from each phase (Phase 1, Phase 2, and Phase 3) of data collection will be analysed in steps. Step 1 analysis includes a preliminary analysis (likely one month into data collection or when one third of the data is collected) and step 2 involves an analysis following data collection completion. The third key step of data analysis in mixed methods studies is the 'mixing of data' (Creswell and Plano Clark, 2011) during a data integration phase. The purpose of data integration is so that multiple pools of data can be interpreted in a meaningful way and create a more comprehensible understanding (Uprichard and Dawney, 2019).

Data can be linked in several way such as connecting, building, merging and embedding (Fetters *et al.*, 2013). Once the data from each data collection phase has been analysed individually (see Figure 13), these will be brought together and

merged, with analysis occurring across the datasets to reveal higher-level insights and conclusions.

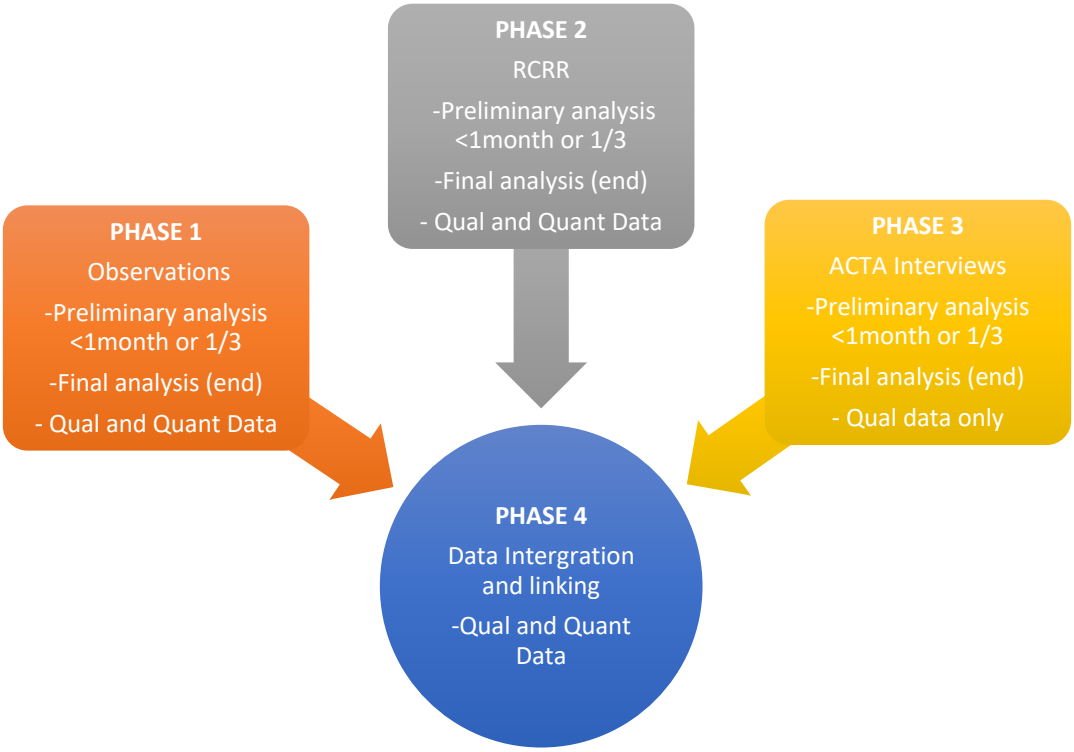

Figure 13 Data Integration

It is possible however that the data analysis method may evolve as data emerges through the study (Dixon-Woods, 2011) and this plan provides an initial guide.

3.12. Framework of Escalation Success Factors

In the final phase, study data were analysed, linked and compared (viewed as a whole or mixed) (Creswell and Plano Clark, 2011; Cresswell, 2015) to enable the generation of a Framework of Escalation Success Factors. Full study data were analysed together after initial analysis (in each of the phases), defining areas of data convergence or divergence (O'Cathain *et al.*, 2010). Following data tabulation,

success factors to escalation were identified, which were then incorporated into a Framework of Success Factors.

3.12.1. Rigor

The rigor of research is integral to its meaningfulness and its ability to contribute to the wider healthcare context. The rigor of this study has been assessed in relation to four key elements: credibility, transferability, dependability and confirmability (Lincoln and Guba, 1985). Data management and confidentiality will also be described in the following sections.

3.12.2. Credibility

Credibility relates to the confidence that the reader can draw from results and that these represent the data collected (Forero *et al.*, 2018). Credibility within the SUFFICE study was supported by several design measures. Firstly, a second researcher extracted a proportion of the care record reviews data in Phase 2. Scores were analysed, and a Kappa Co-efficient was calculated to identify reviewer agreement. Secondly, an interview schedule was designed and used in every ACTA interview (Phase 3) to ensure interview consistency. Themes derived from both the record reviews and interviews were discussed amongst the research team to ensure a coding consensus.

3.12.3. Transferability

This relates to the degree to which results are transferrable or generalisable to a wider population (Forero *et al.*, 2018). This is particularly challenging given the

nature of qualitative research, but several study design features aimed to maximise transferability. Firstly, the study was conducted in two contrasting NHS sites. Secondly, qualitative data were purposively sampled to ensure participant variation. A sampling matrix was maintained to demonstrate overall of key participant overlap and divergence (see Appendix 5) and further study participants recruited to balance characteristic spread where possible. Care records also captured multiple patient groups in differing ward environments. Interviews were conducted with a breadth of clinical professions and clinical experience (although this must have been >4 years clinical experience to meet the study definition of "Expert") across both study sites.

3.12.4. Confirmability

This relates to the extent to which the results of the study would be corroborated by another researcher (Forero *et al.*, 2018) and free from researcher bias. Results were regularly discussed with supervisors, who had expertise in the subject area to specifically identify any methodological or analysis weaknesses. Key themes and data were agreed upon. As previously indicated, a reflective piece was undertaken by the researcher that explored professional background (ICU Nurse) and how this may affect or influence enquiry (see Appendix 1).

3.12.5. Dependability

This relates to whether results of the study are repeatable (Forero *et al.*, 2018). This was addressed through several key design decisions. Firstly, an in-depth study protocol was peer reviewed and published. Secondly, this project formed a Clinical Doctoral Research Fellowship (CDRF), funded by the National Institute for Health and

Care Research (NIHR) and was subjected to a rigorous methodological review. Thirdly, an in-depth audit trail was completed during study preparation, data collection and analysis phase. A second audit trail was also completed, which detailed coding decisions made during thematic analysis. Whilst data saturation is commonly identified, this was not an absolute requirement of the interview phase. Instead this was guided by the concept of information power, which means that more in-depth data, collected from experts, may mean fewer participants are required (Malterud *et al.*, 2016).

3.13. Data Management

The data within this study were subject to rigorous data protection at every step. A clear Data Management Plan (DMP) was developed (see Appendix 6). Information Governance processes for both participating sites were maintained with a Data Protection Impact Assessment (DPIA) agreement approved by the NHS Trusts' Cyber security and Governance departments.

3.14. Confidentiality

In addition to the ethical considerations addressed in the design and conduct of the study (see protocol manuscript earlier in this chapter), confidentiality of patient and staff data were a priority during this study. The study was subject to stringent Data Protection and Information Governance procedures with Data Protection Impact Assessments being completed for both NHS sites. General Data Protection Regulations (GDPR) have underpinned this work. Key confidentiality issues are described for each phase of data collection below.

In Phase 1 no identifiable patient or staff data were collected. For Phase 2, it was not feasible to gain direct patient consent for this phase of the study as this was a retrospective review of records and patients were unlikely to still be within the healthcare system. Approval was gained from the Confidentiality Advisory Group (HRA-20HRA/3828; CAG-20CAG0106) to allow screening of hospital patient lists including name, DOB and Hospital number) for eligible patients who met the inclusion criteria. JE was the only person with access to the main patient list and a second clinical researcher reviewed care records via a secure NHS server. Patients who met the inclusion criteria had their medical records reviewed and data pertinent to answer the research question were anonymously extracted. The report was generated by the hospital information teams and information kept to the minimum required to allow for eligibility assessment.

For Phase 3, no personal information was collected from or about staff or patients during interviews. If a staff member wished to participate in the staff interviews and has previously been observed in Phase 1, contact information was collected and stored in a password protected document and destroyed 3-6 months after the study had ended. All other data will be kept for a minimum of 5 years as per GDPR regulations. Audio recordings and the patient list required for the record review were kept on an NHS server, which is password protected.

3.15. Conclusion

This chapter has provided an overview of the methods and design used within the SUFFICE study. To summarise, the rationale for a mixed methods design in the SUFFICE study is based on the ability to answer the research questions and how

these methods align with current healthcare issues. A mixed methods design has been justified based on rescue being multifaceted, and the need to understand the human element of this process whilst identifying contextual organisational data. The design was such that the rich qualitative narrative derived from this study will contribute to our understanding of rescue and the tacit knowledge and experiences that staff hold about escalating the care of a sick and deteriorating ward patient. The quantitative strands of the SUFFICE study were required to describe rescued patients and escalation, quality of care and the system factors, such as staffing or ward acuity, that may contribute to outcomes. Using one strand of data collection in isolation would not give the breadth of data required to develop a Framework of Escalation Success Factors and certainly would not give enough of a whole system view to inform a multi-faceted intervention based on this framework.

3.15.1. Dissemination

A short, animated video was developed to illustrate the aims and design of the SUFFICE study. It was also used to introduce a key defining concept of the study which is the exploration of successful events in healthcare rather than focusing entirely on those events with poor outcomes. This was published via social media (Twitter) with the hope of engaging other researchers locally, nationally, and internationally, as well as members of the public.


Oxford University Hospitals
NHS Foundation Trust
NIHR | National Institute for Health Research
UNIVERSITY OF PLYMOUTH
THE SUFFICE STUDY
SUCCESS FACTORS FACILITATING CARE DURING ESCALATION
WE NOW UNDERSTAND MORE ABOUT HOW CLINICAL STAFF CREATE SAFETY AND RESCUE UNWELL PATIENTS
1:16
VideoScribe

4. Chapter Four: Results of Observations of Escalation Events

4.1. Introduction

In this chapter, the results of escalation events are presented as a published manuscript. The aims of this work were to:

i) develop a theoretical understanding of the process of escalation

ii) identify escalation success factors.

The results consist firstly of the descriptive data surrounding the escalation events captured, patient types and EWS to give an understanding of the events. This is then followed by a theoretical map of escalation using a Hierarchical Task Analysis (HTA), description of escalation phenotypes and finally the qualitative data, which give further description to the escalation tasks observed. The chapter concludes with an overview of the implications of these results for the SUFFICE study.

4.2. Submitted Observation of Escalation Events paper (Journal of Advanced Nursing)

Background 300/300

An NHS priority is improving escalation. Little is understood about the unwell, non-triggering patient and more detailed examination of escalation communication is required to make process improvements. The aims of this paper are to present i) a

theoretical understanding of the process of escalation and ii) identify escalation success factors.

Design

Non-participant escalation events observation data were collected between 16 February 2021–17 March 2022 from two NHS Trusts. Escalation events field notes were analysed using Framework Analysis, data were presented as 95% CI and a Hierarchical Task Analysis diagram mapped escalation tasks.

Results

A total of 105 hours of observations were completed across 38 sessions. Escalation events occurred on 151 occasions, for medical (n=81), surgical (n=65), and trauma (n=1), unknown (n=4) patient specialities. Half the escalations (51%, 77/151) were not score-initiated and resulted from bleeding, infection, or chest pain concerns. From 137/151 events, four escalation communication phenotypes were identified: **Outcome Focused Escalation** was the most common (57/137, 41.6%, 95% CI 33.3-50.3). The referrer anticipated the interaction output (blood cultures, sepsis screen or antibiotic prescription). **Informative Escalation** was frequently observed (49/137, 35.8%, 95% CI 27.8-44.4) and employed when a triggering patient was a low clinical concern. Communication was only informative. **General Concern Escalation** was evident in 26/137 events (19.0%, 95% CI 12.8-26.6) and the referrer did not have preconceived ideas of what was required and based on gut concerns. **Spontaneous Interaction Escalations** were the least frequently observed in 5/137 (3.6%, 95% CI 1.2-8.3) and communication was opportunistic, informal and took place in communal workspaces.

Conclusion

Most escalations did not relate to a score and are not homogenous phenomenon. Informative Escalations were common and represent an organisational requirement to report all triggering warning scores. Spontaneous Interaction Escalations were effective and should be encouraged through hospital designs and systems, facilitating a deterioration dialogue.

4.2.1. Introduction

Improving care for the deteriorating ward patient is a National Health Service (NHS) priority (Hogan *et al.*, 2019). Post-operative deterioration results from physiological or biochemical instability (Mohammed Iddrisu, *et al*, 2018; Connell, *et al*, 2020). To avoid worsening instability, an escalation of care is required whereby clinical staff recognise and communicate this deterioration to specialist teams and implement first line treatments (Johnston *et al.*, 2016). Failure to escalate has been cited to be between 10-50% (Connell, *et al.,* 2020*)* and can result in cardiac arrests, unplanned Intensive Care Unit (ICU) admissions (Hogan *et al.*, 2019) and increased ICU mortality and morbidity rates (McQuillan *et al.*, 1998; Stelfox, *et al*, 2014; Magor *et al.*, 2022). Up to 1% of ICU admissions may be avoided with timely and appropriate care (Redfern *et al.*, 2020).

4.2.2. Background

The two main escalation processes are an Afferent (recognition and communication of deterioration) and Efferent limb (management of patient deterioration) (Odell, 2015). Early Warning Score (EWS) systems aim to improve the Afferent limb by facilitating healthcare staff to recognise deterioration and signpost clinical actions (increasing frequency of monitoring or further support) (Hogan *et al.*, 2019). However, evidence suggests a high percentage of patients are transferred to the ICU without triggering an alert, indicating screening for early critical illness is much less reliant on vital signs that first thought (Nestor *et al.*, 2022). Similarly, clinical staff

frequently cite examples when patients do not meet the required EWS threshold but are clinically concerning (Ede *et al.*, 2020). Data examining these patients who do not meet the EWS thresholds is limited and their contribution to escalation workload is uncertain, predominantly because they are difficult to identify through traditional systems (Ede *et al.*, 2021).

The concept of escalation is described homogenously and lacks nuance within the literature. Escalation communication, which adequately relays patient risk across healthcare teams, remains central to patient safety (Bradley *et al.*, 2015) but is often described in transactional terms. Communicating risk during deterioration dialogues is multifaceted and challenging, resulting in a risk mismatch between parties (Lavoie *et al.*, 2020). Evidence suggests that when clinical staff are given the choice of using an online referral system or a verbal interaction, the majority of surveyed staff prefer a conversation (Amarouche *et al.*, 2017). This infers that escalation is more than a transaction of information; the output of which evolves because of the verbal discussion. Seminal work on deterioration events indicates a greater understanding communication is central to informing further process improvements (Ghaferi and Dimick, 2017).

Overall, there is a lack of detailed evidence fully describing escalation in the non-triggering patient and there appears to be an assumption of escalation communication homogeneity. The aims of this research are to address these gaps by i) developing a theoretical understanding of the process of escalation and ii) identifying escalation success factors. Objectives were to:

- Observe escalation events in the acute ward setting of medical, surgical and trauma patients
- To report the process of escalation
- To report escalation success factors derived from observations

4.2.3. Design

This is one phase of a wider mixed-methods, multi-site study (SUFFICE) examining escalation of care in the deteriorating ward patient (Ede, *at al*, 2021) and its success factors. This study was registered with the International Standard Randomised Controlled Trial Number organisation (study number: ISRCTN 38850) and this manuscript has been reported against the COREQ checklist (see Supplementary File. 1). An observational approach was chosen to understand the contextual environment and collaborative process, as it has been used as a method to collect escalation data in previous studies (Chua *et al.*, 2013; Johnston *et al.*, 2014). In order to minimize the Hawthorne Effect (McCambridge, *et al*, 2014), non-participant observations were utilised where the observer did not directly influence the phenomena of interest (Handley *et al.*, 2020). Escalation of care is broadly defined as any communication relating to the recognition of patient deterioration (Johnston *et al.*, 2015) or clinical change. A success factor was defined as any mechanism, context or process which promoted a completed escalation of care.

4.2.4. Sample

Data on escalation events for medical, surgical, and trauma patients were collected from two NHS Trusts, spanning the period from 16th February 2021 to 17th March

2022. A purposive sample of clinical staff were shadowed and observed by the researcher to capture escalation events. Observations were conducted across entire hospital sites (see Supplementary File. 2 for observed ward descriptions) rather than being limited to single wards, depending on the individuals being shadowed and the locations of unwell patients. In April 2021, two months after starting data collection, the first COVID-19 wave presented which significantly restricted access to clinical areas.

4.3. Data collection

4.3.1. Observational data

The observations of escalation events focused on the interactions between clinical staff and other staff groups, capturing the collaborative and multi-professional nature of the escalation process. No direct patient observations, identifiable patient/staff data were collected. Sessions were limited to a maximum duration of 4 hours and staff members were observed at multiple times at various shift time-points (early, late, night, and day) across different month clusters to capture any temporal or seasonal variations. Data (field notes, researcher reflections/memoirs, interview data) were collected with an electronic case report form.

4.3.2. Ad hoc interview data

To document staffing, specific events or behaviours, field notes and observations were supplemented with ad hoc interviews. These were short discussions with staff lasting no longer than 30 minutes.

4.3.3. Ethical considerations

Permission to conduct this research was granted from the Queens Square Research Ethics Committee (REC) reference number HRA-20HRA/3828 and both hospital research departments. During this study, two consenting processes were employed to reduce the inadvertent observation of someone who may not have directly consented. Given the collaborative nature of escalation and the fluid nature of the observation sessions across multiple clinical environments, it was not possible to consent all observed clinical staff prior to observations. In the first instance, clinical staff who were directly shadowed provided written consent before the observation session commences. Clinical staff that were indirectly observed (due to the nature of deteriorating patient management and care delivery in the acute ward) were asked to provide verbal agreement to being observed on initial contact so as not to interrupt the clinical workflow when managing a deteriorating patient. This was done out of professional curtesy and ensured that staff felt empowered to stop the observations. Retrospective consent was obtained once the observation or escalation event had concluded.

Staff were assured that observations were not focussed on critiquing medical or nursing care but aimed at understanding the collaborative process of rescue. Before the start of the study, the divisional matrons and lead consultants were contacted and informed about the goals and objectives of the research. Ward managers were provided with an email to notify staff of the possibility of being observed, and how to object to observations. Researcher safety was paramount due to the onset of

COVID-19 infection and adherence to hospital and Public Health England (PHE) advice on PPE was required during observation sessions.

4.3.4. Data Analysis

Data were inputted directly into a spreadsheet during and following the observations. Hand drawn diagrams were copied and refined in PowerPoint. Data analysis was completed as follows:

- Quantitative escalation event data were checked for errors and cleaned. Data are presented as proportions (%, 95% CI). Confidence intervals of proportions were calculated using the Clopper–Pearson method.
- Qualitative data from observations in field notes were read several times to allow the researcher to become familiar with the content.
- Tasks were documented by process mapping (Lane, Stanton and Harrison, 2006) within a Hierarchical Tasks Analysis (HTA). Hand drawn and sketched HTA drawings were refined based on the content of the qualitative fieldnotes data and researcher reflections. The HTA provides a theoretical framework for understanding the escalation process and serves as a basis for analysing the qualitative data.
- Qualitative data were summarised in a Framework Analysis matrix with the specific aim of identifying escalation success to the main sub tasks identified within the HTA.
- The theory of Escalation phenotypes was tested across multiple observation sets and definitions were refined. Whilst escalation types have been defined and categorised, there is some overlap between them.

4.3.5. Rigor

Comprehensive field notes were documented throughout and after the observation sessions. Notes consisted of direct observations (descriptions of tasks), direct staff quotes from ad hoc discussions (centred on the escalation event), researcher conceptual diagrams (HTA) and researcher reflections/memoirs. The observation data collection tool was trialled and refined as the sessions continued, which included creating some categories of commonly observed events (e.g., face to face referrals abbreviated to F2F). All observations were completed by one researcher (JE) who has a critical care background and acute ward experience. JE had previous training on qualitative research methods including techniques of ethnography and had conducted observation work in previous research related activities.

4.4. Results

A total of 38 observation sessions were conducted at different standard shift time points, including early shift (n=30, 79%), late shift (n=6, 16%), and night shift (n=2, 5%), resulting in a cumulative observation duration of 105 hours. Several clinical staff were shadowed including consultants, senior doctors, junior doctors, sepsis specialist nurses, outreach practitioners, Practice Development Nurses, and ward co-ordinators. A breadth of ward processes was also observed which included ward Safety Huddles, ward rounds, shift or team handovers, acute admissions and 'Hospital at Night' meetings.

4.4.1. Escalation Events

A total of 151 escalation of care events were captured for patients in the following clinical specialities: medical (n=81/151), surgical (n= 65/151), trauma (n=1/151), and unknown (n=4/151). Of these, 44% were female (66/151) and 10 events had missing gender data as no direct patient observations were conducted. Key escalation steps observed were documented using a Hierarchical Task Analysis (HTA) (see Figure 1).

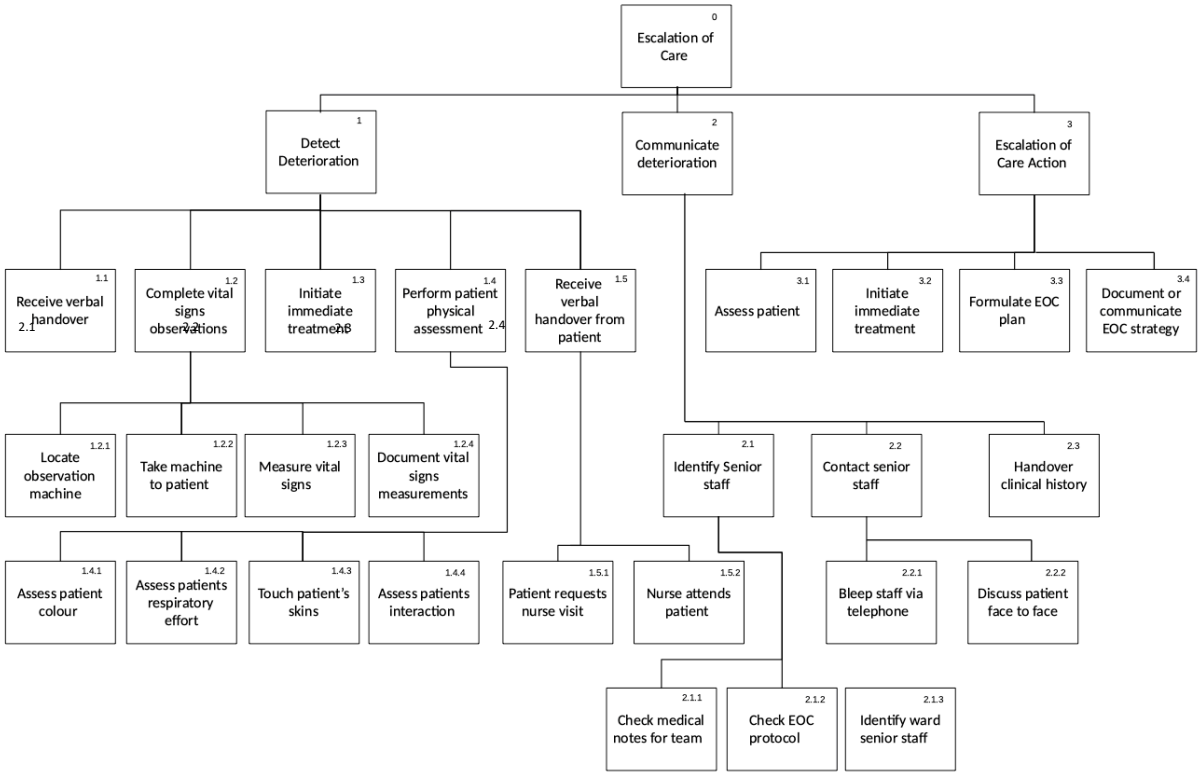

Figure 14 Hierarchical Task Analysis (HTA) of Escalation of Care

The HTA consists of three top level escalation sub tasks (detection of deterioration, communication of deterioration and escalation of care action) and 26 sub-level tasks. Detecting deterioration required the completion of the highest number of lower-

level sub-tasks (n=15). Communicating deterioration (n=8) and escalation action (n=3) had fewer lower-level sub-tasks.

4.4.2. Detection of Deterioration (Sub Task 1.1)

Among escalated patients, the majority had a EWS of 3 or lower (n=66/151, 44%). The number of observed events decreased with increasing EWS scores: EWS 4-7 (n=53/151, 35%), EWS 8-11 (n=26/151, 17%), EWS >12 (n=3/151, 2%), and 3/151 events had missing EWS data (2%) (see Supplementary File. 3, Figure 2) for EWS score frequencies and distribution). Half of the escalations were not initiated through concern surrounding the patients EWS score (Non-EWS initiated escalation 77/151, 51% versus EWS initiated escalation 74/151, 49%) (see Supplementary File 3, Figure 3 & 4). This was also supported by the Qualitative data *'Twice daily assessment of hospital wide NEWS scores. We do have data to show that most of our referrals are based around nurse concern.' Observation Sessions 8, outreach nurse 2*. Commonest clinical concerns for EWS initiated escalations were sepsis (n=11/74, 15%), hypotension (n=10/74, 14%), low Glasgow Coma Scale (GCS) (n=7/74, 10%) and hypoxia (n=6/74, 8%). Commonest clinical concerns for Non-EWS initiated escalation were bleeding (n=7/77, 9%), infection (n=4/77, 5%), chest pain (n=4/77, 5%) and resolved desaturation (n=4/77, 5%) (see Supplementary File. 3, Figure 3, 4 & Table 2 for raw clinical concern data).

Generally, the detection of ward patient deterioration came from the assessment of vital signs, patient complaints, nursing assessments, automated alerts, or team

handovers (see Supplementary File. 4, Table 3). Deterioration detection was completed by nurses or medical staff, but other actors of escalation were captured such as healthcare support workers, student nurses and housekeepers. Staff also gave examples whereby family members of patients had recognised pending deterioration earlier than the clinical staff or re-escalated unresolved concerns to outreach, which resulted in a critical care admission. Organisational visibility of deterioration improved clinical staff, ward managers, outreach, and medical teams' awareness of unwell ward patients allowing them to maximise the clinical support they could provide. This was generally achieved through electronic EWS, or laboratory results presented via interfaces such as whiteboards or mobile devices. Increased visibility also meant that some staff (outreach, sepsis nurses) had the ability to proactively identify unwell patients before an official escalation was initiated. To ensure organisational visibility of those patients who were clinically concerning but not triggering, one Trust was trialling the use of a Nurse Concern criteria along with EWS.

Staff described a complexity to deterioration detection, giving examples where some diagnosis criteria were not met once first line treatments were given such as fluids and Oxygen in septic patients. Similarly, staff often commented that escalating a patient with a raised EWS was easier for more junior staff. There were instances where detection of deterioration was done in the absence or before clear objective indicators (rising blood counts in the absence of fever or poor progression). This added further difficulty to sense making, and in some cases the ability to

convincingly convey risk to other teams required for that's patients care. Conversely, there were examples where clinical staff were confident in their ability to anticipate or predict deterioration and created positive workarounds based on this. For instance, they adapted technology (mobile devices) to generate specific alerts relating to the patients' blood results day 5 following surgery, as this was when their patients were most likely to deteriorate.

4.4.3. Communication of Escalation (Sub task 1.2)

Communication of escalation events occurred mostly between a nurse and a doctor, nurse to nurse or doctor to doctor through mobile devices, bleeps, team handovers or Safety Huddles. Communicating escalation proved to be challenging at times due to environmental factors such as ward configuration, large geographical areas, front door patient access. Organisational factors could compound escalation challenges, such as multiple medical teams being responsible for patients which resulted in one nurse manager having 38 patients with 9 consultants leading care on a single shift. This posed a significant number of issues when trying to identify which medical team to escalate to and created a time-consuming escalation process (see Supplementary File. 4, Table 3).

Social interaction played a role during escalation communications and was particularly evident in escalations involving the outreach team and static medical consultants who were well acquainted with the acute ward staff. For example, outreach weighted medical information differently depending on context such as the

ward's familiarity with unwell patients. The importance of communicating concern efficiently and creating the correct deterioration narrative was frequently raised by clinical staff so their patient was suitably prioritised for a response. Clinical staff had adapted the way escalation was communicated depending on the patient context (success factor) and their requirements of that interaction. Four escalation phenotypes were subsequently identified; Outcome Focused Escalation, Informative Escalation, General Concern Escalation, and Spontaneous Interaction Escalation attributes are described in the following section and have been summarised in Table. 1. There were 137/151 escalation events captured which the researcher was able to identify the escalation type (see Supplementary File. 5 for SPSS 95% CI outputs).

Table 6 Definitions of Escalation of Care Phenotypes

Escalation Phenotype	Key Attributes	Excerpt from field notes/ad hoc interviews/researcher reflections
Outcome Focused Escalation	Most common phenotype of escalation Outcome was pre-anticipated by referrer Often preceded by a full patient review and strong clinical reasoning Efficiently prioritised	*"Nurse describes a patient escalation that she had last week. She knew the patient was unwell and felt the medics were slower to take control. She escalated up to the reg who agreed…... Nurse knew the patient needed an intervention and conservative management would not reverse deterioration alone. She escalated knowing what she needed" Site A/Nurse 2* *Nurse escalated to team. Patient has been deteriorating overnight and had initial dose of digoxin. She was very firm in asking for an urgent review "I don't want this patient to deteriorate further". Site A/ Esc 43* *'Really required an escalation plan as patient 90. Patient clearly very unwell, high trigger score. Being treated for sepsis. Newly admitted so yesterday unlikely to be able to limit care or initiate palliative care pathway.' Site A/ Esc 45* *'If you don't use the right language to escalate then it may not be taken seriously" Previous call today, complete jumble. Advised to use SBAR to organise call" Site B/Observation Session 6*

Informative Escalation	Frequently observed To fulfil organisational requirement Generally, has about a low clinical concern Usually does not require a medical review May be a 'reverse escalation' to avoid the automatic escalation of flagged patients (False Positive)	*"Sometimes staff will escalate just because of a score but should document if not escalating." Site B/ outreach nurse* *'Referral to outreach can sometimes be a way to shed responsibility.' Observation Session 10* *"Just letting you know as the patient is triggering. outreach ask if they need any fluid prescribing. Patient is probably going to be palliated….." Site B/Esc 26* '*Staff aware that patient was reaching end of life care. Escalation was informative to just let you know. This was to ensure that there was an awareness of treatment direction for the day team.' Site B/ Esc 42* *"Patient on incorrect NEWS2 scale and therefore triggering so the ward was notifying that the system EWS was incorrect." Site B/ Esc 58*
General Concern Escalation	Not employed frequently No clear outcome requirement from referral Related to softer signals of patient deterioration	*'HCA escalated to ward round due to patient complaint and sweaty. Noted to be short of breath on exertion and unable to wean oxygen. ' Site A/ Observation Session 1* *"We recently had a patient that was referred to us by their family, who became progressively more unwell and was admitted to ICU. We have had several examples where patients care has been directly altered due to a family escalation to outreach" Site B/outreach nurse 1* *'Housekeeper escalated patient complaint of pain to the nurse in charge.' Site A/ Esc 28* *'During one session I was shadowing a surgical ward round. The MDT were reviewing a patient within the side room. During this time an HCA came out of the*

		opposing side rooms and spoke to the nurse in charge. I found out that the HCA had just been mobilising this patient with the physiotherapy team which she had done previously. She was concerned because the patient was notably short of breath of exertion, more so than previous rehabilitation sessions. The nurse in charge suggested that this patient been seen next and diverted the ward round to this patient. This started several interventions such as a chest x-ray and full medical review' Site A/Observation Session 3
Spontaneous Interaction Escalation	Least common type of escalation phenotype Occurred during informal discussions or in joint clinical workspaces 'Opportunistic in nature' Heavily influenced by workspaces creating 'discussion zones' Form of social interaction Driven by organisational awareness of unwell patients Prompted by alerts, whiteboards, or mobile devices	*"Whilst observing Site B's Sepsis Nurse a concurrent escalation was observed. Patient A was unwell on ward XX and was alerting for sepsis. The Sepsis Nurse specialist begins her day by assessing all automated sepsis alerts and remotely reviews each patient. Patient A had alerted for increased NEWS2 signals and laboratory results indicating a severe infection. She shares the same office as the ICU outreach team so proceeds to refer Patient A prior to going to see the patient. A few minutes after the sepsis nurse's verbal handover, the ICU outreach Team received a bleep from the ward nurse caring for Patient A to refer him due to NEWS >7 and sepsis alerts. Reflecting on this there are many mechanisms at play. Technology features heavily in this escalation event which allowed staff to have knowledge of the unwell patient prior to any referral being made. Having teams which 'seek out the sick' appears advantageous." Site B/Observation Session 20* *"Senior nurse reviewed dashboard and interrogated notes due to high trigger and sepsis flag on dashboard (not their patient). Initiated a discussion with doc to ask about antibiotics……This flag is generated from observations " Site A/ Esc 17.* *'Outreach was concerned by a nurse's tone of voice (appeared unnerved), so they (outreach) decided to visit ward regardless although unlikely to add much to patient's care. Known that this ward do not usually have very sick patients and therefore may need some support' Site B/Observation Session 9*

		'Outreach decided to proactively review patient with the ENT team (who was just reviewing the patient) just in case they were asked to review again overnight, and they could handover a full clinical picture to the night outreach cover.' Site B/Esc 30 *"Systems that seek deterioration seem to find it. The outreach team actively review all the EWS throughout the hospital and rank them according to acuity" Site B/Observation Session 7* *"Once a shift we see a patient who is triggering but not been referred…we find them when reviewing Trust-wide EWS scores. This may be because they are chronic high NEWS, palliative or known to team." Site B/ outreach nurse 2*

4.4.3.1. Output Focused Escalation

Output Focused Escalation was the most common accounting for 57/137 escalations (41%, 95% CI 33.3-50.3). Staff often anticipated the required output of escalation (i.e., what was required to manage the patient clinical deterioration or further diagnostic investigations) such as blood cultures, fluid boluses or medical review and this was communicated, or suggested. Output Focused Escalation was followed by a highly structured patient assessment by the bedside nurse, which contained multiple data points to support clinical suggestions and demonstrated a convincing referral when bidding for clinical time. These data points may have been generated from EWS, other signals of deterioration or patient/relative/other staff concern. Staff indicated that this was a more effective type of escalation when critical actions were required. In some instances, this escalation was employed to initiate end of life discussions when patients were becoming more unstable and at risk of unnecessary interventions.

4.4.3.2. Informative Escalation

Informative Escalation was the second most frequently observed escalation type accounting for 49/137 events (36%, 95% CI 27.8-44.4). This approach was employed in cases where a patient's EWS score indicated a need for further assessment or intervention, but the level of clinical concern was relatively low. The communication episode was employed to fulfil an organisational or a local escalation policy requirement and to ensure due diligence, but often had little clinical effect. A medical review was often not required, and the communication content consisted of “just to

let you know". Informative Escalations also consisted of 'reverse escalations', where patients were flagged electronically (False Positive) but this alert needed to be overridden following a clinical judgement, and an escalation actively avoided (patient on the palliative care pathway). The NEWS2 scale generated the need for 'reverse escalations' due to patients being on the wrong oxygen scale and falsely triggering.

4.4.3.3. General Concern Escalation

General Concern Escalation was employed much less frequently and evident in just 26/137 escalation events (19%, 95% CI 12.8-26.6). These escalations related to patients with no clear signs of deterioration such as poor weaning of oxygen, confusion, or mobility changes. The referrer did not state any preconceived ideas about what the cause of the clinical concern was or the required outcome of the escalation. This was often based on a 'gut feeling' of deterioration and lacked structured evidence from EWS, or assessment of other data points.

4.4.3.4. Spontaneous Interaction Escalation

Spontaneous Interaction Escalation were the least frequent, being observed in 5/137 (4%, 95% CI 1.2-8.3) events. These were informal face to face discussions occurring in joint clinical workspaces and was a type of 'social interaction'. The ease at which these escalations occurred was influenced by the team structure and socio-cultural factors. Some Spontaneous Interaction Escalation's were driven through organisational awareness of deterioration through electronic vital signs alerts, whiteboards or mobile devices and teams that were seeking out unwell patients through deterioration surveillance and may have preceded a formal referral.

4.4.4. Escalation Action (Sub Task 1.3)

Actions surrounding a deteriorating patient were sometimes initiated before an escalation occurred when care pathways were predictable to more experienced staff or clearly documented in guidelines for less experienced staff. Staff were aware of time critical elements to escalation such as Sepsis 6 and delivering antibiotics within the 'golden hour'. Despite the criticality of these tasks, they were prone to interruptions and staff were observed to have competing demands and workload. There were examples where clinical staff were trying to manage two unwell patients simultaneously or, when caring for unwell patients, were interrupted with requests from other patients. To mitigate this staff worked collaboratively to limit the care deficit for the other ward patients. One clinical staff member described how she had experience of both an outreach organisation and one where there was no outreach. She described how, during some patient deterioration episodes, outreach would provide first-line treatments so she could then manage her other patients. To balance care and resources, some escalations observed involved staff stepping outside of the expected procedure (renal doctor supporting general surgery doctor) to support other clinical areas providing intra-organisational expertise during deterioration events (see Supplementary File. 4, Table 3).

4.5. Discussion

Half of the escalations in this study were triggered by a clinical concern not relating to an elevated EWS; a finding supported in both the qualitative and quantitative data. When an escalation was non-EWS initiated, it predominantly involved symptoms

such as bleeding, infection, chest pain and resolved desaturation. When an escalation event was EWS initiated, it predominantly involved low level triggering patients with physiological changes such as those secondary to sepsis, hypotension, reduced conscious level, and hypoxia. Interventions to improve care escalation have focused on EWS (Hogan *et al.*, 2019), which target patients with physiological instability. But our study data has shown this may only account for half of the escalations occurring in every day clinical work. Simplistically, escalation should be triggered by EWS and follow a clear protocol (Sujan *et al.*, 2022), but observation data suggest many escalation subtleties. To our knowledge, this is the first study, to challenge the concept of escalation homogeneity. Our data indicates four care escalation phenotypes: Output Focused Escalation, Informative Escalation, General Concern Escalation, and Spontaneous Interaction Escalation.

Informative Escalations and Spontaneous Interaction Escalations are clinically significant. Informative Escalations were commonly observed, resulting from NEWS2 over predicting deterioration, being on the wrong scale and inflexibility within the escalation protocols which dictate clinical actions based on score thresholds. Despite the positive predictive value of NEWS2 being 6% (of all the patients who trigger, 6% will have an adverse event), scores still require a clinical assessment and follow-up. False positive workloads impact clinical team's ability to deliver care to those patients who would benefit (Forster *et al.*, 2018) and the true number of Informative Escalations may be greater had staff escalated all triggers, which is unlikely as literature suggest only 40% escalation compliance (Connell, *et al*, 2021). Instances of

'failed escalations' may be clinician's functioning as a barrier between a false-positive scores and potential harmful or costly investigations (Haegdorens *et al.*, 2018). It may be prudent to revaluate the need for Informative Escalations and measure process improvements through their reduction as this would demonstrate an improvement in EWS performances and organisational responses to deterioration.

No data exists which differentiates escalation or its communication, but some studies have examined the efficacy between communication modes such as mobile phones or face to face discussions (Gharaveis, Hamilton and Pati, 2018). Our study data supports that escalation communication is not simply a transfer of information, but collaborative sense making. Maximising opportunities for Spontaneous Interaction Escalations, which were observed to be highly effective in our study, may be harnessed through environmental (Ede *et al.*, 2022) and system designs. Environmental factors such as layout design, visibility between staff/patients, and accessibility of areas affect the way clinicians interact (Gharaveis, *et al*, 2018). Healthcare designs can promote knowledge exchanges (Lu and Zimring, 2012), therefore a focus should be on maximising deterioration dialogues (Sujan *et al.*, 2022) when creating healthcare work spaced. Similarly, face to face Safety Huddles (Franklin *et al.*, 2020), replicate Spontaneous Interaction Escalations by creating opportunities for inter-professional communication (Sujan *et al.*, 2022). Our data showed spontaneously generated safety critical tasks from huddles which may not have occurred otherwise, including increasing vital signs frequency, rechecking investigations, and validating clinical concerns prompting a full escalation.

4.6. Conclusion

Most escalations in this study were initiated by a concern that did not relate to EWS and indicate a large proportion of deterioration care occurs with no influence of national escalation protocols. There are subtle differences between escalation types and a broad and homogenous definition of escalation is misleading and will not contribute to process improvements. Informative Escalations may be a signalling that current escalation policies are too inflexible to support clinical staff fully and warning systems are overpredicting risk. Environmental and system design may encourage more Spontaneous Interaction Escalations through well designed clinical spaces to facilitate Safety Huddles and ultimately improve patient care.

4.7. Limitations

As the data demonstrate, observing within a clinical area during a patient deterioration episode is sensitive and difficult, which is why no direct patient observations were undertaken during this study. However, this meant that fulfilling all the requirements of the data collection was not feasible for every observation session and explains the data gaps illustrated in the study results. For research purposes without CAG support, identifying unwell patients within the hospital is challenging and this work was undertaken during a period of significant healthcare turbulence and access to clinical areas was significantly restricted. Another influencing factor on this work was the evolving COVID-19 pandemic which meant the access to some wards were restricted in the early phases of data collection.

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Supplementary File. 1 COREQ Checklist

Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist

No. Item	Guide questions/description	Reported on Page #
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Interviewer/facilitator	Which author/s conducted the interview or focus group?	J.E.Ede
2. Credentials	What were the researcher's credentials? E.g. PhD, MD	MSc
3. Occupation	What was their occupation at the time of the study?	Nurse Researcher
4. Gender	Was the researcher male or female?	F
5. Experience and training	What experience or training did the researcher have?	GCP 5 years Research experience
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	
8. Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? e.g., Bias,	

	assumptions, reasons, and interests in the research topic	

Domain 2: study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	p5
Participant selection		
10. Sampling	How were participants selected? e.g. purposive, convenience, consecutive, snowball	p5
11. Method of approach	How were participants approached? e.g. face-to-face, telephone, mail, email	p5
12. Sample size	How many participants were in the study?	p5
13. Non-participation	How many people refused to participate or dropped out? Reasons?	p5
Setting		
14. Setting of data collection	Where was the data collected? e.g. home, clinic, workplace	p4
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	p5
16. Description of sample	What are the important characteristics of the sample? e.g. demographic data, date	p5
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the	Appendix 1 p

	authors? Was it pilot tested?	
18. Repeat interviews	Were repeat inter views carried out? If yes, how many?	No
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	p5
20. Field notes	Were field notes made during and/or after the interview or focus group?	No
21. Duration	What was the duration of the inter views or focus group?	p5
22. Data saturation	Was data saturation discussed?	p4
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	No
Domain 3: analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	p5
25. Description of the coding tree	Did authors provide a description of the coding tree?	
26. Derivation of themes	Were themes identified in advance or derived from the data?	p5
27. Software	What software, if applicable, was used to manage the data?	p5
28. Participant checking	Did participants provide feedback on the findings?	No
Reporting		
29. Quotations presented	Were participant quotations presented to	p6-12

	illustrate the themes/findings? Was each quotation identified? e.g. participant number	
30. Data and findings consistent	Was there consistency between the data presented and the findings?	Yes
31. Clarity of major themes	Were major themes clearly presented in the findings?	Yes
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	Yes

Supplementary File. 2 Ward Descriptions

Ward Type	Site Descriptor	General Description
Surgical Assessment Unit Triage	Site A	Front door access for patients, 10 beds which are under direct observation, staffed with ANP, Surgical Junior and Senior Doctors, Care Support Workers
Surgical Ward	Site A	Two 23 bedded wards separated by patient gender, 4 side rooms on each ward, staffed with 3 qualified, and 2 HCWs
General Surgical Unit	Site B	40 bedded surgical assessment unit,
Emergency Medical Assessment Unit	Site A	Large front door access for patients, situated next to the A+E department, 30 bedded unit, 6 side rooms, staffed with 6-8 qualified and 4 HCWs
Accident and Emergency	Site B	4 resus beds, 35 majors' beds, paediatrics and adults

		admissions, assesses around 400 patients per day
Surgical Vascular Ward	Site A	23 bedded vascular wards 4 side rooms,
Ambulatory Assessment Unit	Site A	Admission length 5-7 hours, approximately 30 beds
Acute Medical Unit	Site B	52 beds, higher level monitoring ward,

Supplementary File. 3 Raw EWS frequency and clinical concern data

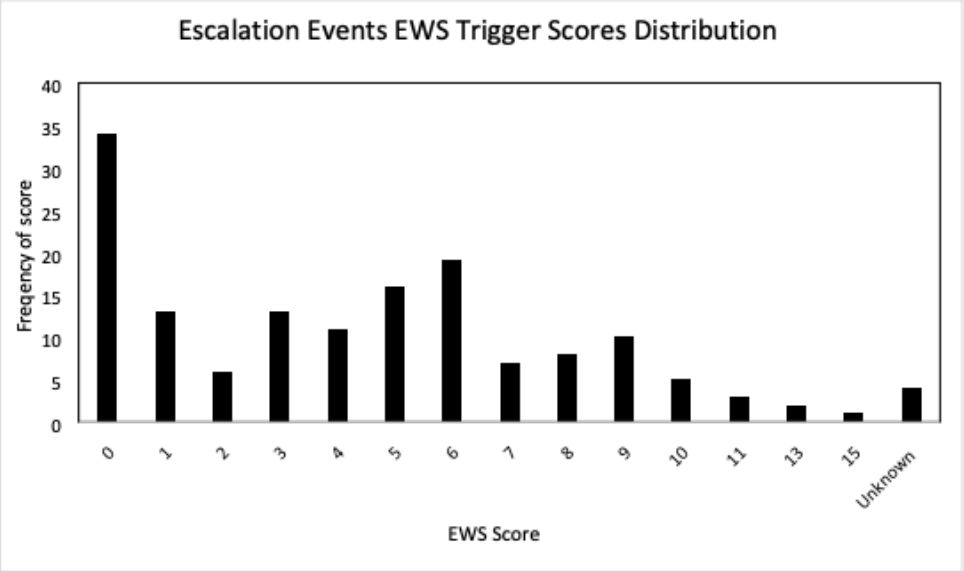

Figure 2 Escalation Events Trigger Scores Distribution

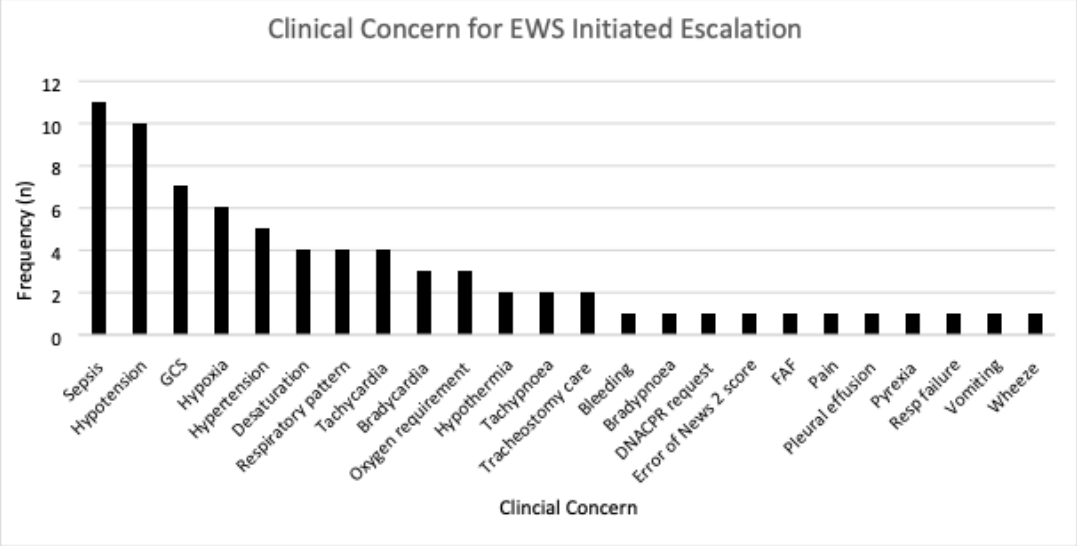

Figure 3 Frequency of Clinical Concerns in EWS Initiated Escalations (n=74)

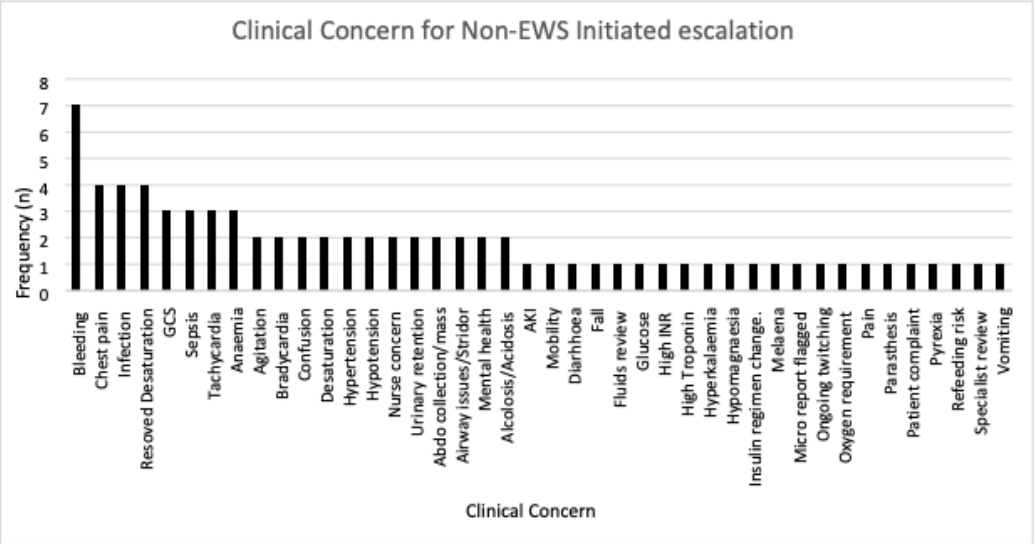

Figure 4 Frequency of Clinical Concerns in Non-EWS Initiated Escalations (n=77)

Table 2 Raw Escalation Concern Data

Count of Escalation cause	Initiated by EWS No	Initiated by EWS Yes	Grand Total
Abdo collection	1		1
Abdo mass	1		1
Acidosis	1		1
Agitation	2		2
Airway issues	1		1
AKI	1		1
Anaemia	2		2
Bleeding	7	1	8
Blood transfusion	1		1
Bradycardia	2	3	5
Bradypnea		1	1
Chest pain	4		4
Confusion	2		2
Confusion and mobility	1		1
Desaturation	2	4	6
Diarrhoea	1		1
DNACPR request		1	1
Error of News2 score		1	1
FAF		1	1
Fall	1		1
Fluids review	1		1
GCS	3	7	10
Glucose	1		1
High INR	1		1
High Troponin	1		1
Hyperkalaemia	1		1
Hypertension	2	5	7
Hypomagnesemia	1		1
Hypotension	2	10	12
Hypothermia		2	2
Hypoxia		6	6
Infection	4		4
Insulin regimen change	1		1
Melaena	1		1
Mental health	2		2
Micro report flagged	1		1
Nurse concern	2		2
Ongoing twitching	1		1
Oxygen requirement	1	3	4
Pain	1	1	2
Parathesis	1		1
Patient complaint	1		1

Pleural effusion		1	1
Pyrexia	1	1	2
Refeeding risk	1		1
Respiratory failure		1	1
Respiratory pattern		4	4
Sepsis	3	11	14
Severe alkalosis	1		1
Specialist review	1		1
Stridor	1		1
Tachycardia	3	4	7
Tachypnoea		2	2
Tracheostomy care		2	2
Urinary retention	2		2
Vomiting	1	1	2
Wheeze		1	1
Resolved Desaturation	4		4
Grand Total	**77**	**74**	**151**

Supplementary File. 4 Qualitative Themes (Framework Analysis)

Each escalation sub theme documented in the HTA (deterioration detection, deterioration communication and escalation action) was supported by evidence from the observational qualitative data, field notes and researcher reflections/memoirs (see Table 3).

Table 3 Escalation success factors and system recommendations

Escalation Sub task	Key Success Attributes	Excerpt from field notes/ad hoc interviews/researcher reflections
Deterioration Detection 1.1	Pathways to enable **'Family Escalations'**	*"We recently had a patient that was referred to us by their family, who became progressively more unwell and was admitted to ICU. We have had several examples where patients care has been directly altered due to a family escalation to Outreach" Site B/Outreach Nurse 1* *"Call for concern a very interesting concept, "at least once a month we have a relative call that initiates a rescue of the patient" Site B/Sepsis Nurse 1*
	Creating opportunities for a broad spectrum of **'Escalation Actors'**	*'Housekeeper escalated patient complaint of pain to the nurse in charge.' Site A/ Esc 28* *'Patient desaturated to 82-76 and student escalated to qualified nurse. The replaced oxygen and patient refused to wear oxygen again. They escalated to medical team due difficulty managing. Patient was on a cardiac monitor.' Site A/ Esc 137* *'During one session I was shadowing a surgical ward round. The MDT were reviewing a patient within the side room. During this time an HCA came out of the opposing side rooms and spoke to the nurse in charge. I found out that the HCA had just been mobilising this patient with the physiotherapy team which she had done previously. She was concerned because the patient was notably short of breath of exertion, more so than previous rehabilitation sessions. The nurse in charge suggested that this patient been seen next and diverted the ward round to this patient. This started several interventions such as a chest x-ray and full medical review' Site A/Observation Session 3*

	Understanding the advantages and limitations of **'Early Warning Scores'**	*"It is easier when the EWS trigger but I can still escalate when they don't. I think the junior staff rely more on the EWS to direct escalation" Site A/Nurse 1* *'Medics don't change the scale for COPD patients. Just seen a patient triggering 4, background of COPD and still on scale 1' Site A/ Nurse 3* *'Patient admitted having had surgical procedure few days previously, history of rigors at home. Was admitted and given ABx. Patient was really keen to go home. Was going to be discharged but nurses not happy given history despite not triggering. Patient kept in overnight developed sepsis and became unwell.' Site A/ Esc 27* *"COVID patients don't initially score highly on NEWS but have huge potential to become more unwell." Site A/Nurse 2.* *'When clinical staff are concerned about patients, they increase monitoring from ad hoc monitoring to continuous monitoring. This is for both prevention and efficiency. Prevention to allow early detection of changes whilst reducing workload of increased vital signs measurements required" Site A/ Observation Session 11*
	Understanding the **'Complexity and Nuance of Deterioration'**	*'Went to see a patient who had a sepsis flag, but discussion with docs suggest no infective concern. Contacted later in the afternoon to say patient had dropped blood pressure, and now on IVAbx.' Site A/Observation Session 10* *'Key escalation was the concern for a patient that has ongoing diarrhoea following a Covid injection and rising inflammatory markers. Although she looks well, team want to exclude abdominal pathology following Whipples' Observation Session 1* *"Patients who come in have physiology normalisation with fluids and oxygen then don't meet sepsis criteria." Site B/Sepsis Nurse 1* *'Data to show that most referrals are based around nurse concern.' Site B/ Observation Session 7*

	Technology that promotes the **'Visibility of Deterioration'**	*'Electronic notice boards feature heavily in these escalation events. This generates and accessibility of information.' Observation Session 7* *"Patient had already been identified earlier in the day by NEWS Review" Site B/Esc 25* *'Today has 15 sepsis flags hospital wide' Site A/Observation Session 10*
	'Technology Adaptability and Usability' to meet users' needs	*'Discussion with consultant about surgical leaks which occur on day 3 to 5. Has an alert for CRP on patients operated on earlier in the week. This gives an indication about leak prior to trigger. Young patients can compensate a leak, but older frailer patients can't as well and are much sicker' Site A/ Surgical Consultant*
Escalation Communication 1.2	Creating a **'Social Currency'** to facilitate escalation	*'Social relationships with patients, relatives and medical team generates a form of 'social currency' element to escalating care. This can smooth the course when escalating to people known to each other. This was particularly evident with the Outreach Teams' Site B/ Observation Session 13* *'One ward had 38 patients and 9 consultants sharing patient care plus take consultants. Finding the right person to escalate to and then contacting them is very challenging and time consuming'. Site A/ Observation Session 12* *'Patient admitted for a week following biopsy of sigmoid. Had 3litres of fluid. For resus. VBG done about an hour ago by ward staff. Outreach knows the nurse referring and she is very experienced.' Site B/ Esc 29*
	Allowing for **'Multiple Modes of Communication'**	*"Surgical Registrar phoned in from home and asked junior doctor to give stat dose of Gent to a patient. Not sure what triggered this interaction, but clearly the doctor accessed new patient information. Patient had this prescribed' Site A/ Esc 12* *'Staff use multiple modes of communication. Frequently referring to handover emails on mobile devices.' Site A/Observation Session 1*

	Developing the skills in forming a convincing **'Deterioration Narrative'**	*"If you don't use the right language to escalate then it may not be taken seriously" Previous call today, complete jumble. Advised to use SBAR to organise call" Site B/Observation Session 6*
Escalation Action 1.3	**'Predictable Care Pathways'** such as Sepsis 6	*'Patient came in from a nursing home. Looks very unwell. Currently being escalated to nurse in charge and then this being escalated to sepsis nurse. Patient is not for resus. Being reviewed by Medical reg..... On discussion the nurse is very conscious of the golden hour for ABx delivery to meet the Sepsis 6 criteria.' Site A/ Observation Session 11* *"Patient is clearly unwell. Concurrent tasks being completed. Manual bp monitor at bedside as bp low. VBG completed. Nurse in charge at bedside as well. Trying to get access in. On a continuous monitor. Noted lactate 2.6 with high potassium. Nurse recognised that patient was septic based on observations. Knew sepsis 6 would be initiated and that antibiotics would be needed. Therefore, escalated to medics straight away to ensure this was done. History and observations were directing to sepsis. Uses a sepsis 6 crib sheet on ID cards." Site A/Esc 37*
	'Mitigating the impact to the Wider Ward' Population	*"Nurse came from MET system. Knew the plan would be organised, because the MET team would look after sick patient which meant that you could look after case load" Site A/Nurse 3* *'Despite nurse looking after sick patient, she also then had to help two patients to the toilet. Whilst she did this the nurse in charge seamlessly took over sick patients care' Site A/ Observation 11* *'The same nurse has two patients triggering. Nurse actively encouraging family to participate in care' Site A/ Observation 16*
	'Collaborative Sense Making' to identify key escalation tasks	*'Patient who was seen overnight and re-referred. Doctor letting outreach know patient still unwell and now struggling. Tried nebs and not improving. SHO referred. Outreach review prompted a DNACPR discussion between team and family.' Site B/ Esc 148* *"Patient had already been identified earlier in the day by NEWS Review. Reassuring staff that she has a reason for high trigger, and this is being treated with diuretics and known to have pleural effusions." Site B/ Esc 25*

		"..when we did visit the Outreach nurse was concerned that she was still doing neuro observations with a patient who is likely palliation. Outreach contacted team to ask to review and reduce unnecessary interventions" Site B/ Esc26 *'Observing Safety Huddle this am on Neurosciences ward which centred around the large ward whiteboard. Patients who were a clinical concern were discussed. Some of these patients were not triggering or had high early warning scores. The actions that staff generated from these meetings may not have been addressed had this discussion not occurred' Site A/ Esc 141*
	'Utilising Unexpected Resources'	*'Asked to see patient by FY1 (day team to the night team handover). Whilst reviewing the nurse requests review of urine for haematuria.... SHO from Urology helped review concerning patients' Site A/ Observation Session 3*

Supplementary File. 5 SPSS Outputs for Clopper-Pearson 95% Confidence Intervals

Escalation Phenotypes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Informative	49	5.0	35.8	35.8
	General Concern	26	2.7	19.0	54.7
	Outcome focused	57	5.8	41.6	96.4
	Spontaneous Interaction	5	.5	3.6	100.0
	Total	137	14.0	100.0	

Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95.0% Confidence Interval	
			Lower	Upper
One-Sample Binomial Success Rate (Clopper-Pearson)	Probability(Escalation=Informative).	.358	.278	.444

Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95.0% Confidence Interval	
			Lower	Upper
One-Sample Binomial Success Rate (Clopper-Pearson)	Probability(Escalation=General Concern).	.190	.128	.266

Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95.0% Confidence Interval	
			Lower	Upper
One-Sample Binomial Success Rate (Clopper-Pearson)	Probability(Escalation=Outcome Focused).	.416	.333	.503

Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95.0% Confidence Interval	
			Lower	Upper
One-Sample Binomial Success Rate (Clopper-Pearson)	Probability(Escalation=Spontaneous Interaction).	.036	.012	.083

4.8. Implications for the study

The results and discussion from this paper have several implications for the SUFFICE study. Firstly, they challenge what we understand about escalation of care. Most escalations were not initiated through a triggering EWS score and, therefore, current protocols are not addressing nor facilitating most of the real work of escalation. As the data from this phase suggest, there are several clinical concerns that are not currently integrated into EWS, but these may indicate future directions and identification of variables that could improve model performance. The identification of escalation phenotypes adds further to the complexity of escalation but does provide evidence why a homogenous definition of escalation may not fully describe the phenomenon of interest. Recognising escalation heterogeneity can help refine and focus hospital process improvements such as reducing Informative Escalation episodes (that fulfil an organisational requirement only) and increasing the prevalence of Spontaneous Interaction Escalations through hospital designs and process such as safety huddles.

4.9. Summary

To summarise, observational data revealed that most escalations were for medical patients and were not prompted through a EWS score. Staff detect and use a wide range of clinical concerns, ranging from subtle to significant, to identify pending or current deterioration in their patients. Tenets of good care were observed when staff were escalating or managing unwell patients, which included adherence to sepsis care pathways and family-initiated escalation pathways. Staff also employ different

escalation communication strategies depending on the context and the required outcome, such as simply escalating to fulfil an organisational (escalation protocols) obligation or the requirement of care interventions (antibiotics, fluids).

5. Chapter Five: Results of Retrospective Care Records Review

5.1. Introduction

In this chapter the results of the Retrospective Care Record Review are presented. The methods relating to this phase of data collection have been presented in the published protocol. The aims of this work were to:

i) identify success factors to escalation documented in care records of patients who triggered a EWS ≥7 in the ward, avoided ICU and survived

ii) compare with ward patients who triggered a EWS ≥7, went to ICU and died.

Firstly, a summary of the research methods is presented as an aide memoir. To contextualise the results, an overview of the organisations in which the care records were reviewed is provided. Specifically, this indicates how many admissions each hospital had during the data collection period and how frequently these patients became unwell/died/were admitted to ICU. Then the results of the care record reviews of patient deterioration events are presented, which include descriptive data for the Survivors and Non-survivors' groups and the characteristics of their trigger events. Quality of care scores (1-5) for before, during and after their trigger event is analysed, alongside metrics used to evaluate the quality of their escalation care.

5.1.1. Summary of methods

This is a multi-site, mixed methods exploratory sequential study conducted in two large NHS hospitals in England. Review of care records from Medical, Surgical or Trauma ward patients with an Early Warning Score ≥ 7 who survived without an Intensive Care Unit admission was conducted. A comparator group of Non-survivors who were admitted to Intensive Care Unit following a trigger score of ≥ 7 and died were also examined. Two reviewers extracted qualitative and quantitative trigger and rescue event data using the Structured Judgement Review tool. All aspects of the patient's care were considered by examining records from nurses, Allied Health Professionals, doctors, medication charts and diagnostic test results. The sample size was decided upon using three main points of consideration

- Previous care record reviews studies sample sizes
- Breadth and depth of data
- Pragmatic and realistic data collection

5.1.2. Organisational overview data for the period of data collection

Two sites were used for data collection; the table below summarises key characteristics of the sites.

Table 7 Organisational Overview data for study sites during the data collection period (1st November 2019 to 31st October 2020)

Descriptor n (%)	Site A	Site B
Total adult in-patient admissions 1st November 2019 to 31st October 2020	105090	155869
Total number of adult ward patients who scored EWS ≥7	3981	4184
Number of adult ward patients who survived following EWS ≥7	2945	3009
Number of adult ward patients who died following EWS ≥7	1036	1175
Total number of adult ward patients admitted to ICU following EWS≥7	268	133
Total number of adult patients admitted to ICU following EWS score of ≥7 and died	68	53

5.2. Results

A total of 390 care records were reviewed (340 Survivors and 50 Non-survivors) for patients admitted between 1st November 2019 and 31st October 2020. For patients who met the inclusion criteria and care was reviewed, the admitting speciality was most commonly medical, surgical then trauma and this was consistent for both groups. Survivors and Non-survivors matched in terms of gender, but Non-survivors were older and had a greater number of co-morbidities. There was a greater proportion of emergency admissions in the Non-survivor group (96%) compared to the Survivor group (88%). Full patient demographics data are presented in Table 7.

Table 8 Demographics of Survivors and Non-survivor notes reviews

Patient characteristic	EWS ≥7 Survivors n=340	EWS ≥7 Non-survivors n=50
Age median (IQR)	58 (46-70)	64 (56-73)
Female n (%)	142 (42)	21 (42)
LOS median (IQR)	7.1 (4.1-11.5)	8.9 (4.9-14.1)
Charleston Co-morbidity Index median (IQR)	2 (1-4)	4 (2-6)
Clinical Frailty Scale median (IQR)	4 (2-5)	4 (3-5)
Hospital Admission Type n (%)		
Emergency	299 (88)	48 (96)
Elective	41 (12)	2 (4)
Admitting Team n (%)		
Surgical	105 (30.8)	14 (28)
Medical	216 (63.5)	35 (70)
Trauma	19 (5.6)	1 (2)
Covid-19 Positive n (%)	51 (15)	7 (14)

5.2.1. Trigger event characteristics

In the Survivor group, the most common admission diagnoses were Sepsis (22.4%), Covid-19 (9.4%), Community Acquired Pneumonia (8.8%) and Hospital Acquired Pneumonia (7.6%). In the Non-survivor group, the most common admission diagnoses were Sepsis (30%), Covid-19 (12%), Hospital Acquired pneumonia (8%) and Liver failure (6%).

Median warning score for Survivors were lower (8, IQR 7-9) than that of Non-survivors (9, IQR 7-10). A small number of patient notes were reviewed who were in extremis scoring EWS≥10. See distribution of warning scores in Table 8.

Table 9 Distribution of EWS scores for patients first trigger of ≥7

Trigger Score n (%)	EWS ≥7 survivors n=340	EWS ≥7 non-survivors n=50
7	159 (46.8)	14 (28)
8	81 (23.8)	8 (16)
9	46 (13.5)	11 (22)
10	27 (7.9)	8 (16)
11	20 (5.9)	3 (6)
12	3 (0.9)	2 (4)
13	4 (1.2)	3 (6)
14	0	1 (2)

5.2.2. Quality of care

Median quality of care scores [IQR] for Survivors were 3 [3-4] versus 4 [3-4] for Non-survivors. Overall, 77% of Survivors and 92% of Non-survivors were judged to have had adequate to good care (Table 9).

Table 10 Overall Quality of Care Scores for care reviews

Care Quality Category n (%)	EWS ≥7 Survivors n=340	95% CI	EWS ≥7 Non-survivors n=50	95% CI
[1] Very poor care	0	n/a	1 (2)	1-11
[2] Poor Care	51 (15)	11-19	3 (6)	13-16
[3] Adequate care	125 (36.8)	32-42	15 (30)	18-45
[4] Good care	136 (40.0)	35-45	31 (62)	47-75
[5] Excellent Care	28 (8.2)	5-12	0	0-7

Quality of care score agreement between reviewers in this study was good; Weighted Kappa, 0.74, 95% CI 0.59-0.89 (for all scores combined).

Several key care metrics relating to deterioration care were assessed. Non-survivors were escalated, had vital signs completed within 1-hour, better quality of documentation, medical reassessments within 4 hours of trigger and relatives involved with care more frequently than that of Survivors. The sepsis care bundle was completed more frequently in the Survivor group compared to the Non-Survivor group (57% versus 46%) and the most frequently missing components were urine output measurements and lactate levels (see Table 10).

Table 11 Survivor and Non-survivor care metrics

Care Metric n (%)	Survivors (n=340)	Non-Survivors (n=50)
Escalated according to local policy	147/340 (43%)	36/50 (72%)
Vital signs Observations checked within 1 hour of trigger event	180/340 (53%)	27/46* (59%)
Sepsis 6 Care Bundle completed (for patients with Sepsis)	44/77 (57%)	7/15 (46%)
Missing Sepsis 6 element		
Lactate	11/33 (33%)	1/8 (13%)
Urine Output	13/33 (39%)	4/8 (50%)
Blood Cultures	8/33 (24%)	2/8 (25%)
O2	Nil	1/8 (13%)
Intravenous fluids	1/33 (3%)	Nil
Antibiotics	Nil	Nil
Re-assessed by medical team within 4 hours of trigger	163/340 (48%)	45/50 (90%)
Good quality of documentation	234/340 (69%)	44/50 (88%)
Relative involved with care	68/340 (20%)	26/50 (52%)
Review referral made to ICU	127/340 (37%)	50/50 (100%)

*4 patients in ICU within 1 hour of observations

5.2.3. Escalation of care metrics Trust sub-analysis of Survivors and Non-Survivors

There were few differences between Trusts in terms of quality of care, escalation compliance, vital signs being completed within 1 hour, being reviewed by the medical

team within 4 hours, quality of documentation and having a relative involved with care (see Table 11). However, the escalation of Survivors for a critical care review or to provide support for ward-based therapy, was significantly higher in Site B (92/173, 53%) than Site A (34/164, 21%, Chi-Square Test p=0.01).

Table 12 Site specific escalation of care metrics for Survivors and Non-survivors

	SITE A		SITE B	
n (%)	**Survivors**	**Non-survivors**	**Survivors**	**Non-survivors**
Quality of care scores	4 (IQR 3-4)	4 (IQR 3-4)	3 (IQR 3-4)	4 (IQR 3-4)
Escalation according to local policy	62/165 (38%)	15/25 (60%)	85/175 (49%)	21/25 (84%)
Vital signs observations checked within 1 hour of trigger event	86/165 (52%)	14/23* (61%)	93/175 (53%)	13/23* (57%)
Re-assessed by medical team within 4 hours of trigger	81/165 (49%)	21/25 (84%)	85/175 (49%)	24/25 (96%)
Review referral made to ICU/Outreach	34/165 (21%)	n/a**	92/175 (53%)	n/a**
Good documentation	126/165 (76%)	22/25 (88%)	109/175 (62%)	23/25 (92%)
Relative involved with care	43/165 (26%)	13/25 (52%)	25/175 (14%)	13/25 (52%)

*4 patients in ICU within 1 hour of observations

** All Non-survivors were referred to ICU or Outreach

5.2.4. Success Factors for escalation of care

To develop an understanding of the process of escalation, 40 in-depth reviews were completed for both Survivors and Non-survivors who were deemed to have Good to Excellent Care. Examples of narratives are given in Vignette 1, Vignette 2, and Vignette

3 (see Appendix 7 for In depth record reviews). Success mechanisms present in the in-depth qualitative narratives map to three key areas of escalation resilience: Monitoring, Visibility, Adjustment, Adaptation, and Expertise.

5.2.4.1. Care Vignette (18-year-old lady with anorexia and further weight loss) RTH002P33

An 18-year-old female with anorexia was referred by her psychologist to the Emergency Department due to ongoing/excessive weight loss. On admission, she was hypoglycaemic (3.3 mmol/l- treated with oral Glucose) and commenced on IV fluids (documented as high-risk cardiomyopathy and cautious fluid replacement) and admitted to the Gastroenterology ward due to a high risk of refeeding syndrome. Her observations were checked at 18:42 (T+T 3) and 21:00 (T+T 3) until 06:00 the next morning when her Early Warning Score increased to 9 (hypothermia, bradycardia, and hypotension) following which she was escalated by nursing staff to the on-call night Junior Doctor. The Junior Doctor reviewed the patient's ward admission ECG (sinus bradycardia) and suggested close monitoring with active warming. At 09:00 a Senior Gastroenterology Doctor reviewed the patient and noted **"Hypothermia, hypoglycaemia and low BMI last night- deadly triad for occult sepsis in malnourished patients".** The Senior Doctor initiated the sepsis pathway, which included antibiotics, blood cultures, lactate measurement and fluid bolus. The patient was discussed with the intensive care unit twice giving input into the ward management of the patient such as electrolyte management and antibiotic prescription. The patient's condition improved within four days and the patient was discharged home.

5.2.4.2. Care Vignette 2 (89-year-old lady with lymphoma) RTH002P53

The Haematology Senior Doctor was contacted by the hospital laboratory due to an abnormal blood test result for a community patient who was at home (suggestive of haemolysis, anaemia, high bilirubin, high MCV). The doctor telephoned the patient who was mildly SOB but otherwise feeling well, however she was still asked to attend triage in the morning. She was seen at 12:00 by a Consultant Haematologist in clinic and noted to have worsening SOB. Her NEWS score was 10 (SaO2 86%, respiratory rate 32, Temp 36, HR 99, Systolic BP 87/50, no oxygen). The Consultant planned to admit the patient, ECG, Troponin, transfuse 2 units HB, O2 therapy, steroids, and monitor. Given high dose prednisolone 50mg and prescribed blood transfusion "***to give a buffer of HB as a steroid response may take some time and the cycle likely to occur again".*** Patient trigger event resolved within 2 days and the patient was discharged home feeling well.

5.2.4.3. Care Vignette 3 (81-year-old with cholecystitis) RTH002P61

An 81-year-old patient was admitted with right upper quadrant pain with a previous history of cholecystitis. He underwent a laparoscopic cholecystectomy and following the procedure developed a post-operative delirium. The nurse noted a change in mental state and escalated to night Junior Doctor after completing a blood glucose and ketone check.

'Obs stable, patient responsive to voice. Mumbles incoherent words.

……. Bleeped on call doctor, FY1 XX, she is coming to review'

Trigger had increased to 5 and patient seen by Junior Doctor who took a blood gas, checked wounds, within 1 hour of escalation. Reviewed at 11pm by both the Junior and Senior Doctor and NEWS increased again to 6- placed on continuous monitoring. By midnight, the patients NEWS score had increased to 7, low BP, conscious level dropped, needing IV fluids and had a Computed Tomography Pulmonary Angiography (CTPA) and chest x-ray completed placed on a cardiac monitor, and given treatment dose anticoagulation for multiple pulmonary emboli at 05:00.

Several success factor mechanisms were identified within the data. Data excerpts to illustrate the themes are annotated with either the vignette number or site/participant number. Themes specifically relate to these are Visibility and Monitoring, Adaptation and Adjustment, and Expertise.

5.2.5. Visibility and Monitoring (of patient deterioration)

The ***visibility*** of deterioration varied from rescue events with red flags ranging from significant (Hypotension, elevated NEWS) to more subtle deterioration signs (high drain outputs, exertional hypoxia). Clinical concerns about patients were identified through vital signs observations, EWS score thresholds, patient complaints, personality changes, high drain outputs, abnormal laboratory results or through team communication. ***Monitoring*** of patients consisted of ad-hoc vital signs, continuous monitoring ("Cardiac monitors"), requesting follow-up reviews when teams changed (shift changes), to moving patients to wards with the ability to give higher level monitoring. Rescue events provided evidence of systems which automated or augmented patient monitoring and deterioration visibility by creating multiple channels through which a patient could be escalated. Information

Technology systems with remote capabilities, including electronic observations and sepsis alerting, allowed staff to become aware of ward patients without the need for a direct referral. Similarly, organisational systems (Outreach, Sepsis Teams, Microbiology) that were designed to identify patients who were sick created an in-built escalation redundancy, meaning that patients could be reviewed and received specialist input without the need for direct referral. Once deterioration had been identified, there was evidence of clinical staff inviting further escalations if certain physiological criteria were not met (such as a satisfactory reduction in tachycardia). This involved anticipating what would be a reasonable response to treatments and being explicit about this in care documentation.

- *"Catastrophic event with unambiguous threat (Site A/P71)"*
- *"Catastrophic physical change (unambiguous threat). Clear cause of abnormality" (Site A/P73)*
- *Nurse noted increase in WOB and exertional hypoxia and alerted Junior Doctor and Senior Junior Doctor (Site B/P5)*
- *"Patient was confused the previous day and escalated despite normal NEWS. Subtle hints of being unwell were acted upon" (Site A/P61).*
- *At about 0100, the patient became v. short of breath at rest (RR>30). SpO2 checked – SpO2=79-80%. Pt put on venturi mask – Required 10L to achieve target SpO2. Asked Junior Doctor to do ABG and contacted reg and outreach" (RHW002P48)*
- *"Raised NEWS and a change on her clinical condition: rob drain commenced to drain high volumes of bile and NEWS being between 6 to 9 since then. Observations checked hourly: informed doctors and Senior Doctor and Outreach informed. Patient*

became more tachycardic and tachypnoeic and requires at the moment 3 Litres of oxygen nasal specs" (RHW002P22).

- *"Advanced Clinical Practitioner review after noticing on computerised observation system that patient had become unstable-ACP then escalated further to Medical Senior Doctor" (RTH002P156).*
- *"Senior Doctor clearly asked for notification if heart does not improve with fluid bolus" (RTH002P157).*

5.2.6. Adaptation and Adjustment (of staff and organisational systems)

Adaptations (referring to long term behaviour/process/organisation change) and ***Adjustments (referring to shorter-term*** behaviour/process/organisation change) were demonstrated when clinical staff responded to imperfect conditions and employed workarounds. Documentation from rescue events demonstrated significant hospital resources being allocated to patients who became acutely unwell such as observations monitoring frequencies, medical interventions, reviews by multiple specialist teams (one rescue event having had 5 medical reviews in one night shift) and further investigations such as CT scans. Patients who demonstrated unusual presentations (Pulmonary Embolism primary presentation as delirium) required staff to adapt and to adjust care based on the individual needs. In these instances, collaborative sensemaking with team members afforded a greater understanding of the patient deterioration event. Adaptability of plans were evident based on patients progress and illness trajectories whereby firm escalation plans were changed (avoiding an ICU admission). Similarly, the criteria on which clinical staff evaluated treatment response

were flexible, ranging from reductions in laboratory results to using softer clinical signals (subjective opinions) to evaluate a patient's response to treatment.

- "*Vital signs monitoring far exceeded local policy*" (RTH002P18)
- *"Nurse who escalated noted that patient was not himself. On Co-Amoxiclav. Given fluids and increased observation frequency. Junior Doctor discussed this patient with Senior Junior Doctor at 22:15 and plan to do an ECG to see if changes are suggestive of PE. ECG reviewed at 23:00 with Senior Doctor and Senior Junior Doctor. Noted -tachycardia, tachypnoea, and alkalosis CTPA requested" (Rescue Vignette 3, RTH002P61).*
- *"Patient became acutely septic (NEWS 13) (CRP >300, Lactate 10, pH 7.2) Patient seen within 1 hour of trigger event by Junior Doctor, Senior Junior Doctor, and Senior Doctor. Bloods taken, cultures sent, IV Fluids 1L STAT, 1L over 2hours then reassess. STAT Gentamicin. ICU reviewed within 1 hour" (RTH002P68).*
- *"Team appeared to evaluate efficacy of antibiotics on how the patient was feeling as well as other objective measures (temp, CRP, BP)" (RTH002P157)*
- *Very thorough nursing evaluation with several updates from the night. Clearly high level of concern and surveillance for patient (RTH002P173)*
- *Was reviewed by ICU who decided to admit patient. However, when they went to retrieve the patient was much more comfortable (RTH002P173)*

5.2.7. Expertise

Examples of what constitutes domains of ***expertise*** were identified in the rescue events, specifically relating to "predicting consequences". Staff anticipating potential issues before they arose were evident when Microbiology teams documented an antibiotic escalation plan if patients were to deteriorate further, allowing more junior staff to make appropriate care decisions at critical times. Some treatments were given, such as blood transfusions, to prevent issues that would be encountered if the patient had any further drops in haemoglobin (Rescue Vignette 2). Another example was when clinical staff had made plans that may be challenged, given the patients clinical condition, so detailed the decision rationale clearly within the notes.

- *"Night Senior Doctor discussed patient with on call Microbiologist who took a thorough history. Start Meropenem after blood cultures from two different sites. Gave a backup up dose of Gent if deteriorates" (RTH002P144).*
- *"Backup Gentamycin plan if more unstable later in the day and clear that this was despite her AKI" (RTH002P12)*

Utilising available organisational expertise was a success factor in the analysed escalation events when unwell patients were supported by the Intensive Care Medical Team or ICU Outreach services. Once an ICU review referral had been made (which is not necessarily to admit the patient to ICU but to give an opinion on treatment), configurations of the teams who provided ICU ward support between the sites varied, being either the ICU medical team (ICU registrar or ICU consultant) (Site A) or a

dedicated critical care Outreach team led by a nurse who were Advanced Critical Care Practitioners or Advanced Care Practitioners (Site B). The reviews showed evidence of critical care Outreach teams and medical ICU teams having input into patients' care on multiple occasions throughout the patients' trigger events. Care input ranged from providing comprehensive documentation of the patient's admission, adding in medications, restarting medications that were stopped in error, implementing treatments and ordering investigations. In one situation the ICU team remained with the patient for an hour to evaluate treatment response. Rescue in these events also took the form of identifying when the patient's trigger event was a patient death event with evidence of end-of-life discussions being had with family members initiated by the ICU Team.

- *"Hypothermia, hypoglycaemia and low BMI last night- deadly triad for occult sepsis in malnourished patients" (Rescue Vignette 1, RTH002P33).*
- *"Nurse escalated to Outreach due to a NEWS of 6. Patient not felt to be safe on XXX and registrar asked that she be transferred to a ward with higher monitoring facilities. Patient deteriorated shortly after moving" (RHW002P48).*
- *"Nurse noted increase in WOB and exertional hypoxia and alerted Junior Doctor and Senior Junior Doctor" (RHW002P5, Covid-19)*
- *"Patient at one point desaturated and was on oxygen between 1-4 titrated as per the saturations via nasal cannula. Respiratory rate remains high and continues to be high. Junior Doctor has been informed and reviewed the patient" (RTH002P173, Covid-19).*

- *"Reviewed by ICU who stayed with patient for 1 hour to monitor" (RTH002P132).*
- *"ICU review consolidates history and gives a focus to care" (RTH002P68).*
- *"I feel he would significantly benefit from a monitored bed. I am concerned that the patient is feeling dizzy, has a low BP and now showing signs of AKI" (RHW002P53)*
- *Reviewed by Outreach... Resus discussion had with family who would still like the patient to have full active treatment despite poor prognosis (RHW002P8)*
- *"Doctors' advice to do 1 hourly observations for the next two hours and stable could move to 2 hourly observations and then normal obs. At around 4 am XX desaturated, become tachycardic and temperature was high. Doctor r/v and arranged for chest x-ray. Inform the nurse in charge to update the outreach team" RTH002P47*

5.3. Implications for the study

The results from this phase have implications for the SUFFICE study. The majority of patients reviewed were deemed to have adequate to good care prior, during and after their trigger event. This suggests that care of deteriorating patients is of an acceptable standard and not sub-optimal. Patients with poor outcomes died despite high resource care and this is significant; healthcare learning focuses on those patients with poorer outcomes, but this group may have better care than those that survive. Our data also suggests that staff are adept at identifying those patients who are and are not at risk of deterioration despite having comparable EWS and adjust care, including escalation compliance and vital signs adherence, accordingly.

5.4. Summary

The results of 390 care record reviews have been presented within this chapter. To summarise, most patients who experienced a deterioration were medical or surgical. The patients who died were older, had more comorbidities, had higher median EWS scores and had a greater proportion of emergency admissions than Survivors. Ultimately, it may have been these differing characteristics which contributed to patient mortality in this group of patients and not the care delivered. Non-survivors received better quality escalations in terms of hourly vital signs and medical re-reviews. This would suggest that clinical staff recognised that these patients were extremely unwell and were attempting to address their deterioration event and subsequent instability.

The main difference in the care delivered to the deteriorating patient between NHS Trusts was the referral to ICU, which was significantly higher in Site B (Outreach) than Site A (medically led) and indicates intrinsic organisational differences in the way deteriorating patients are managed. Success factors that were identified as qualitative themes from in-depth reviews in both the Survivors and Non-survivors were Visibility, Monitoring, Adaptation, Adjustment and Expertise. These factors promote successful escalation of care and healthcare organisations should invest in increasing the capability of the system to harness these more fully.

6. Chapter Six: Results of Applied Cognitive Task Analysis Interviews

6.1. Introduction

In the previous chapter, the results of the care record reviews were presented. In this chapter the results of the Applied Cognitive Task Analysis interviews are presented in the form of a published manuscript. The aims of this work were to:

i) develop a representative model detailing escalation of care, and

ii) identify performance variability that may negatively or positively affect escalation of care.

iii) examine linkages between steps in the clinical escalation process

The methods relating to this phase of data collection are presented in the published protocol (Chapter 3) and have remained true to the original ACTA methodology.

6.2. Published ACTA Manuscript

Ede, J., Hutton, R., Watkinson, P., Kent, B. and Endacott, R. (2023) 'Improving escalation of deteriorating patients through cognitive task analysis: Understanding differences between work-as-prescribed and work-as-done', *International Journal of Nursing Studies*. The Authors, 151, p. 104671. doi: 10.1016/j.ijnurstu.2023.104671.

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

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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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- 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

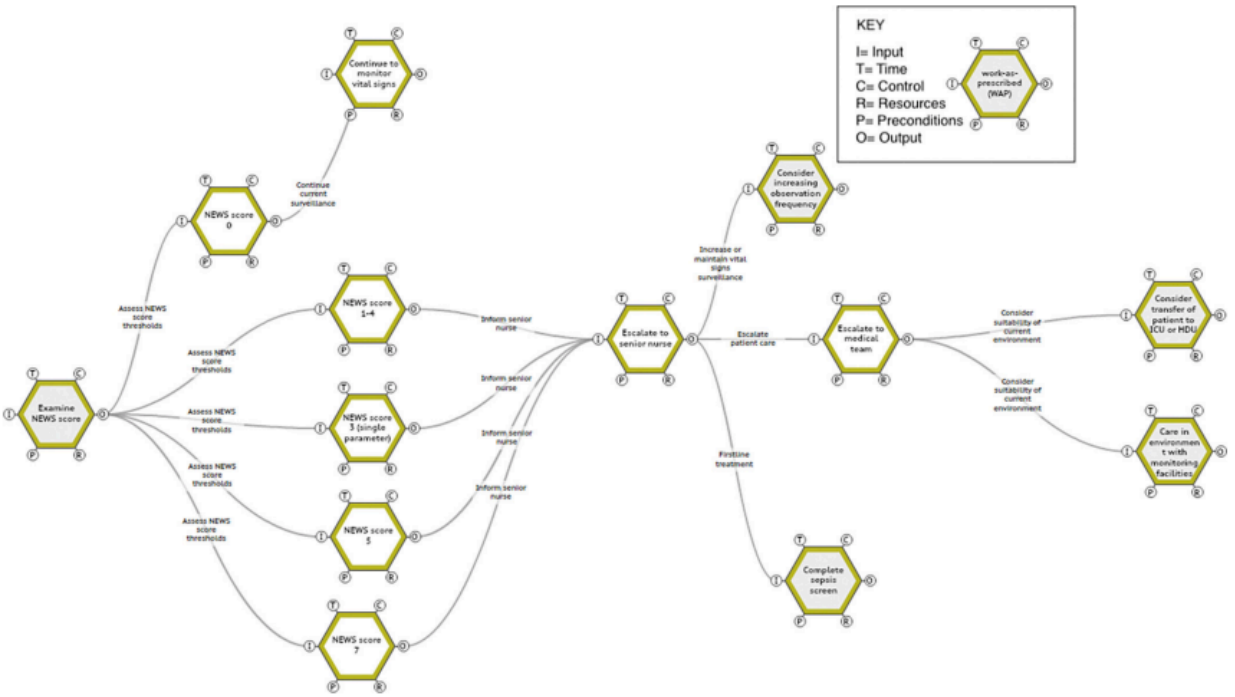

Fig. 1. FRAM Model 1 - illustrating NEWS2 escalation tasks (work-as-prescribed).

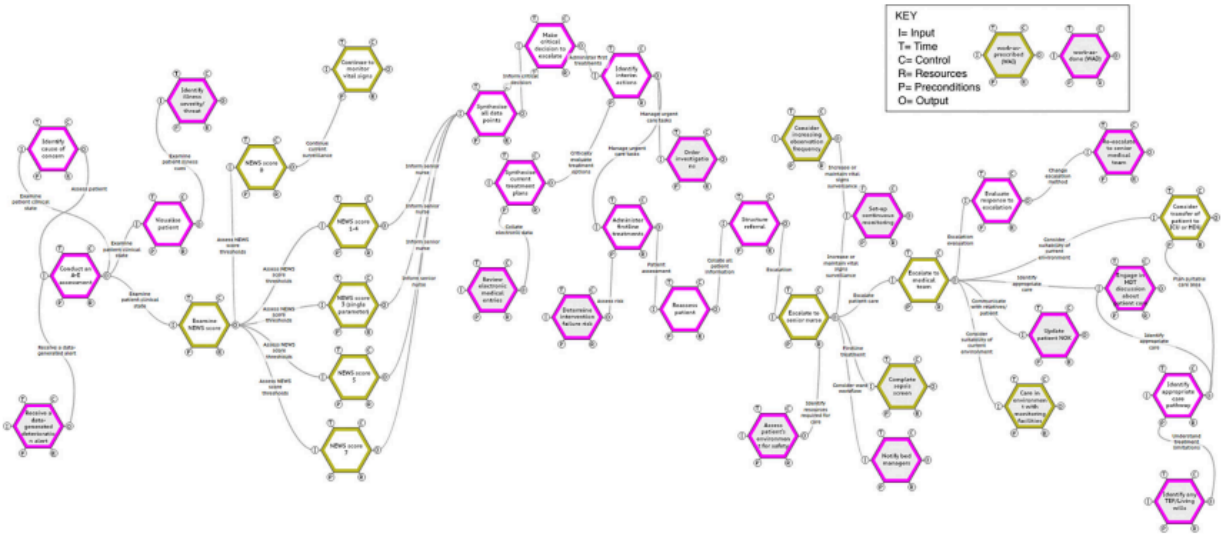

Fig. 2. FRAM Model 2a - illustrating NEWS2 escalation tasks plus ACTA escalation tasks (work-as-done).

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

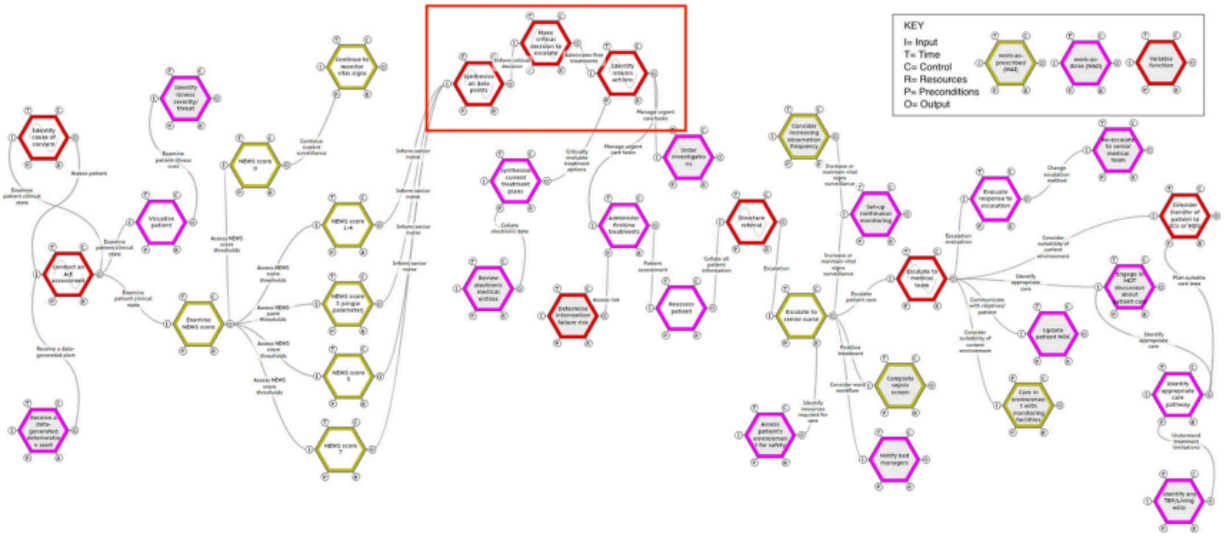

Fig. 3. FRAM Model 2b - escalation tasks at high risk of performance variability (highlighted in red).

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	Novices don't know what is expected	Advanced Care Practitioners/Outreach can request advanced investigations arterial blood gases, chest X-rays, blood work
		Lack confidence	May be misdirecting concern elsewhere rather than focusing on critical elements	Escalate to Outreach team to provide nursing support[b]
		Being overwhelmed and missing details	Dismissing guidelines	Pinpoint hospital resources to best support patient
			Initiating an inappropriate treatment	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	Providing treatment despite high failure risk from feeling pressure to "provide care"	Review of case studies
		Patient response to treatment		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	Escalation response is not deemed proportional to urgency	Escalate to outside resources i.e., such as ICU or Outreach
		Medical teams rotate regularly	Lack of awareness of specialist patients	Re-escalate to senior medical team
		Medical teams are not based to a single ward	Ward round follows their own priorities	Face to face referrals when possible
		High medical workload/limited resources	Overwhelmed Remote communication.	
		Medical team responsibilities outside of the ward (theatre)	Unable to grasp concerns	
		Not happening in isolation	Sepsis has a time limit for treatment	
		May have multiple patients who need medical attention		
		Difficult to escalate patients who are not in the extreme.		
n = 3	Consider transferring to critical care or HDU	Lack of hospital resources	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
		Organisational limitations of higher-level care beds (no HDU)		
		COVID-19 pandemic		
		Staff may not recognise end-of-life		

[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.

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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.

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Supplementary File 1. Study Design

Study flow diagram showing methods (ACTA and FRAM) and analysis.

Supplementary File 2. Interview Topic Guide

A cognitive exploration of successful escalation of care using Applied Cognitive Task Analysis (ACTA)

INTERVIEW TOPIC GUIDE

INTERVIEW TOPIC GUIDE

AIM

To i) understand, factors that affect successful escalation of care and identify how these could be applied effectively across healthcare settings ii) identify and explore emerging models of care during the Covd-19 pandemic

CORE THEMES TO EXPLORE

1. Understand the process of escalation of care (EOC)
2. Understand success factors that contribute to EOC
3. Identify implementation strategies to improve the reliability of identified success factors
4. Explore emerging care models during the Covid-19 pandemic

INTERVIEW SCHEDULE Introduction to be read to participants

"Thank you for taking part in this semi-structured interview. We are hoping to explore escalation of care (the detection and management of deterioration) within your local area and what contributes to the success of this process. You may stop the interview at any time without giving us an explanation. The interview is being voice recorded, but information will be made anonymous and you will not be identified by the answers you give. We may use quotes in publications as a result of these interviews."

Overview of method

Militello and Hutton, 1998 – Applied cognitive task analysis (ACTA): A practitioner's toolkit for understanding cognitive task demands (seems to be the most widely recognised and accepted method for completing this)
Split into 4 sections:

1) Task diagram
    a. Aimed to get the interviewee clear about the area of work you're focussing on
    b. Output: high level task analysis (+ shorter interview time!)
2) Knowledge audit
    a. To identify ways in which expertise is used, provides examples based on actual experience
    b. Organised around knowledge categories that have been demonstrated to characterize expertise: diagnosing and predicting; situational awareness; perceptual skills; developing and knowing when to apply 'tricks of the trade'; improvising; meta cognition; recognizing anomalies; compensating for equipment limitations
    c. Elicited by using a set of prompts
    d. Output: table of aspects of expertise, cues and strategies and difficulties.
3) Simulation interview

Additional reflections

2. Simulation interview

- ***May be use simulation interview if knowledge audit data is not rich enough or participant is struggling to think of real-world examples.***
- ***May be developed following first 5 interviews.***

3. Implementation strategies

- You have identified several key features of expert knowledge in relation to detecting patient or managing patient deterioration. Can you think of any ways in which the organisation can apply these more effectively?

"The interview is now finished. Thank you very much for your time and we will

General Impressions from the interview

Significant non-verbal cues, particular questions or thoughts raised that stood out, any changes to interview schedule that should be considered?

Context of interview

What was going on today that may have affected interview? Time pressures, sources of bias, reflexive reflections

- What are the major elements you have to know and keep track of?

1.1. Improvising or Noticing opportunities

- Can you recall a situation when you noticed that following the standard procedure wouldn't work? Can you think of an example where the procedure would have worked but you saw that you could get more from the situation by taking different a position?
- Have you had experiences where part of a situation just 'popped' out at you; where you noticed things going on that others didn't catch?

1.2. Job smarts (tricks of the trade)

- When you do this task, are there ways of working smart or accomplishing more with less- that you have found especially useful?
- Are there tricks of the trade that you use?

1.3. Self-monitoring

- Experts notice when their performance is sub-par and often figure out why this is happening (high workload, fatigue, boredom, distraction) in order to make adjustments.
- Can you think of examples where you did this?

1.4. Anomalies

- Experts can notice when something unusual happens. They can detect deviations. They also notice when something that should happen doesn't. Is this true here? Can you think of an example?
- Can you describe and instance when you spotted a deviation from the norm, or knew something was amiss?

1.5. Equipment and Information

- Unless you are careful, the equipment or information can mislead you. Novices may believe whatever the equipment says. Can you think of examples where you had to rely on experience to avoid being fooled?
- Have there been times when the information pointed in one direction, but your own judgement told you to do something else?
- Or when you had to rely on experience to avoid being led astray by the information?

1.6. Scenario from hell

- If you were going to give someone a scenario to teach someone humility (that this is a tough job), what you put into that scenario? Did you ever have an experience that taught you humility on performing this job?

a. Interviewee is posed a simulation, and answer questions on the simulation based on probes

4) Cognitive demands table
    a. Combining the information from the above sections into a meaningful way for the aims of the project

Questions

Demographics

a. Can you tell me how old you are please?
b. How long have you been qualified?
c. What is your profession?
d. What grade/seniority level are you?
e. Male or female

Task diagram

- **"Think about what you do when you decide to escalate a patient's care. Can you break this task down into less than 6, but more than 3 steps"**
    - *Produce a high-level task analysis from this*
- **"of the steps you have just identified, which require difficult cognitive skills?"**
    - *Define the focus of the rest of the interview around this specific task*

Knowledge audit (why is this difficult? Cues and strategies?)

1.1. Perceptual skills

- Experts detect cues and patterns and make discriminations that novices can't see. Can you think of any examples whilst detecting patient deterioration/managing an escalation of care?

1.2. Past and future

- Experts can figure out how a situation developed, and they can think into the future to see where the situation is going. Among other things, this can allow experts to head off problems. Is there a time when you walked into the middle of a situation and knew exactly how things got there and where they were headed?

1.3. Big picture

- If you were watching novices, how would you know that they don't have the big picture?
- Can you give me an example of what is important about the big picture for this task?

INTERVIEW INFORMATION

DATE OF INTERVIEW	

WITHDRAWL FROM STUDY

STAFF MEMBER REQUESTED WITHDRAWAL FROM STUDY	☐
DATA DESTROYED	☐

Supplementary File 3. Qualitative Interview codebook

This table depicts definitions of themes present within the paper. This also highlights how certain qualitative data were coded.

Nodes

Name	Description
Conducting an A-E assessment	Systematic approach to assessment. Code anything in relation to this, it may also be an unsystematic approach as this is useful for comparisons. How important is this approach? What does this add? Do different professions do different things? Do assessment methods change for different patients? Are weightings of findings different for different patients.
Consider transfer to critical care or HDU	Patients may require transfer to another clinical area. How and when is this decision made? What are the current guidelines and protocols to help make this decision? How do clinical teams balance risk of transfer, know the critical point that transfer is required?
Critical Decision to escalate	This is the point within the deterioration process when a health professional has identified a critical point has been reached and current actions are no longer viable. This may relate to Klein's "Problem Detection Theory" and Cowan's Model. How do staff do this? What do novices find difficult? Do professionals have different thresholds.
Determining intervention failure	What actions need to be completed during the task of escalation and how are they identified? What are they? Who completes them? What resources do they need to complete them? Sub theme- how do professionals apportion risk to certain interventions? How do they know when to "abandon" and seek help?
Escalating to medical team	What is the process of escalating? To whom? What are the preferred mechanisms of referral?
Identify cause of concern	How is this achieved? What are the red flags of concern? How do these differ between patients?
Indentifying interim actions	What actions need to be completed during the task of escalation and how are they identified? What are they? Who completes them? What resources do they need to complete them?

Name	Description
Strategies to avoid variability	Once a task has been identified as variable=cognitively challenging how do senior staff use this variability in positive ways of developing strategies to resilience engineer that system. How to they reduce variability?
Structuring a convincing referral	Making a referral to another medical professional requires that that referral has the correct 'illness narrative". This is selling that patient to the other professional in order that they are prioritised in amongst competing demands.
Synthesising all data points	This relates to data points about a patient's illness. These may be subjective or objective measures. The clinician collates all the relevant information to then make a critical decision about escalation and deterioration trajectory,
Variability in outputs	Variability=cognitively challenging. Experts who indicate difficulty with a certain task whilst escalating should have this coded. Difficulty leads to variability and unpredictability of task outputs. This may relate to organisation, tasks, tools, technology.

Supplementary File 4. COREQ Checklist

Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist

No. Item	Guide questions/description	Reported on Page #
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Interviewer/facilitator	Which author/s conducted the interview or focus group?	J.E.Ede
2. Credentials	What were the researcher's credentials? E.g. PhD, MD	MSc
3. Occupation	What was their occupation at the time of the study?	Nurse Researcher
4. Gender	Was the researcher male or female?	F
5. Experience and training	What experience or training did the researcher have?	GCP 5 years Research experience
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	No
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	See supplementary file 3 Interview Topic Guide. Standardised opening talk by researcher.
8. Interviewer characteristics	What characteristics were reported about	Pg10

	the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	

Domain 2: study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	Pg7-11
Participant selection		
10. Sampling	How were participants selected? e.g. purposive, convenience, consecutive, snowball	Pg8
11. Method of approach	How were participants approached? e.g. face-to-face, telephone, mail, email	Pg7-11
12. Sample size	How many participants were in the study?	Pg8
13. Non-participation	How many people refused to participate or dropped out? Reasons?	n/a
Setting		
14. Setting of data collection	Where was the data collected? e.g. home, clinic, workplace	P7-8
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	n/a
16. Description of sample	What are the important characteristics of the sample? e.g. demographic data, date	Pg7-8, Supplementary File 5

Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	Supplementary File 2, Pg8-9
18. Repeat interviews	Were repeat inter views carried out? If yes, how many?	No
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	Pg 8-9, Supplementary File 1
20. Field notes	Were field notes made during and/or after the interview or focus group?	Pg 8-9, Supplementary File 1
21. Duration	What was the duration of the inter views or focus group?	Pg8
22. Data saturation	Was data saturation discussed?	n/a
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	No
Domain 3: analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	Pg9-10
25. Description of the coding tree	Did authors provide a description of the coding tree?	Pg9-10, Supplementary File 3
26. Derivation of themes	Were themes identified in advance or derived from the data?	Pg9-10
27. Software	What software, if applicable, was used to manage the data?	Pg9-10

28. Participant checking	Did participants provide feedback on the findings?	No
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	Pg 13-19
30. Data and findings consistent	Was there consistency between the data presented and the findings?	Yes
31. Clarity of major themes	Were major themes clearly presented in the findings?	Yes
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	Yes

Supplementary File 5. Interview participant demographics table

	Gender	Age	Profession	Grade	Years qual	Speciality	Trust
1	Female	27	Nurse	6	5	Surgical	Site A
2	Female	28	Nurse	7	7	Surgical	Site A
3	Female	26	Nurse	6	5	Surgical	Site A
4	Female	43	Nurse	7	19	Surgical	Site A
5	Male	30	Physio	6	3.5	Surgical	Site A
6	Female	31	ACP	6	5	Medical	Site A
7	Male	30	Nurse	7	8	Surgical	Site A
8	Male	47	ACCP	8a	25	Critical Care	Site B
9	Female	48	ACCP	8a	30	Critical Care	Site B
10	Female	31	Sepsis Specialist Nurse	7	9	General	Site B
11	Female	28	Sepsis Specialist Nurse	6	7	General	Site A
12	Female	35	Sepsis Specialist Nurse	7	14	General	Site A
13	Male	38	Doctor	SpR	11	Medical	Site A
14	Female	25	Nurse	6	4	Medical	Site A
15	Male	29	Physiotherapist	6	5	Medical	Site A
16	Female	59	Outreach	7	37	Critical Care	Site A
17	Female	31	ACP	7	10	Medical	Site A
18	Female	37	Ward Nurse	5	4	Medical	Site B
19	Female	59	Nurse Consultant	8b	38	Critical Care	Site B
20	Female	28	Physiotherapist	6	7	Medical	Site B
21	Female	31	Ward Sister	7	8	Medical	Site B
22	Female	30	Outreach	6	6	Critical Care	Site A
23	Male	30	Physiotherapist	6	6	Critical Care	Site B
24	Female	35	Ward Sister	7	11	Medical	Site B
25	Female	39	Practice Educator	6	15	Medical	Site B
26	Female	31	Junior Sister	6	7	Medical	Site B
27	Female	34	ANP	7	11	Ambulatory Care	Site B
28	Female	29	Outreach	6	7	Critical Care	Site B
29	Female	31	Nurse Lead	8b	10	Surgical	Site B
30	Female	46	Nurse Lead	8b	24	Medical	Site B

6.3. Implications for the study

The results and discussion from this paper have several implications for the SUFFICE study. Firstly, these demonstrate the real complexity of escalation and give an indication why simplistic strategies to improve the process may not yield maximum benefits. This research has demonstrated that analysing key elements to tasks such as Interdependence, Criticality, Preconditions, and Variability gives a much richer understanding of escalation when compared to previous literature and could be a focus of future escalation research.

Over 28% of escalation tasks are challenging even for experienced staff to complete. To compensate, staff utilise cues and strategies to successfully escalate patients, some of which are not recognised in any formal documentation. Crucially, the difficulties that staff face when amalgamating all the required information to successfully bid for clinical time, is a critical limiting factor. When done successfully with minimal cognitive load, staff can creatively care for their patients by expertly identifying supportive elements within the wider healthcare system.

6.4. Summary

Mapped escalation tasks in this study naturally grouped into Exploratory (pre-escalation), Critical Decision (pre-escalation), Action (Escalation) and Evaluation (Post Escalation). There is a stark contrast between the mapped tasks in the national NEWS2 escalation protocol (n=8) and how escalation is achieved (n=24) in everyday clinical practice. ACTA Interview experts cited 28% (9/32) of all escalation tasks being

identified as cognitively challenging (and therefore high likelihood of variability). Data from this study examined escalation tasks Interdependence, Criticality, Preconditions, and Variability to give a greater understanding of how escalation tasks interact with each other why they may or may not fail to be completed.

7. Chapter Seven: Patient and Public Involvement and Engagement

7.1. Introduction

The importance of the previous three results chapters is partly defined by their relevance to real clinical problems, i.e., patient experiences. Research improving the identification of patients who become more unwell within the ward and may need ICU is a priority set by the James Lind Alliance (James Lind Alliance, 2023).

A descriptive paper outlining the SUFFICE Patient and Public Involvement and Engagement (PPIE) strategy has been published as a critical commentary. The aim of which was to describe practical PPIE strategies using a case study approach (the SUFFICE study) to assist other researchers in the process of planning PPIE work. The SUFFICE PPIE group specifically identified public requirements, care priorities and provided context to the perceived importance of the study. Their involvement began before submission for funding and has informed every key milestone within this project. Authorship for the publication included members of the PPIE group, reflecting the ethos of involvement and engagement.

7.2. Published PPIE Critical Commentary (Nursing in Critical Care)

Critical Commentary

Patient and Public Involvement and Engagement (PPIE) in Research: The Golden Thread

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Words: 1449

Keywords: Patient and Public Involvement and Engagement, research,

7.3. Introduction

7.3.1. What is PPIE and why is it important?

Patient and Public Involvement and Engagement (PPIE) has been an important element in research design for several years and is a requirement of many funding bodies and ethics review. Their contribution to research studies can vary, but can include asking whether a proposed study question and design are acceptable, co-designing the information and consent materials, and advising on the dissemination of findings (Mc Menamin *et al.*, 2022). The aim of this critical commentary is to describe PPIE and further underscore its importance with reference to an ongoing research study as an example.

PPIE groups consist of stakeholders, lay advisors (Mc Menamin *et al.*, 2022) and patients or relatives (Tobiano and Dale, 2022), some of whom have lived experiences of the research phenomena being investigated. The inclusion of these representative groups improves early study participation in healthcare research (Bagley *et al.*, 2016). A recent systematic review and meta-analysis of 26 studies found evidence that PPIE involvement increased the odds of recruitment and enrolment to studies (odds ratio 1.16, 95% confidence interval and prediction interval 1.01 to 1.34). In a subgroup analysis, involving people with lived experience of the condition being investigated significantly improved enrolment (odds ratio 3.14 *v* 1.07; P=0.02) (Crocker *et al.*, 2018). However, research-centric benefits should not be the only driver for PPIE; fundamentally involving patients and the public throughout the research process is

viewed as the 'right thing to do', ensuring studies address relevant problems and identify the correct evaluation outcomes (Tobiano and Dale, 2022). Because of this, PPIE is a requirement of funding organisations/ethical review boards, and a number of journals have made PPIE reporting mandatory (Tobiano and Dale, 2022), suggesting this follows a reporting checklist such as the GRIPP2 framework (Staniszewska *et al.*, 2017).

Despite PPIE being highly advocated with guidance and advice regarding inclusion, its use, methods, and topics vary (Lang *et al.*, 2022) and importantly it is not universally applied. In their cross sectional study examining whether papers published in 2020 demonstrated PPIE involvement, Lang et al found that only 20% (618/3000) of papers reported compliance (Lang *et al.*, 2022). Healthcare studies from the United Kingdom (UK) are 10 times more likely to have PPIE than studies conducted outside of the UK, as evidenced by research papers from Germany, Central and South Asia and Central and South America. Also, studies funded by the English National Institute for Health and Care Research (NIHR) have the highest level of inclusion (Lang *et al.*, 2022). Demonstrating good examples of PPIE may be a way to bridge this uptake gap by promoting and educating health care professionals in its use and application.

7.3.2. PPIE in the SUFFICE Study

7.3.2.1. Structure

The Success Factors Facilitating Care during Escalation (SUFFICE) study is an NIHR funded, mixed methods, multi-site study aiming to understand rescue events in the

deteriorating ward patient (Ede, Watkinson, *et al.*, 2021). The PPIE group was recruited through an ICU Steps (*ICUsteps*, no date) advert and consisted of patients, relatives, and public members, formed in the early stages of study design. Early comments from PPIE members centred on the focus of SUFFICE (patient deterioration) and provided evidence of the value of patient involvement and their 'scientific' reflections on their experiences. To summarise, members described how at times their deterioration went unnoticed which they believed may be because of high staff workload or unqualified staff doing vital signs measurements meaning that subtle deterioration signals were potentially missed. However, some members described excellent healthcare experiences where several processes lined up enabling fast and effective care to be delivered at the critical time.

The structure of each PPIE session varied and was flexible. The overarching aims were to co-design the research and prioritise the study focus, functioning as a forum for detailed discussions to gain opinions from members who were not research or healthcare orientated. An agenda was used to plan meetings, which members could add to if required. Findings from presentations and rich discussion were documented in a summary email allowing feedback from participants to ensure the information collected was captured accurately and that the research team understood all the points made by members.

7.3.2.2. Digital Delivery

As with other elements of healthcare that use remote medical consultations (Wherton and Greenhalgh, 2020), most PPIE for SUFFICE was conducted online during the pandemic. An online element was always intended to engage and give a research voice to populations who may otherwise find travel difficult or impossible (this was case with a housebound SUFFICE PPIE member). The sessions were conducted for no longer than one hour and used packages to present information such as PowerPoint, screen share etc. An unanticipated benefit was that this meant PPIE input into the study was able to proceed despite the unfolding Covid-19 pandemic, possibly giving members a semblance of normality and connectedness. This mode did have limitations as the social element of PPIE meetings were lost, such as the sharing of food/drink, and some conversations may have been less fluid and more formal.

7.3.2.3. Timing and Outcomes

SUFFICE had PPIE input at all stages of the study lifecycle, which included pre-study (to refine the aims of the research), pre-funding submission, pre-ethics application, mid-point through data collection and at completion of data collection and analysis. Several PPIE meetings were conducted, and the content of sessions and outcomes were documented. Specific contributions to the study were language changes in documents, recruitment of additional PPIE members and ethical justification for methods. The last PPIE meeting involved presenting the final study data and was the one of the most interesting and rewarding sessions. What wasn't fully captured, but was important nonetheless, was the detailed and rich discussions about SUFFICE that motivated the

researcher and allowed the data to be reviewed by non-healthcare related people, which in turn refined the communication of this work. Full details of the PPIE input and impact have been detailed in Table 12.

Table 13 SUFFICE Study PPIE input and impact

DATE	DESCRIPTION	OUTCOME
January 2019	ICU Steps Intensive Care support charity feedback on plain English summary	Wording changes to summary (e.g., avoid "tool" means different things to different people)
February 2019	Review of study documents in preparation for NIHR submission. Feedback given on Protocol specifically (study design, data collection methods) and plain English summary.	Refined grant documents Validated objectives Discussed personal experiences of healthcare
March 2019	Study aims, the plain English summary and any ethical concerns were discussed (none being raised). We agreed on PPIE plans, and the training and education support representatives may require.	Detailed ethical consideration of study
April 2020	Email correspondence regarding Confidentiality Advisory Group (CAG) support with Phase 2. Confirmed that the inclusion of COVID-19 patients and the use of confidential data without consent remained ethically supported.	Justification for CAG support detailed considering Covid-19 pandemic
April 2021	Update to the PPI group given about commencing data collection (see Supplementary File 2 for PPIE presentation). We specifically covered the use of confidential patient information supported by CAG. We reviewed some initial early data from Phase 2 which the group found fascinating. Noted by the group that broad diversity was	Addition of new PPI member Refined communication of data with a lay audience

	not reflected in the PPIE group and that this should be addressed.	
May 2021	Introductions and initial contact with a new SUFFICE PPIE member. Agreed input into the study.	
April 2022	Animated video of study protocol promoted on Twitter SUFFICE Video	Large number of online interactions with >6500 Tweet impressions, being re-tweeted 17 times
November 2022	Results of the SUFFICE study presented to PPIE members to evaluate and discuss. We identified the research priorities going forward and raised points of interest that arose from this work that were deemed worthwhile pursuing.	Developed focus for ongoing research Refined dissemination plans Co-authored paper

A study infographic was developed to represent the SUFFICE PPIE process and research outcomes (see Figure 14).

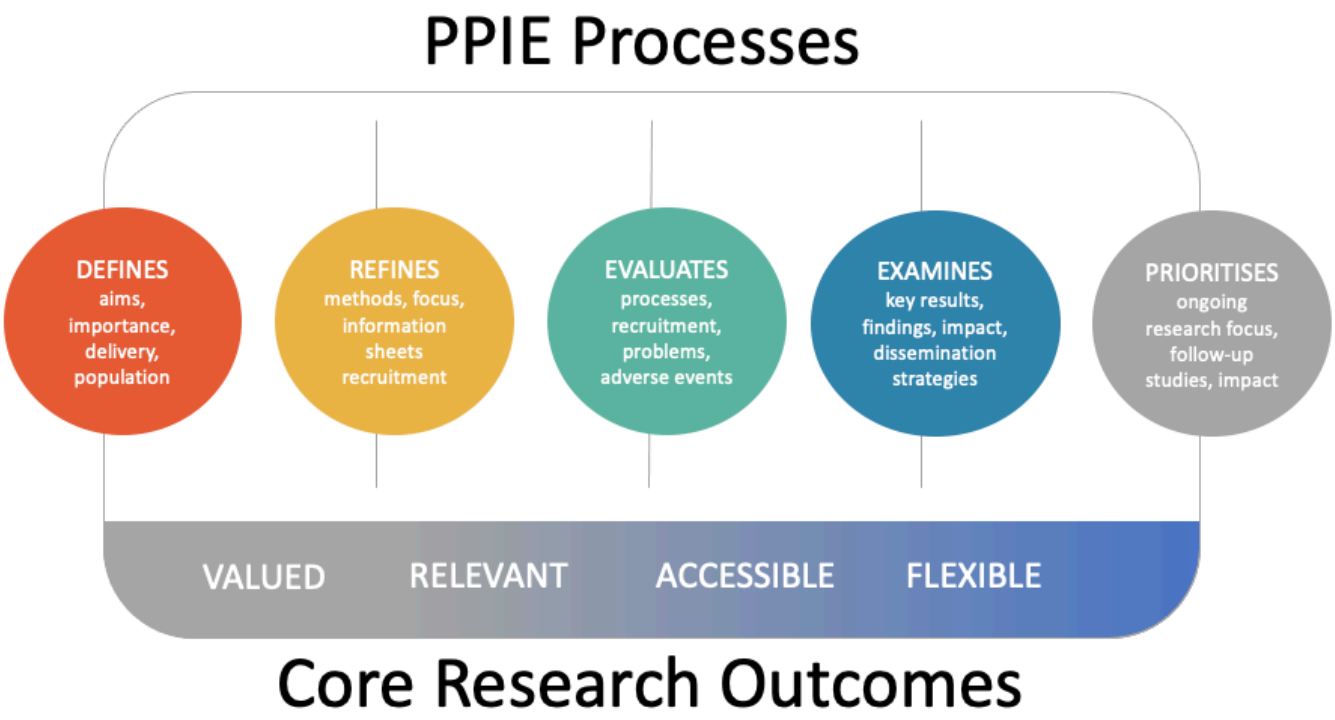

Figure 15 Patient and Public Involvement and Engagement Process and Outcomes

7.3.3. Conclusion

PPIE is central and adds value to healthcare research, but its use is variable across studies and there still needs to be greater uptake. The SUFFICE study was designed to fully incorporate PPIE by making it a 'Golden Thread' woven into all stages of study design and implementation. PPIE input was captured in a structured and systematic way to demonstrate its value and impact. However, reporting the number of study changes resulting from PPIE does not do its 'impact' justice. Fundamentally, the richness of the study was enhanced through the PPIE interactions with the research group, and this remains difficult to truly capture.

Conflict of Interest

The authors declare no conflict of interest.

Authors contributions

JE drafted the manuscript and is first author. All authors contributed to the manuscript, to the studies' PPIE process or provided expertise based on their disciplines of interest. All authors read and agreed with the final manuscript.

Data Availability

Data are available on request to the lead author.

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7.4. Implications for the study

This chapter provides evidence of the PPIE process that was undertaken to develop a highly relevant research topic. This work-stream within the larger study had several implications, which included notable study changes, prioritising the research focus, and pinpointing to future research. This work evidences an ethical approach to study conduct by valuing and respecting the input of patients and the public. There is also potential benefit to the wider research community and early career researchers, in that this published PPIE paper clearly documents the process within a large study. It demonstrates practical approaches that may be adopted within other studies.

7.5. Summary

A summary of key points is that PPIE is essential and adds value to healthcare research however, there is some variability within the literature as to its use. This represents a need to increase its uptake and reporting. The PPIE for the SUFFICE study was documented in a structured way and evidenced study changes directly attributable to the PPIE interactions. These reflections may prove useful to early career researchers and improves PPIE uptake. Ultimately, PPIE adds 'richness' to the data, which is quite challenging to measure.

8. Chapter 8: Discussion

8.1. Introduction

This study was designed to examine the process of escalation and rescue in the acutely deteriorating ward patient. A mixed methods design was employed to give a full and comprehensive review of why and how some patients are escalated and rescued from deterioration and what can be learned from this, to then be applied to make escalation process improvements.

To recap, data were collected in three key phases. Phase one, the researcher captured 151 escalations of medical, surgical and trauma patients in the acute ward setting by observing and shadowing clinical staff, mapped the process of escalation and identified success factors to this. Phase two comprised of 390 medical, trauma and surgical care record reviews from patients who had a trigger event (defined as EWS of $\geq$7) in the acute ward. The care of Survivors who avoided an ICU admission (n=340) was compared to Non-survivors (n=50), who were admitted to ICU and died. Phase three consisted of 30 clinical staff interviews using an ACTA methodology to collect data relating to expert knowledge, and FRAM to dynamically model escalation. The results from each phase of data collection give an in-depth understanding of the escalation of care process, what factors contribute to the success of this, and illuminate how staff navigate a complex and often unstable healthcare system.

All results (Phase 1, Phase 2, and Phase 3) have been presented in Chapter 4, 5 and 6. Results within Chapter 4 are presented in a submitted manuscript, results in Chapter 6 are presented within a published manuscript. Each of these has an associated discussion, but this chapter will integrate all the findings from across the data sets. Collectively, the study data may be triangulated or interpreted in relation to the main study question: "What are the success factors to escalation and how can these be applied more effectively?"

Given the large volume of data generated within this study, a data summary and source table (Table 13) is presented, which captures the core components of the discussion and links this to the phase where the source data may be found.

Table 14 Data summary and source table

Temporal Stage of Escalation	Relevant results	Study Phase/s
Exploratory	Activation of Escalation Actors of Escalation	Phases 1 & 2 Phase 1, 2 & 3
Critical Decision	Nuance of EWS Tool's Scores	Phase 1, 2 & 3
Action	Failure to escalate Successful escalation Communication of escalation	Phase 1,2, & 3 Phase 1, 2 & 3 Phase 1
Evaluation	Frequency of vital signs as a predictor of adverse patient events	Phase 2
Organisational and environmental influencers on deterioration care	Deteriorating Patient Systems Environmental influencers	Phase 1, 2 & 3 Phase 1 & 2

First presented within this chapter is a diagram of the proposed Framework of Escalation Success Factors, which includes the key concepts and themes that are discussed throughout this chapter (see Figure 15). This illustrates (from left to right)

system success factors present in escalation events, escalation communication phenotypes, the temporal stages of escalation and escalation task's interaction. It gives a high-level system view of escalation (system escalation success factors), conceptually becoming more focused (escalation tasks). The framework is 'built' as the discussion progresses and referred to throughout.

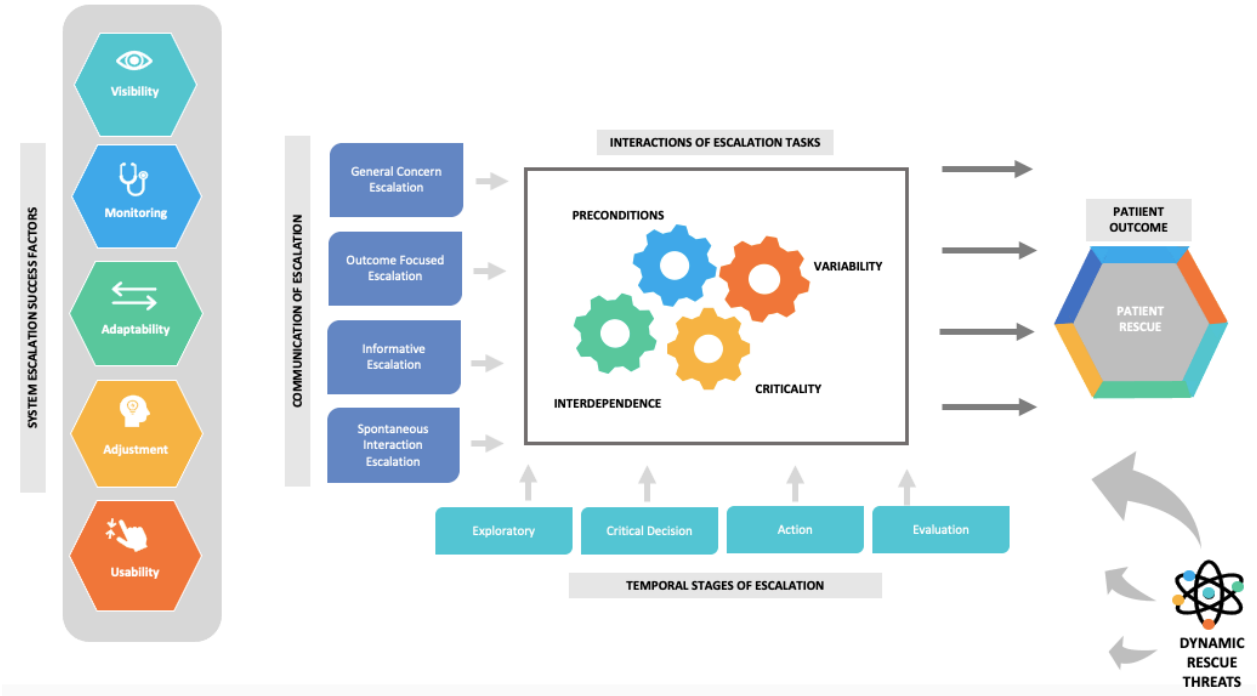

Figure 16 Full Framework of Escalation Success Factors

Presented in the following sections are patient demographics, prevalence of deterioration and an overview of escalation to re-orientate the reader to the phenomena of interest, its definitions and core processes. Findings from all phases of this study are presented within the temporal stages of escalation as this provides a logical flow to the data narrative. Drawing on the SEIPS framework, organisational and environmental factors will also be discussed towards the end of the chapter to ensure that all areas of the working system have been addressed. Finally, the chapter will be

concluded by briefly discussing this studies' methodological contribution to knowledge, re-presenting the conceptual Framework of Escalation Success Factors, outlining some future research priorities, and describing the influence this work could have on healthcare education.

8.2. Patient Demographics and Prevalence of Deterioration

During the care record review data collection period, the total number of adult admissions for Site A were n=105090 and Site B n=155869 (see Table 6, section 5.1.2). The prevalence of physiological deterioration in my study (3-4%) was lower than in other studies reporting 10-30% in ED and general surgical areas (Mohammed Iddrisu *et al.*, 2018; Connell *et al.*, 2021), which may be explained by different study populations. Also, the definition of deterioration used is potentially less 'relaxed', as indicated by the higher EWS scores used to identify care records for review, thus ensuring greater confidence that patients improved through medical care and interventions, and not through a natural improvement of the patients' condition.

Most patients who suffered a deterioration (trigger) event within this study were admitted under a medical speciality, followed by surgical then trauma for both Phase 1 (observations of escalations) and Phase 2 (care record reviews) patients. The patient case mix is consistent with 2019-2020 Hospital Episode Statistics (HES) report indicating that national NHS patient admission speciality is predominantly medical 73%, surgical 9%, and trauma 7% (Hospital Episode Statistics, 2019). In this study, deterioration episodes were most commonly seen in medical patients, similar to that of other MET activation studies (Mullins and Psirides, 2016; Malycha *et al.*, 2022). Commonest admission diagnoses were similar in both Survivors and Non-survivors

(Sepsis, CAP, HAP, COVID-19) and predominantly deterioration data were for male in-patients in both Phase 1 (66%) and Phase 2 (58%). The demographic data for patients whose care records were reviewed and died following a trigger event were older than those that survived, with a greater number of co-morbidities at the time that they became unwell and were more commonly admitted as an emergency rather than an elective.

8.3. Overview of Escalation

Descriptions of care escalation are common within the deterioration literature (Spiers *et al.*, 2015; Ede *et al.*, 2020) and formed a central part to the Qualitative Evidence Synthesis presented in Chapter 2. In these papers, escalation was presented through linear concepts, with broad, high-level descriptions. For example, Johnston and colleagues describe escalation as the recognition and communication of patient deterioration (Johnston, *et al.*, 2015). The SUFFICE study data, however, take this existing evidence base forward by mapping escalation to develop a theoretical understanding of care processes (Holden *et al.*, 2013; Hollnagel *et al.*, 2014) utilising a more in-depth analytical approach.

The observation (Phase 1) and ACTA interview (Phase 3) data, describing the tasks of escalation, were theorised, and modelled using Hierarchical Task Analysis and the Functional Resonance Analysis Method process and are presented in the submitted/published manuscripts. These models give a conceptual overview of escalation and are re-illustrated below for reference (see Figure 16 and Figure 17).

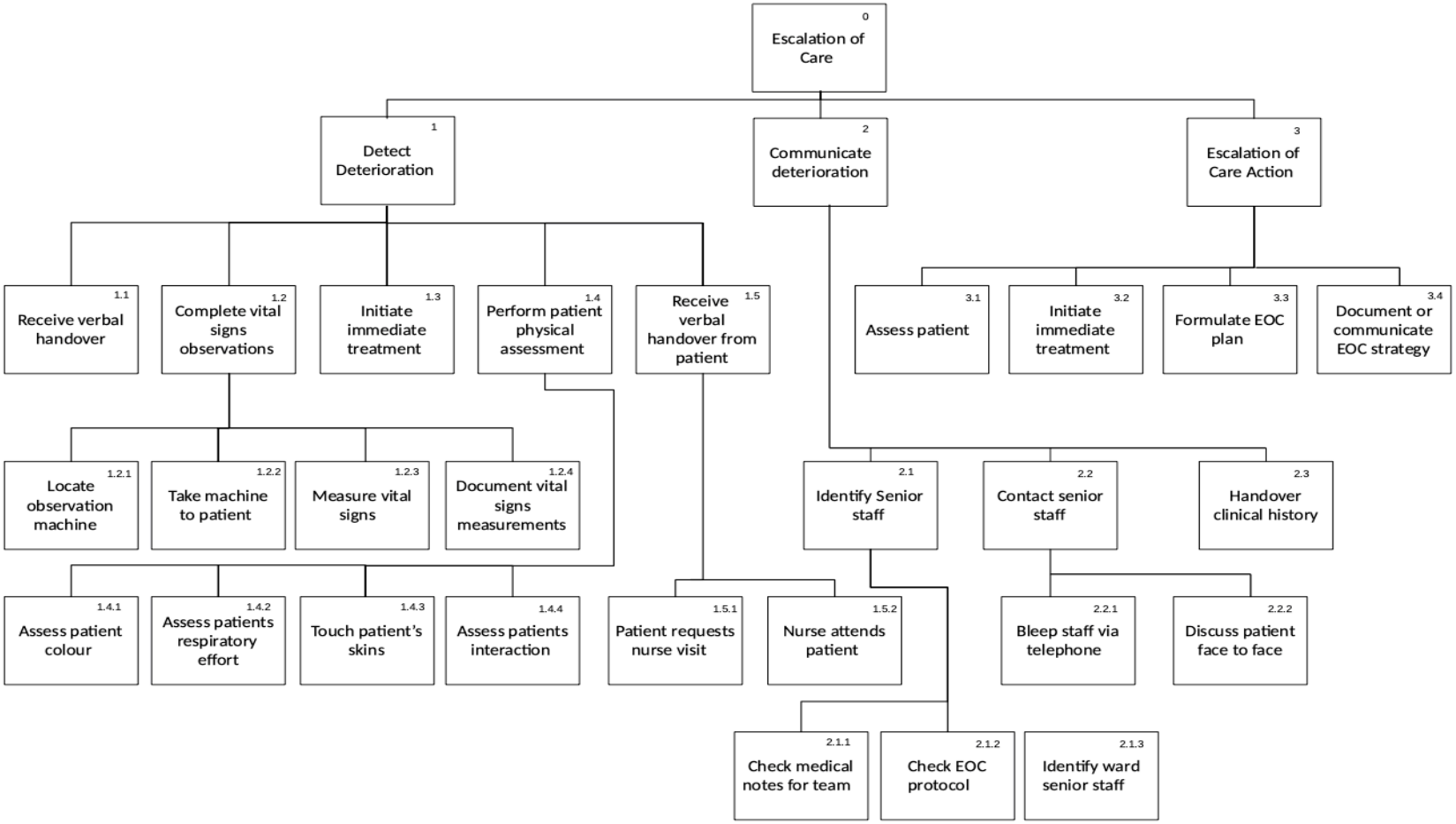

Figure 17 Hierarchical Task Analysis (HTA) of Escalation of Care

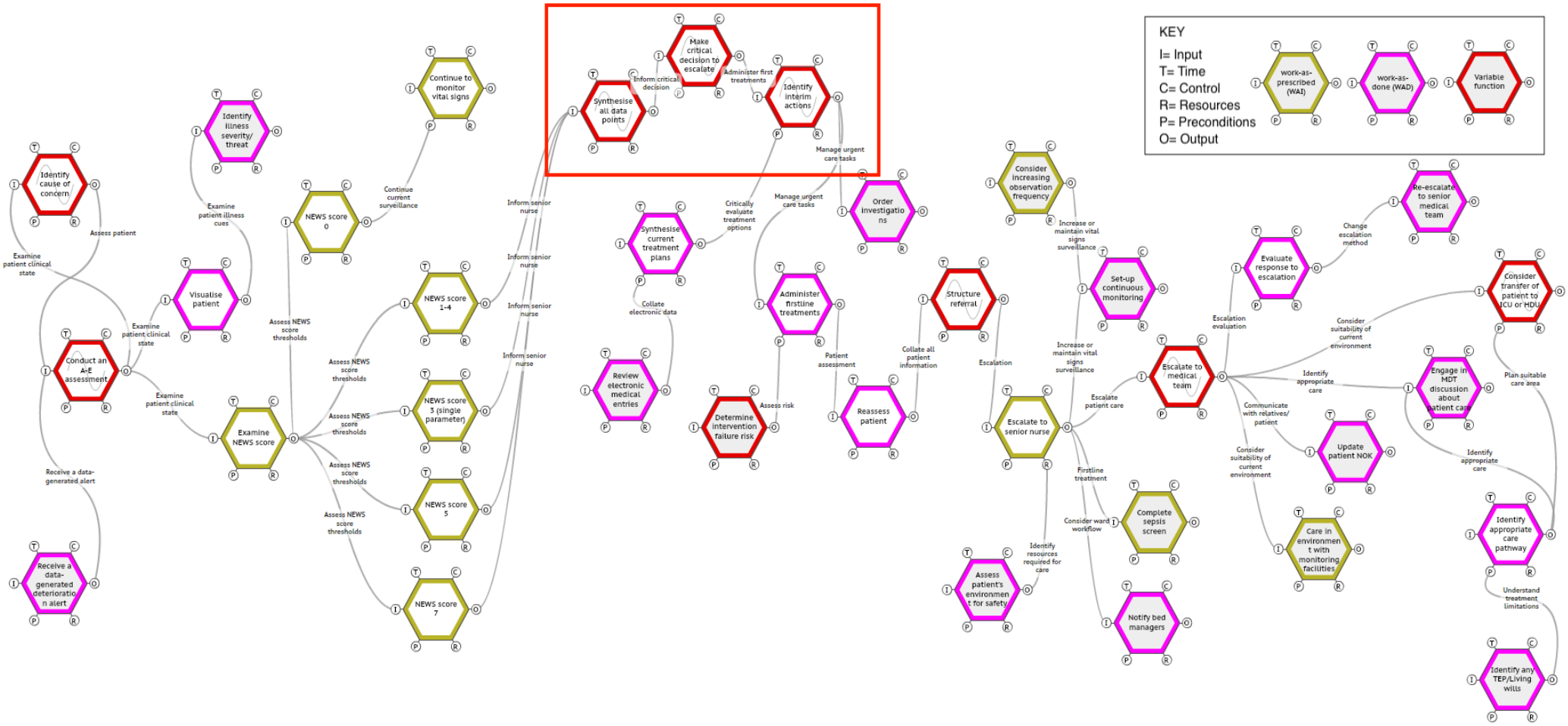

Figure 18 FRAM Model 2b-escalation tasks at high risk of performance variability (highlighted in red)

The focus of the HTA and FRAM mapping processes and subsequent models were to follow the escalation of care process up until the point that deterioration had been communicated and some form of care direction had been established (review, documentation, or acknowledgement of patient risk). It is important to note that the boundaries of these methods were defined out of necessity, as additional steps and tasks can be added ad infinitum.

The escalation tasks identified through both mapping processes triangulated well and were replicated within the different data collection methods in Phase 1, (HTA escalation tasks from observations), and Phase 3 (ACTA interview data represented in a FRAM). These data indicate that the main goal of escalation consists of between 29-32 individual steps and are consistent with two other studies that cite between 23 and 33 steps (Johnston *et al.*, 2015; Sujan *et al.*, 2022). The two studies that have examined escalation at a task level, grouped these as recognising deterioration, escalating care, collaboration across departments and organisational functions (Sujan *et al.*, 2022) or by professional role, nursing, junior medical or senior medical steps (Johnston *et al.*, 2015).

However, tasks in this study were identified to form four temporal stages of escalation (see Figure 18) and create a logical flow to the processes involved. Exploratory (pre-escalation), Critical Decision (pre-escalation), Action (Escalation) and Evaluation (Post Escalation).

Figure 19 Temporal stages of escalation

Broadly, the exploratory stage occurred when healthcare staff attempted to understand the patient's clinical situation (synthesising data) to identify patient risks. Tasks in this stage often generated the cues and identified data sources that prompted clinical staff to activate the escalation process. Following the exploratory stage, staff made the critical decision to escalate, or not, based on these cues and an accumulation of anomalies. This decision is then followed by actions (communication of escalation, first line treatments) that are then evaluated for effectiveness, or if further care interventions are required (such as increasing observation frequency further), as well as considering if the overall escalation response is proportionate to clinical concern. Integrated data from all phases of the study are now presented using the escalation temporal stages.

8.4. Exploratory Stage

The interview and observation data indicated that the exploratory escalation stage is when clinical staff, across a number of professional groups, attempt to understand the risk of clinical deterioration (collecting data) to make decisions about required actions. Exploratory tasks were focused on generating, receiving, interpreting, or weighting cues, which clinical staff used to prompt escalation activation.

8.4.1. Activation of Escalation

The observation data highlighted details of escalation activations that are important to explore from an educational perspective and to support advances in risk prediction models or algorithms predicting patient deterioration (Douw *et al.*, 2016). Deterioration events captured through observations and care record reviews varied in their visibility (how observable to both staff and the organisation) and severity ranging, from obvious red flags to very subtle signs, with patient EWS scores ranging from 0-14.

The interview data revealed that staff were often prompted to escalate following a patient A-E assessment, data alert or an observation set (Phase 3). Specific observed clinical concerns that prompted staff to escalate the care of their patients were categorised as either physiological and EWS related (n=74/151), or as soft signs that were not directly relating to an alerting EWS tool (n=77/151). The top three deterioration cues for EWS escalations were sepsis, hypotension, and low GCS. For Non-EWS initiated escalation cues were bleeding, chest pain and predictive infection risk. Importantly, these are consistent with other deterioration studies, which identified from 100 care record reviews of surgical and trauma patients that the main cues prompting escalation were also low blood pressure, fever, and hypoxia (Heale and Forbes, 2013). Similarly, a study from New Zealand summarises reasons for 335 MET activations as being decreased consciousness level, cardiovascular concerns (such as hypotension), severe pain, and bleeding (Psirides *et al.*, 2013).

Observation data from this study adds to the current body of literature, by revealing that less than half of escalations were initiated through a triggering EWS and instead were related to clinical concerns surrounding subtle deterioration signals (such as

patient complaints) or variables not integrated into current EWS systems. One Outreach practitioner, during an observation session, suggested that most of their service data indicated that nursing concern was the most common reason for referral (See Chapter 4, Observation data, Supplementary File 4, Table 3*).* During another observation session, a Non-EWS initiated escalation preceded an alerting score, indicating staff make clinical judgements that warning tools are simply not capturing (See Chapter 4, Observation data). The interview data further corroborated this by suggesting that escalation was often driven by patient and organisational factors and assessing a EWS score was not completed in isolation. For example, clinical experts suggested that they assess the environment for patient safety and suitability to deliver the required level of care, whilst also considering the changing clinical conditions, which may also be a driver for escalation.

8.4.2. Actors of Escalation

From the care record review most escalations were activated by ward nursing staff, which supported findings from a MET activation study (Psirides *et al.*, 2013). However, observations and staff interviews indicated that escalation was activated by a much broader group of healthcare staff, such as student nurses, healthcare assistants, housekeepers, and family members, who often escalated to the nurse in charge of the ward. Communication breakdowns are common to FTR events (Ede, Petrinic, *et al.*, 2021) and tend to stem from a perceived 'steep' hierarchy leading to a negative effect on working relationships (Bould *et al.*, 2015). The SUFFICE data provide evidence that, at an organisational level, communication about concerns appeared valued and there were ward processes in place to allow this to occur.

There is limited literature surrounding the breadth of potential escalation actors but it is suggested that student nurses can play an important role in recognising patient deterioration (Herron, 2018; Sterner *et al.*, 2019), which was also evident from the observational data in this study. Nearly 10 years ago, Benner suggested that education of nurses should centre around patient experience as well as physiology (Benner, 2015) and, given the breadth of cues staff use to escalate, this is even more pertinent. For example, patients in the SUFFICE study were detected as deteriorating through signs of delirium, hypothermia related sepsis, (care record reviews), high drain outputs, and personality changes (observation data). These patient experiences are unique and, to some extent, do not follow the standard or expected pattern. Given the breadth of cues prompting staff to escalate and that most escalations are not supported by national escalation protocols, it is important that graduate nurses' exposure to the sickest patients should be facilitated as much as possible (Herron, 2018) and the data suggest an even greater emphasis on patient experience is warranted.

8.5. Critical Decision Stage

The second escalation stage relates to the critical decision when clinical staff decide to escalate or not based on their synthesis of EWS or Non-EWS data points. SUFFICE data shows that most escalations are not initiated through scoring systems and provides further evidence of the complexity of this decision-making process. Furthermore it illustrates why current tools, such as scoring systems, may be too simplistic to fully support escalation reliably.

8.5.1. Nuance of EWS Tools' Scores when deciding to escalate

Early warning scores were introduced to ensure that escalation responses were more consistent between care providers (Royal College of Physicians, 2012). However, their use and uptake are variable, as indicated by recent national survey of 55 hospital Trusts (Freathy *et al.*, 2019). Of those that returned surveys, 36.2% had locally developed responses to deterioration and 83% of these don't prescribe clinical actions (Freathy *et al.*, 2019). The SUFFICE data also demonstrate a nuanced interpretation and variable responses to EWS scores across all data collection phases, each viewing escalation through a slightly different lens. As described in the previous section, Phase 1 data indicated that most escalations were not related to an alerting EWS. Phase 2 indicated staff employed variable escalation responses between Survivors and Non-survivors despite comparable EWS scores (which is discussed more fully in the following section), and in Phase 3 experts cited cognitive complexity relating to many escalation tasks, specifically making the critical decision to escalate, which is not solely based on score thresholds.

Other studies provide some contextual information on the use of EWS that assists with our data interpretation and understanding of why staff in SUFFICE continued to have to make critical decisions surrounding escalation notwithstanding scoring systems. Despite being a newly developed tool, the prognostic accuracy of NEWS2 to predict mortality within 24 h is only 'acceptable' and its performance in predicting IHCA is 'poor (Thorén *et al.*, 2022). Poorly performing EWS tools translate into an increased clinical burden due to risks associated with potentially unnecessary additional investigations such as imaging, blood tests, invasive lines, all of which incur cost

(Haegdorens *et al.*, 2020). It is also recognised that EWS tools do not take into account patient heterogeneity, different disease processes and individualised physiological responses to early interventions and treatments, which may mask hypotension/hypoxia and falsely indicate a physiological improvement (Langkjaer *et al.*, 2022).

During observations, it was evident that staff were able to detect deterioration prior to, or in the absence of, an alerting score and this was a theme that was described by interview experts also. Similarly, staff demonstrated skills and knowledge in relation to identifying when the score was over predicting deterioration, which is also supported by evidence within the literature. One way to address EWS limited ability to meet the needs of different populations is to support a level of clinical judgement within escalation systems and responses which our data shows staff already do. For example, EWS performance (DENWIS-model and I-EWS) (Douw *et al.*, 2016; Nielsen *et al.*, 2022) was improved by adding in a 'Nurse Concern' variable, which increased ability to predict ICU/HDU admission (0.86 versus 0.87) (Douw *et al.*, 2016) and reduced workload without increasing patient mortality (0·17 per day vs 0·19 per day) (Nielsen *et al.*, 2022).

There is a plethora of studies that describe the failure of staff to utilise EWS systems correctly, with calculation errors evident in paper-based systems (Johnston, *et al.*, 2015; van Galen *et al.*, 2016; Smith, *et al.*, 2020). However it is suggested that in some situations, escalation delays are purposeful, with staff making decisions based on their judgement to wait and repeat observations prior to referral (McGaughey *et al.*, 2010). Similarly, a study identified that incorrectly documented EWS which did not trigger a

response, were commonly followed by a true observation which correctly did not trigger or require a response (Clifton *et al.*, 2015). This may be explained by staff detecting nuanced signals which indicate the patient is not clinically concerning and therefore create workarounds to avoid escalation in those patients who may not benefit. These factors may not always explain staff escalation behaviours and it is prudent however to explore other possible escalation outcomes which the SUFFICE data can illuminate further.

8.6. Action Stage

Once staff had moved through the exploratory and critical decision stage, they entered an action phase. In some instances staff may or may not attempt to escalate and system problems or clinical judgements may hinder their ability. Alternatively, they may successfully escalate patients who ultimately do or do not survive their trigger event. Central to escalation actions is the communication of risk across professional groups.

8.6.1. Failure to escalate

Care record data (Phase 2, Chapter 5) indicated that escalation failure occurred in that 57% of Survivors and 28% of Non-survivors. Our failure to escalate data are similar to other studies citing 20-39.7% in surgical wards (Johnston, *et al.*, 2015), 42% hospital-wide (Shearer *et al.*, 2012) and 47% in ED (Connell *et al.*, 2020). Suggested causes of failure to escalate in a previous study were ‘nurse fails to notice that patient is unwell’, ‘nurse fails to measure vital signs correctly’, ‘junior doctor fails to complete thorough

examination' and 'senior doctor fails to arrange definitive management' (Johnston, *et al.*, 2015). These failures appear very person centric and located at an individual level.

The literature describes common barriers to escalation, such as communication failures, poor teamworking, workload and staffing (Ede, Petrinic, *et al.*, 2021). The SUFFICE study data potentially provide a greater understanding of the challenges staff face when escalating. Observation data highlighted organisational challenges for wards with front-door access. This led to overly complex medical team structures and multiple team members caring for patients, meaning that identifying who to escalate to was difficult and time consuming (See Chapter 4, Section 3.2.2). Ward workloads were also observed to contribute to staff escalation challenges such as simultaneous deterioration episodes in a single nurse's caseload (See Chapter 4, Observation 16), with other staff members needing to step in and support care. Other patient requests often created competing clinical demands whilst caring for unwell patients and interrupted clinical workflows (See Chapter 4, Observation 11). The interview experts also gave detailed descriptions of escalation challenges and described common novice errors, such as not using the family as an early deterioration indicator, not being able to see what is absent (normal progress, absence of symptoms such as pyrexia), and misdirecting concern elsewhere rather than focusing on critical elements.

The detailed escalation task analysis (FRAM) developed from the interview data explains performance variability and identifies sources of potential escalation failure more fully than current available literature. Desired or undesired escalation outcomes can be a result of task interactions such as their Interdependence, Criticality, Preconditions, and Variability (see Figure 19).

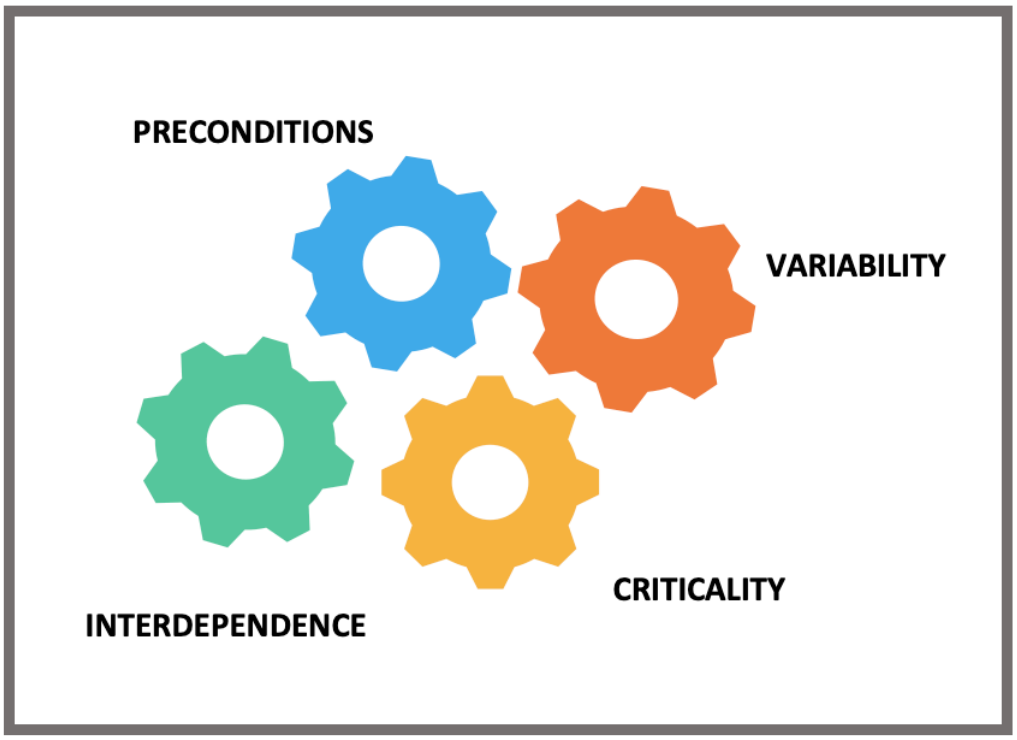

Figure 20 Interactions of escalation tasks through Interdependence, Criticality, Preconditions, and Variability.

Experts suggested that of the 32 escalation tasks identified, 28% (9/32) were cognitively difficult to complete. Consequently, it is highly likely that the outputs of these tasks will vary between people, ward, and Trusts. In SUFFICE, the critical decision to escalate was highly dependent on the downstream tasks of synthesising all the relevant data points (interdependence) to allow clinical staff to detect a problem existed. Interview data also suggested that certain preconditions were required to be present to allow for completion of tasks (Hollnagel, 2012). To efficiently synthesise all the relevant deterioration data points, a fundamental precondition is clinical staff's ability to review all medical documentation through accessible hospital IT systems in a timely manner (Usability). This is often not the case, as it is well documented that

hospital electronic records are fraught with usability problems, technical errors, and inability to access basic equipment (Greenhalgh *et al.*, 2017). This was also captured following an observation session, with one sepsis nurse clearly describing clinical situations where sepsis screening tools occasionally did not reflect the patient's conditions accurately or alert correctly, potentially contributing to decision uncertainty (See Chapter 4). Conversely observations revealed that, when technology had effective usability, staff would utilise this in novel ways to meet the demands of their patient groups based on their clinical understanding and anticipation of particular risk points. For example, a consultant described how his patients were most likely to develop a surgical leak between day 3-5 and would set an alert on his phone to notify him of inflammatory changes on these days (See Chapter 4).

Other tasks were highly critical, which meant that several upstream functions were not initiated if they were not completed. One such function was *'Escalate to Senior Nurse'* which, in the FRAM model, generated n=4 immediate upstream functions, including increasing monitoring surveillance, escalating to medical team, completing sepsis screen, and notifying bed managers. This is partially supported by the literature, which indicates that a medical referral will often be preceded by a discussion with nursing peers (Pattison and Eastham, 2012b) demonstrating the importance of that first escalation step.

The interplay of tasks (Interdependence, Criticality, Preconditions, and Variability) captured in the interview data strongly highlights why root cause analysis of escalation failure may not be beneficial or feasible given the number of fleeting interactions and the effects these problems have on downstream and upstream tasks. This concurs with

conclusions from a patient flow study (interviews n=62 and document analysis n=700) that identified improvements to timeliness and efficiency were locally focused, had relatively small gains and only targeted small system elements (Kreindler, 2017). This meant that mitigations were unable to respond to problems (dynamic threats) when moving to different parts of the system (Kreindler, 2017). This is where gaining an understanding of the wider system under investigation is important to address these challenges.

8.6.2. Successful escalation

Whilst escalation was completed for only 43% of the Survivors, of note is the fact the 72% of Non-survivors had a successful escalation despite a poor outcome. A review of the care records for unwell patients revealed that most of the Survivors (77%) and Non-survivors (92%) were judged to have had adequate to good care before, during and after their trigger event. Despite this being an unanticipated finding in this study, it has been replicated in larger multi-site studies of care record reviews (n=7000), in which the majority of patients who died were deemed to have had Good Care (Roberts *et al.*, 2017; Rogne *et al.*, 2019; Vollam *et al.*, 2020). Good quality care for patients who die has also been reflected in an ICU relative satisfaction survey, when compared to those scores from patients who survived (Ferrando *et al.*, 2019). The authors suggest this may be because there was greater family involvement in decision making during end-of-life care, and the fact that relatives of survivors have ongoing care to deliver for the recovering ICU patient (Ferrando *et al.*, 2019). This may also indicate that using simple mortality metrics to evaluate hospital performance may not be as informative

and reliable as it should be, given that people who die may get better care than those that survive.

When examining the other care domains, there was evidence in this study to support that Non-survivors had greater escalation compliance, more cases of vital signs observations being repeated within one hour and they were medically re-reviewed following a trigger event more frequently despite having poor outcomes (See Chapter 5). There is a limitation of this work in that the number of survivors was small and therefore proportions are difficult to interpret. However, multiple data points were triangulated which suggested that overall care quality scores and escalation compliance were higher in the Non-survivor group.

At first glance, this finding seems to contradict the primary focus of the study, which was to identify why some patients are successfully escalated and rescued. However, it is important to examine trends across both Survivors and Non-survivors. The care record data suggest that staff may have made clinical judgements (Adjustment and Adaptations) about all the patients who were scoring a EWS $\geq$7 and who were at high risk of an adverse event. There may have been discrete choices made about who was and was not prioritised to receive high-resource care, which included escalation, hourly observations, and medical reviews, and this did not fit with local escalation protocols. How staff prioritised patients in our study is consistent with their outcome and demonstrates they distinguished between scores which overpredicted deterioration with a degree of accuracy. Patients who went on to survive were less likely to be escalated than those that died which ultimately reduced the number of escalations and unnecessary treatments and investigations. The literature does

capture this concept and describes “implicit rationing” where nursing staff are required to deliver the care to those that are most in need based on clinical judgements, leaving a proportion of the lower risk care undone (Bail and Grealish, 2016). It is important to map these adaptations over time (Carayon *et al.*, 2020), why they occur and if they compensate for difficult-to-change work system components (Holden *et al.*, 2013).

Several escalation success factors, present within the system, were identified across all phases of data collection and were often replicated. Interestingly success factors in my data are not too dissimilar to those found in early work describing the key characteristics of high-reliability organisations which include anticipating failure, redundancy and a focus on learning (Sutcliffe, 2011). Despite HRO operating amongst high levels of risk, they also create and systematically facilitate high safety and reliability (Lekka, 2011; Sutcliffe, 2011) through examining everyday work, adaptations and trade-offs (Sujan *et al.*, 2021). In our data, the success factors present within the system originated from both system processes and from the staff themselves. The care record review’s in-depth qualitative data provides evidence of escalation success factors in both Survivors and Non-survivors trigger events. Similarly, data from observation and staff interviews also indicated commonly replicated success mechanisms which promoted escalation. Broadly, success factors relate to Visibility, Monitoring, Adaptation, Adjustment and Usability (see Figure 20).

Figure 21 System success factors to escalation

Staff were able to effectively anticipate consequences and make adjustments for these and this was a critical element to system resilience in the face of an unstable healthcare system. For instance, a haematology patient (Vignette 2) was identified as having abnormal laboratory results (Monitoring) that were viewed as more significant given her clinical history (Adjustment), which then prompted the registrar to request a review of the patient in clinic. A subsequent physiology check showed significant blood pressure and oxygen derangements (Visibility and Monitoring) despite the patient denying any significant clinical changes or symptoms during a telephone conversation. The interviews also demonstrated how staff anticipated system failures when attempting to escalate and adapted to these. In some instance they predicted bed flow

blocks which could hinder the ability of critical care to accept their unwell patient. For this reason, they initiated prompt discussions with bed managers to facilitate earlier decision making about patient movement (Adaptation). Furthermore, staff were also able to compensate for system weaknesses such as EWS and identified patients becoming unwell before an alert (Vignette 3), through assessment (Monitoring) and previous patient encounters (Adjustment and Adaptations). They were subsequently able to pick up subtle but significant signs of deterioration such as delirium.

Usability of technology was previously described as a critical facilitator to escalation, when during observations, staff would use and adapt technology to fit their individual patient needs. Observation data evidenced how, despite the limitations of EWS, remote scoring systems (Visibility and Monitoring) promoted increased deterioration visibility in certain triggering patients allowing staff to investigate potential deterioration events from anywhere across an organisation. This facilitated in-built redundancy within the escalation system and created opportunities for multiple and simultaneous escalation events about the same unwell patient (Adjustments and Usability) (Chapter 4, Observation data, Table 1) without being reliant on a formal referral. In the staff interviews a critical step in escalating was an ability to synthesise all the relevant data points to create a high-quality escalation event. When the system had good IT usability and this process was efficient (and staff had lower cognitive loads), they were then able to adapt their escalation responses to take into account of

resources from the wider healthcare system to support the management of patients and deliver higher quality care.

Some patients in the SUFFICE study were managed adequately, responded to early treatment within the ward environment due to staff adapting and adjusting to changing clinical conditions and delivering patient centred care. One Covid-19 patient (RTH002P173) had multiple critical care and medical reviews overnight and was being prepared for admission to ICU, however this patient then responded to high-flow oxygen therapy, intravenous antibiotics, and regular monitoring (despite being isolated). A significant improvement in respiratory function therefore meant an ICU admission was avoided and was mostly likely due to good quality care, timely interventions and a well communicated escalation.

8.6.3. Communication of escalation

For a successful escalation to occur, a communication of concern, between and across health care groups, is required. Through observing escalation events, data collected revealed several escalation phenotypes relating to communication including General Concern Escalation, Outcome Focused Escalation, Spontaneous Interaction Escalation, and Informative Escalation (see Figure 21).

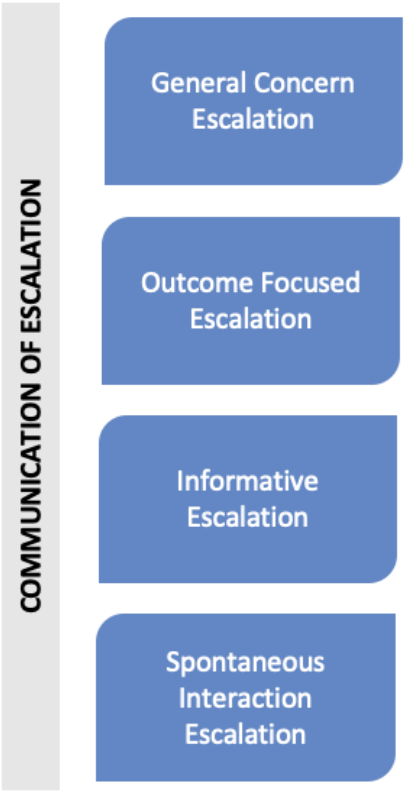

Figure 22 Communication of escalation phenotypes

Importantly this is something that to our knowledge has not been explored within the literature and our study is the first to propose different escalation phenotypes. Staff tailored and used different communication strategies depending on the required output of escalation and their level of concern for their patient. Each phenotype has unique characteristics and were detailed in Chapter 4. For instance, an Informative Escalation was to fulfil an organisational requirement. This is an important point, for Informative Escalations were deemed to have little clinical output and were relatively low value but were commonly seen in the observation data (49/137, 36%, 95% CI 27.8-44.4). Whilst the RCP, who developed the NEWS2 criteria, support the idea of clinical judgement (Royal College of Physicians, 2012), it is then interesting to note anecdotally

that there is a tendency for NHS Trusts to benchmark their performance against NEWS2 compliance, placing significant pressure on staff to escalate scores with low clinical concern. This raises important considerations and future work is clearly needed to better identify those high risk patients who are at real risk of deterioration whilst also reducing the workload associated with false triggers (Thorén *et al.*, 2022). Spontaneous Interaction Escalations were heavily influenced by environmental designs and were often escalations that would not traditionally meet organisational escalation criteria. Importantly, the face-to-face influence of these communication episodes appeared well received and prioritised effectively. There are few studies that describe the impact of the environment on escalation; this is discussed further in section 8.8.2.

8.7. Evaluation Stage

The evaluation phase of escalation involves clinical staff adjusting current care (such as increasing vital sign monitoring).

8.7.1. Frequency of vital signs as a predictor of adverse patient events

There were instances within the care records where monitoring of patients far exceeded that required by protocols. The differences in care delivered to Survivors and Non-survivors also suggest it may be feasible to use adherence to vital signs observations as a metric and predictor of a pending event. This concept is one that has only briefly been explored within the literature identifying only three suitable papers. These studies identified that more frequent vital signs measurements are associated with higher mortality odds (Collins *et al.*, 2013; Asiimwe *et al.*, 2014; Schnock *et al.*, 2021). The data from the SUFFICE study found similar themes with Non-survivors being

more likely to have observations rechecked within one hour of their initial trigger event and may indicate that clinical staff had greater concerns about this deterioration episode.

Clinical judgement clearly remains an important factor and may be a nurse-sensitive predictor of deterioration that can be used in conjunctions with an EWS. The current frequency of vital signs measurements which is mandated is not based on strong, high quality evidence and ironic given its widespread adoption (Smith *et al.*, 2017). The UK's National Institute for Health and Clinical Excellence (NICE) recommended physiological observations frequency, but this was not evidence based and mainly represented the consensus of opinion from within the NICE Guideline Development Group (NICE Clinical Guidelines, 2007). The workload associated with measuring vital signs is significant and it can take between 4-8 minutes to complete one observation set (Dall'Ora *et al.*, 2021; Ullah *et al.*, 2022), which may explain why this care intervention is often subjected to implicit rationing in certain groups of patients. It is currently problematic that clinical staff appear to be making judgements relating to low value care (Grimshaw *et al.*, 2020), which are not recognised, challenged or supported through evidence. This is an important area to further explore in relation to deteriorating patient management.

8.8. Organisational and environmental influencers on deterioration

8.8.1. Deteriorating Patient Systems

There were factors in this study relating to the organisation, which influenced how deteriorating patients were managed for both the afferent (deterioration detection)

and efferent limb (management of deterioration). A key difference between organisations was in the ***efferent arm*** delivery through the provision of critical care Outreach for unwell ward patients and this was evident in all three phases of data collection. Site A had a medically provided ICU assessment and retrieval service, which also had clinical duties to fulfil in ICU at the same time. Site B had an established and dedicated nurse led ICU Outreach team.

In the Survivor group, the number of patients referred for critical care review and ward support was significantly higher in Site B 92/175 (53%), than in Site A 34/165 (21%) (p=0.00). There are several reasons that may explain why patients in Site B were nearly twice as likely to be referred for a critical care review following a trigger event. Firstly, nurses (who were the main actors of escalation) may be more likely to make an escalation to another nurse. The perceived hierarchical and interprofessional boundaries, although not evidenced in our observation data, is a very common theme in the literature and a recent systematic review found 10 papers which discuss this (O'Neill *et al.*, 2021). Underlying this, are complex socio-cultural factors that may explain the stark difference in referral practices between the two Trusts. There is also evidence to suggest that high-performing RRT/MET/Outreach teams are dedicated to the service and have no other competing demands (Dukes *et al.*, 2019), which was not the case in Site A. Even more interesting is that there is literature to suggest that when Trusts have both an Outreach and ICU medical referral processes, doctors have indicated that their first contact will normally be with the Outreach team who will then subsequently refer to ICU if required (Pattison and Eastham, 2012a).

The differences between Trusts in this study meant the site with the established Outreach team was also able to bolt-on another service, which allowed family members to raise concerns and, in some instances, create a rescue event. This was absent from the site with no established Outreach team due to the lack of infrastructure to support this. When speaking to staff during observations and through the ACTA interviews, they described how family members could recognise deterioration and activate escalation pathways. There is wider evidence supporting family escalation pathways, but this is often limited in the adult population and commonly focused on paediatric patients whose parents have concerns.

A CCOT service review (Odell, 2019) where a patient and relative escalation pathway (C4C) has been implemented in adults indicated good usage metrics. Of the total number of calls across the seven-year review period, 0.8% involving 312 patients were activated due to family concerns surrounding clinical care (n=210), communication issues (n=147), advice and reassurance (n=87) and general care concerns (n=47) (Odell, 2019). Three referred patients died and most importantly six were transferred to a higher level of care (Odell, 2019). Whilst this is not highly scalable, family-initiated escalations may have more peripheral benefits which sit outside of patient-related outcomes. For instance, studies have shown positive relationships between quality and safety climate, empowerment, and satisfaction for both patients and relatives (Burlakov *et al.*, 2021) which this type of intervention would undoubtedly foster.

Another organisational difference that Outreach afforded was the ability to 'Seek out the Sick' through Visibility and Monitoring. It is recognised that organisational awareness of patient deterioration should be available to staff (clinical team, RRT or

other healthcare staff) with the appropriate skills to intervene. These staff groups may facilitate earlier intervention and improve clinical outcomes (Smith *et al.*, 2006). Outreach were observed to create escalation system redundancy (fail-safes) as suggested by Johnson's early study (2015). Multiple data points across all three phases of data collection suggested that teams who were dedicated to finding unwell patients, were able to do so in some instances without a formal referral.

8.8.2. Environmental Influencers

Within the SEIPS framework, the clinical environment plays an important role within the working system (Carayon, 2006b), specifically how staff interact with this and how this affects tasks, wellbeing and efficiency. The observation data reported in this thesis suggests that Spontaneous Interaction Escalations may be encouraged and influenced by the design of clinical areas through joint working spaces and optimising the internal environment to maximise deterioration dialogues amongst staff.

There are many well documented environmental effects on patient and staff experiences or outcomes. For patients, it is recognised that delirium is exacerbated by certain environments and there is a drive to manage this as part of evidenced-based care bundles (Kotfis *et al.*, 2022). Similarly, studies have identified clinical designs can negatively affect staff interactions, ability to make critical decisions (Johnson *et al.*, 2014), patient's safety, and wellbeing (Ede *et al.*, 2022). These are likely as a result of commonly encountered environmental performance obstacles such as noise, distractions from families, cramped environments and equipment not being available (Gurses and Carayon, 2009).

The majority of trigger events in the literature are shown to occur within the ward environment (Mohammed Iddrisu, *et al*, 2018) as were the escalations events observed and extracted from care record reviews in this study. It is interesting then to note that most healthcare focused environmental design studies are based within ED, ICU, and theatres whilst neglecting more generalist ward areas. Another important point is that hospital designs have historically stemmed from a Florence Nightingale design of a cohort of 30 beds (Hurst, 2008) with very little change to their original configuration. It has been suggested that most healthcare workplace designs have not developed from an understanding of how staff work, their functional needs, the processes required for task completion or how this affects their physical and emotional wellbeing (Cawood *et al.*, 2016).

Clinical design has become more prominent with recent attempts to avoid nosocomial covid-19 infections in both patients and staff (Ede *et al.*, 2022). There is a small amount of research which has explored the impact on care for patients who are predominantly nursed in side room indicating that they increase cost, distances staff have to walk and, importantly, reduce visibility and nursing surveillance for those patients (Maben *et al.*, 2016). A search of the literature reveals a real sparsity of research specifically examining environmental factors and the effects this may have on the escalation of care element to patient safety.

The data from the SUFFICE study indicated that there may be yet untapped ways to improve escalation of care through clinical space design that encourages the interaction of staff groups through common workspaces. Interestingly a similar theme was noted in a study looking at the referral process to critical care which identified

that when Outreach were on the ward, there were a number of informal referrals which staff may not have felt confident enough or may not have warranted a 'formal' referral (Pattison and Eastham, 2012b). It may be possible that improvements to escalation of care may, in fact, come from the environment and evidenced based designs through understanding WAD. The heterogeneity of ward designs may be used to an advantage in that there is already a natural experiment occurring where staff are detecting and managing deterioration in several different ergonomic spaces. Again, this is largely unexamined and underrepresented in the literature.

8.9. Studies' methodological contribution to research

An interesting concept arising from this research is that with traditional approaches, this study would have focused on the care record reviews from predominantly those patients that died. Mortality rates are often a metric on which the quality of care delivered in a healthcare institution is measured (Bottle *et al.*, 2011). There are two existing criticisms of this approach; not being able to adequately control for patient and hospital characteristics and the inability of mortality rates to identify any issues and learning from care (Rodwin *et al.*, 2020). The data from this study suggest a third criticism; that their care may not be representative of the care delivered to the wider ward population and in fact may be ***better*** that those that were less unwell. Patients may die despite high-resource care when compared to patients who survive. Care that does not compare survival and death, may yield inaccurate and misleading quality of care expectations.

Secondly, this study has combined two novel HF methods (ACTA and FRAM) to examine escalation of care at a level not commonly seen within the literature. The

integration of these methods was subject to rigorous consideration and justification through many supervisory meetings. The study utilised an HF expert in both the ACTA method and cognitive psychology to critique our approach. The integration of the data from ACTA into a FRAM model has been transparently described within the ACTA manuscript in Chapter 6. ACTA is useful at exploring mentally demanding tasks, but it does not identify the relationship or interaction between escalation tasks whilst FRAM represents how an activity is usually carried out (process model) (Hollnagel, 2012). Importantly, without this combination of methods, the analysis would not have robustly revealed how fleeting interactions of tasks create performance variability, which traditional healthcare safety approaches and interventions may not fully account for.

8.10. Limitations of the research

There are some limitations of this work that require discussion and provide an opportunity for reflection by the researcher. The main limitations identified relate to methods and study design. Primarily these include challenges of observing, retrospective nature of record reviews, sample sizes and fidelity of interview responses.

8.10.1. Challenges of observations

There were distinct challenges and limitations to using observations to capture escalation events. Firstly, this work has always made efforts to distinguish observations and not conflate this with ethnography. Ethnography was initially considered in this study and has been used in other similar research studies exploring the practice of

rescue (Mackintosh *et al.*, 2014; Mackintosh and Sandall, 2016). Ethnography as a discipline uses observations as a data collection method. Pragmatically, it was felt that the time spent observing clinical staff would not constitute a true ethnographic approach. During our study, research burden to the area under observation also needed considering. Observing healthcare workers is not without its impact into the clinical area, and staff may develop research fatigue. This can result in staff being unwilling to participate in future research, or further increase the perception of the clinicals/research divide. Therefore, a balanced approach to the hours spent observing was required.

There are gaps in the observation data which were partly discussed within Chapter 4. Observing escalation events surrounding a patient who is unwell, and deteriorating, is a very sensitive matter. For this reason, no direct patient observations were done to minimise clinical interruptions during a critical time. This resulted in 10 events where demographic data were absent from the results. During 14 escalation events, the researcher was unable to identify which escalation type had occurred and felt questioning of the clinical staff at that time inappropriate. The impact of this meant that data was not complete, however the large number of escalation events observed means that relatively small numbers of missing data will not affect the overall interpretation. What was also not collected during this phase of the study, which may have provided more insight into deterioration management, was the skills, expertise and grade of staff managing the deterioration, all of which have been shown to significantly impact failure to escalate rates (Connell *et al.*, 2021).

It was also acknowledged, through previous observation work, that the chances of capturing an escalation event were low and those that were more likely to be observed would be for low-triggering deteriorating ward patients. It was for this reason that the care record reviews were used to examine the care of patients who had higher trigger scores (EWS ≥7) to ensure data represented the more unwell ward population.

8.10.2. Retrospective nature of care record reviews

The RCRR technique is a well-used method to review and extract patient care data but it does have its limitations (Hogan *et al.*, 2012, 2014); reviewer bias and accuracy of records. It has been shown that reviewers are more critical of identical care depending on the patients outcome (Banham-Hall and Stevens, 2019). Knowing the outcome of the patient (survived or died) may unconsciously bias the reviewer to be more lenient or possibly judge care standards more harshly (Royal College of Physicians, 2016; Banham-Hall and Stevens, 2019). It was a deliberate decision to have two expert reviewers of care records, both of whom had NHS Trust training on the technique to minimise bias in results. Care scores and reviewer's judgement can also vary (Hogan *et al.*, 2012), which is why it was important to include scores and inter-rater reliability calculated (Kappa Coefficient). The emerging data from this study, whereby the care was better in the patients who died, was a very surprising finding and one that had not been anticipated. It was the care of patients who survived that were initially of interest to demonstrate what good looks like. These data contradicted early working hypotheses and therefore demonstrate a level of rigor in the data collection and care judgement process.

The sample size of the care reviews is also a potential limitation that requires discussion. The original aim of the care record review work was to identify the success factors for care of those patients that were potentially rescued and survived their trigger event. The inclusion of review of the care records of patients who died gave a qualitative comparator group. What was not anticipated as previously described was that a key finding would relate to the care of patients who died being viewed more favourably in terms of quality. If such a study was conducted again, a key recommendation would be to ensure that there were equal numbers of patients who died and survived included in the analysis. This would, however, be challenging given the low number of patients who met this criterion. For example, in Site A, the number of eligible patients scored EWS $\geq$7 and died following admission to ICU totalled n=68, whilst Site B was n=53. To ensure that the study was sufficiently powered it would be necessary to include at least a third NHS site in the study design or sample patients over a longer period of time to generate the required numbers of patients.

Another key consideration is that not all care delivered to patients is documented, and some care may be documented but not delivered (Vollam *et al.*, 2020). It is also a possibility that records can be less detailed when a negative event has occurred (Rogne *et al.*, 2019). Other studies have identified similar issues when examining the care of unwell ward patients and conclude that patient records do not facilitate tracking of all nurse decisions and actions, and any undocumented care cannot be easily captured by auditing processes (Al-Moteri *et al.*, 2019). The reviewers made a significant effort to make sure all aspects of patient notes were reviewed to give the most representative judgement for the care that the patient received. Also,

observations of escalation events, supplemented with staff interviews were utilised to ensure the resulting data were as comprehensive as possible.

Finally, the study plan for care record reviews as documented in the published study protocol initially included the collection of contextual organisation data related to staffing levels to give a greater understanding of care during the trigger event. The organisations themselves, however, admitted that the staffing data were unreliable, and they could not guarantee its accuracy due to the Covid-19 pandemic and the re-deployment of staff across the sites. One NHS Trust utilised a manually updated excel sheet for staffing, which was then completely halted for 6 months (April 2019-Octgober 2019). Limitations of care record reviews and their lack of organisational data was acknowledged early in the study design and therefore a mixed methods approach was deemed beneficial as data could be triangulated to give a more comprehensive understanding of phenomenon/context.

8.10.3. Credibility of interview responses

It is important to consider the credibility of interview techniques to give a transparent view of the data generated within the study. The aim of conducting interviews was to identify success factors to escalation of care and interviews are flexible generational methods for eliciting human issues and experiences (May, 2016). As with any type of interviews, there is a possibility that participants may not be completely open with their responses, particularly when faced with difficult subject matter. The interviews however did not focus on failure to rescue but the process of escalation and so it was hoped that participants would feel less unsure about disclosing information.

A criticism of interviews is that they can only capture reconstructions of events (Holloway, 2005) and that this may generate an artificial dialogue about people's actions, experiences and views (Knott *et al.*, 2022). ACTA is based on a collective data collection method termed Cognitive Task Analysis (CTA) and utilises simulated scenarios to assist interviewees in describing events or actions more naturally thus facilitating them in their descriptions of expertise. This supports interview credibility and generates a more comprehensive phenomenon overview.

8.10.4. Reflections on study design changes

Following the description of study limitations, it would be pertinent to briefly discuss design changes that may have improved this study. This is a reflective point for the researcher when considering future studies. Firstly, to ensure a more complete data collection during observations, CAG ethical approvals would be sought which would allow the researcher to directly observe the patient and review patient medical records without direct consent. This would ensure a more complete data collection. Secondly, more reviews of patient who had died would also be conducted to make the Survivor and Non-survivor group more equal in sample size. Patients may need to be sampled over a longer period as each Trust only had 50-60 patients who had scored a ≥7 EWS, went to ICU and died per year or through another research site. It would be pertinent to explore this data across more NHS sites, to increase the breadth of data collected. Finally, there would need some alterations in theoretical lenses applied to this work. The assumption that patients who had good outcomes were likely to have had good care has been fundamentally challenged, as patients in this study who died had higher resource care than those that survived. Furthermore, the concept of rescue

may not be limited to those patients that survive and may be present in patients who die despite success factors present in their care. This may include reducing unnecessary investigations or earlier palliation for patients unlikely to survive. These form another type of rescue and should be acknowledged positively.

8.11. Recommendations for Practice and Future Research

8.11.1. Deterioration Systems

In the Introduction chapter, a widely recognised model depicting the essential elements of escalation to a Rapid Response Team (RRT), including afferent and efferent limb activation, was described (Chapter 1, section 1.2.2.5, Figure 5). This paper has been cited 972 times and forms some of the seminal work on deteriorating systems. The data from this study raise four important questions for further research and their positions in the model are highlighted in red (see Figure 22). These are then explained using the Framework of Escalation Success Factors.

1. **How is an event or problem detected?**
2. **What are the triggers used to initiate the afferent limb?**
3. **How is the process of escalation successfully completed?**
4. **What are the system factors that affect escalation?**

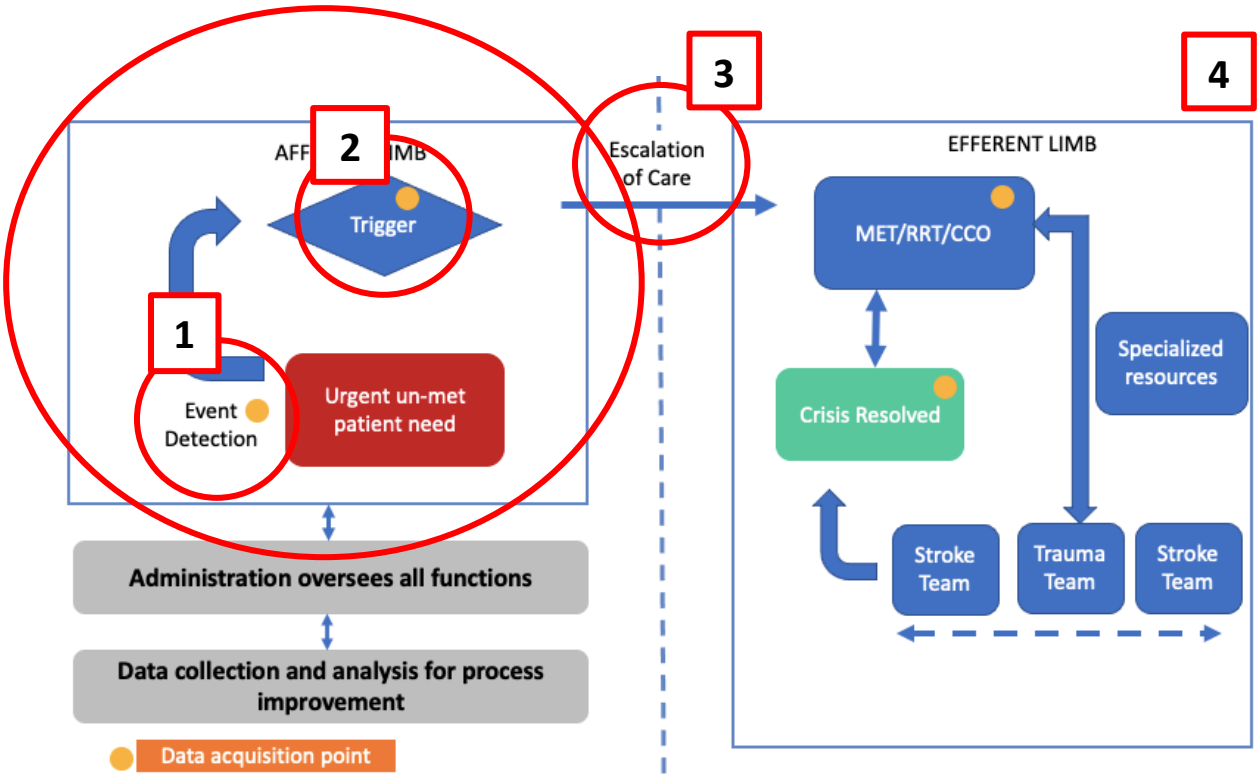

Figure 23 Adapted DeVita, et al. (2006) 'Findings of the First Consensus Conference on Medical Emergency Teams', Critical Care Medicine, 34(9), pp. 2463–2478.

8.11.2. Framework of Escalation Success Factors

A Framework of Escalation Success Factors was developed by incorporating data from this research, adopting a systems-based approach, and addressing certain limitations found in the DeVita (2006) diagram, which are described in the next section. It was developed drawing on expertise from the research team, HFE specialists, clinical staff, stakeholder and PPIE expertise. The framework may be considered as a magnifying glass, viewing escalation more broadly becoming more and more focused as one works their way through it (see Figure 23).

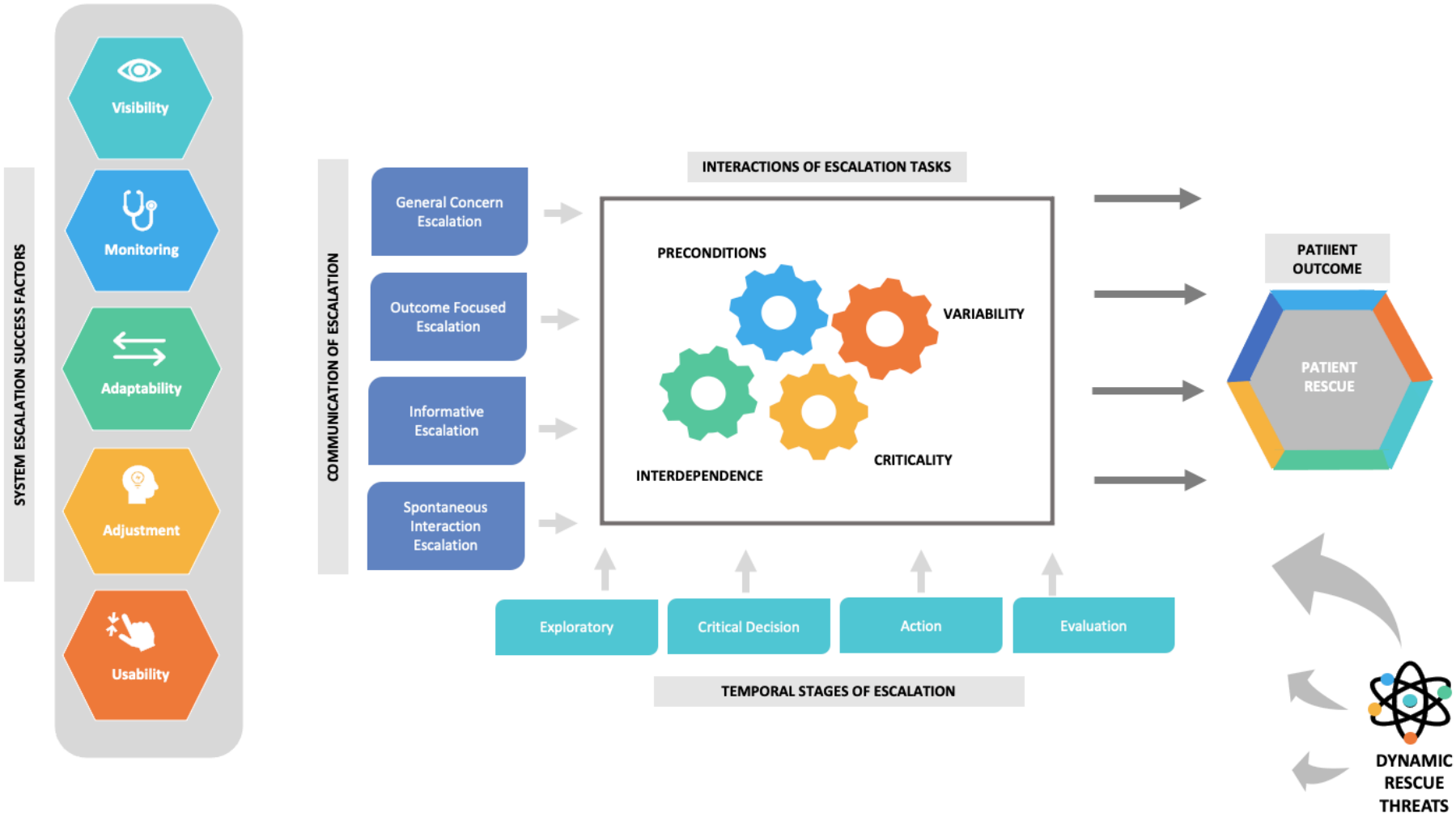

Figure 24 Framework of Escalation Success Factors

Question 1 (How is an event or problem detected?) Problem detection is closely linked to the Exploratory and Critical Decision temporal stages of escalation. WAD indicates clinical staff use ward context, staff context, patient responses to treatments, absence of improvement to alter the weighting of elements of clinical information. This fundamentally changes their significance and stimulated the critical decision to escalate. System success factors such as Visibility, Monitoring, and Usability increased the likelihood of patient deterioration recognition and escalation.

Question 2 (What are the triggers used to initiate the afferent limb?) Most of the escalations within this study preceded an alerting EWS and were not generated from a trigger score (Chapter 4). Triggers for clinical actions are variable, patient centric and based on a case-by-case basis and require staff to adjust and adapt their responses depending on context.

Question 3 (How is the process of escalation successfully completed?) Escalation is complex and communication varies depending on required outcome. Many staff members identified that the most mentally demanding tasks lack inclusion in the current national protocol and are subject to multiple interactions, such as Interdependence, Criticality, Preconditions, and Variability.

Question 4 (What are the system factors that affect escalation? Threats to rescue and escalation are constantly changing and can manifest at various escalation stages. Again, identified system success factors, Visibility, Monitoring, Adjustment, Adaptation and Usability, promote successful escalation allowing staff to improve system resilience.

8.11.3. Research priorities

Several research priorities have stemmed from the SUFFICE study. Firstly, little is understood about how clinical space design can influence the management of deteriorating patients in terms of recognition and the interventions that they receive. Secondly, the data from this study suggest that the frequency of vital signs measurements may be a nurse-sensitive indicator of patient deterioration, but supporting evidence in the literature is limited, with only two papers identified that discuss this. It is also essential that the frequency with which staff are expected to complete vital signs observations is based on very limited evidence. Finally, the proposed Framework of Escalation Success Factors, based on evidence from this research, needs further refining and testing. It is anticipated that this framework will be used to inform the development of an Organisational Escalation Readiness Tool in the next phase of this programme of research. This would be aimed at facilitating organisational assessment of their ability, and preparedness, to recognise and escalate the care of unwell ward patients. It would also serve to assess and measure the effectiveness of interventions to improve escalation against organisational domains such as audit, feedback, system redundancy and mitigations against dynamic threats.

8.12. Education

Data from this study should contribute to deterioration clinical education in three ways:

1. As a tool with which to educate students and healthcare staff on the complexity of escalation and managing deterioration. This will ensure expectations

meet reality and provide reassurance that even for the most experienced staff, caring for unwell is challenging with multiple potential failure points (section 8.3.2).

2. An awareness of risk assessments and mitigations is a skill that could and should be instilled in pre-registration training. But to do this efficiently, staff should be aware of WAD, WAI or WAP as illustrated within the HTA (Chapter 4) and FRAM models (Chapter 6) in our study. These models give a realistic and dynamic representation with which to understand healthcare processes. If teaching is based on idealised, linear processes, then this is problematic and unlikely to support clinical care delivery in everyday working conditions.

3. The cues that staff use to detect deterioration, understanding of anomaly cases and the strategies that staff use to overcome system challenges (early discussion with bed managers, treatments masking deterioration) should be integrated into education programmes. Understanding how student nurses escalate, and identifying any adaptations is valuable. Likewise, the cues that student nurses use to detect deterioration, given their clinical experience, may again be very different to staff who have had more experience with patients.

8.13. Conclusion

This study has demonstrated several novel findings in relation to escalation of care and rescue events. Firstly, this study has challenged how escalation of care is understood. It is now clear from this study that most escalations in the acute ward are not prompted by an alerting EWS and that there are four different phenotypes of escalation communication each with their own unique mechanisms and outputs. The quality of escalations between patients was found to be variable and, at times, did not adhere to

local or national guidelines. Adaptations observed revealed that trade-offs occur, whereby clinical staff are identifying sick ward patients and providing higher resource care to those that are more unwell, despite these not triggering actions in alignment with current EWS models or tools. One important finding was that patients who die, may die despite high-level quality care, and that death may not be the most effective way to learn and address improvements to care.

Escalation is multifaceted with dynamic threats to escalation that are often fleeting in nature, and which move across the process. This study has produced the most in-depth description of escalation of care in the current literature to date, specifically focusing on the interaction of escalation tasks to assist in mitigating threats. Despite workplace challenges, expert staff navigate and compensate for these dynamic issues. Ultimately, this study has provided evidence that has resulted in the development of a Framework of Escalation Success Factors. This now requires further testing within a wider clinical context to determine its usefulness in practice.

9. Chapter Nine Conclusion

9.1. Introduction

This chapter is presented in three sections: 1) original contribution to knowledge, 2) answering the original research question and 3) the conclusion. The SUFFICE data have provided greater insight into the clinical concerns surrounding patient deterioration, the process of escalation, limitations of EWS and how staff continue to escalate care despite variable hospital conditions.

9.2. Original Contribution to Knowledge

There are several important points and concepts that arise from this study, affording a greater understanding of escalation and uniquely contributing to the current evidence base. A summary of the key contributions is presented below.

i) Activation of escalation

Less than half of the escalation events observed (49%, 74/151) in this study were prompted by an alerting EWS, raising the probability that such events precede physiological indications of deterioration. A large proportion of escalations were not triggered by currently used warning systems and indicates an important gap in the evidence base. It would suggest that the detection of acute deterioration is much less reliant on scoring systems than first thought. Furthermore, this would suggest that

additional and broader system strategies to support the detection and management of patient deterioration should be explored.

ii) Theory of Escalation

Escalations are initiated through concerns, rather than an alerting EWS, and these include patient complaints, visual assessments, data generated alerts and clinical assessments. Escalation is a complex process, performed by many staff groups and this study has identified that this can require up to 32 tasks to be completed. Mapped tasks in the national NEWS2 escalation protocol differ to how escalation is clinically completed. It is complicated further by staff utilising different escalation communication phenotypes, dependent on the outcomes required and context. This is something that has not been recognised before in the most prominent escalation literature.

iii) Escalation Failure from Interdependence, Criticality, Preconditions, and Variability

Almost 60% of Survivors were not escalated according to local policy, and such failures have also been identified within other studies. However, the SUFFICE study data go further and adds to the evidence base by providing important understanding of how some failures result from weakness in preceding tasks. Furthermore, these data also revealed that escalation requires a combination of tasks, which are identified as cognitively challenging. Three of these were closely linked within the FRAM model and therefore, have a high likelihood of variability. My PhD adds to the limited numbers of studies to examine care escalation at this level of granularity.

iv) Quality of Successful Escalation

Encouragingly, most patients in our study who were escalated were found to have adequate to good care. However, a high number of Survivors were not escalated according to policy, whilst 72% of patients who died were. This finding demonstrates a nuance to a EWS score of 7, which is currently only detected by clinical staff and not fully represented within the scoring system. There were demographic differences between groups, such as the Non-survivors being older, frailer, having higher median trigger scores and more, likely to be an emergency admission than those that survived. These suggest that this group were more unwell, and may explain the higher care resource provided before, during and after their trigger. Significantly, the SUFFICE study data challenge the usual practice of predominantly reviewing the care of patients who die. The findings revealed that for this population, care was better for those that die, demonstrating staff adjusting and adapting care to meet the needs of those who are most unwell.

v) Nuance of EWS Tools Scores

Non-survivors had greater observation compliance than Survivors. These data suggest that the higher adherence to vital signs national guidelines may be a nurse-sensitive indicator in patients who die. It is feasible that this may be incorporated into future deterioration prediction models to improve performance, with only two papers identified that previously examined this concept.

vi) Environmental Influencers on Patient Outcomes

Observation data from this study suggest that certain escalation phenotypes (Spontaneous Interaction) may be shaped by clinical workspace designs. Utilising the natural experiment of having access to many different ward designs and examining care escalation within these environments can advance the exploration of potential positive or negative impacts on the deteriorating patient's ward care. When examining this within the wider literature, there is very little research found that specifically examined how the environment may facilitate or hinder patient rescue events.

vii) Actors of Escalation

The SUFFICE study highlights that there are several staff groups who can, and will, initiate an escalation if the organisation has the systems to support this. However, little is known about the role of peripheral staff such as housekeepers in escalation of care. Student nurses were observed to initiate an escalation of care and there are contributions arising from this research for educational programmes. Documenting WAD, rather than WAI, provides a much more informative understanding of the processes involved in escalating care. The complexity of escalation should be noted and relayed, as well as the identification of the key failure points through systematic process of examination. Importantly, these failure points do not remain static but rather can move along a process in a dynamic way. Finally, including in education programmes how staff navigate this complexity is important since this would detail the cues and strategies used.

viii) Deteriorating Patient Systems

The findings from this study suggest that unwell ward patients who require a review from a professional with critical care competencies are more likely to be referred to an established Outreach team. Furthermore, the introduction of Outreach enabled bolt-on services to be put in place, such as family-initiated escalation of care, which are not commonly found in organisations without an established Outreach system.

9.3. Answering the original research question

'What factors affect successful escalation and how can these be applied more effectively?'

The study results do address the research question regarding the success factors for escalation of care and how they can be applied more effectively. The findings in phase 1 suggest that success in escalation of care depends on a multifaceted approach that goes beyond relying on a single scoring system and considers organisational, social, and contextual factors. Phase 2 identified success factors present within rescue events for survivors, including Visibility, Monitoring, Adaptability and Adjustments. Findings indicate that enhancing these factors in the escalation process could lead to improved patient outcomes. Phase 3 described factors such as Interdependence, Criticality, Preconditions, and Variability, which were identified as influencing the interaction between escalation tasks. These findings highlight the importance of understanding the cognitive demands and complexities associated with escalation and suggest that addressing these will lead to more effective application of escalation protocols. Implementing these insights into healthcare systems will lead to improved patient outcomes and more efficient escalation of care.

9.4. Conclusion

This thesis has reported several novel findings in relation to escalation of care and rescue events. Firstly, this research has changed our understanding of escalation of care. Most escalations in the acute ward are not prompted by an alerting EWS and there are four different phenotypes of escalation each with their own unique mechanisms and outputs. The quality of escalations between patients is variable and often does not adhere to local or national guidelines. It is possible that these adaptations are trade-offs, whereby clinical staff are identifying sick ward patients and providing higher resource care to those that are more unwell, which is often not reflected in current EWS models or tools.

Threats to rescue and escalation are dynamic and not static. This study has generated the most in-depth description of escalation of care to date, thereby adding significantly to the existing body of knowledge. Specifically, this focuses on the interaction of escalation components to understand and mitigate for these dynamic threats. Despite these challenges, expert staff can navigate and compensate for these dynamic issues. One important point is that patients who die, may die despite high-level quality care and that death may not be the most effective way to learn and address problems in care. Finally, this study has provided evidence that has led to the development of a Framework of Escalation Success Factors; without the novel and interesting approach to examining rescue events, the data would not have been as rich, or challenge the way escalation is considered.

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Appendix 1 Researcher Reflective Piece

This piece of work was undertaken to give me a forum and a process with which to critically reflect on my own biases and assumptions when conducting the SUFFICE study. For the purposes of this piece, I will be drawing on (and adapting) the format used by Malinski and Welsh (Malinski and Welch, 2004) in their published reflective piece which relates specifically to a research study they conducted and is appropriate for this work. To ensure a theoretical approach is taken, I will explore more abstract but key elements of reflection described in the Kolb Reflective Framework (Figure 24) which include experience, reflective observation, abstract conceptualisation and active experimentation (Kolb, 1984).

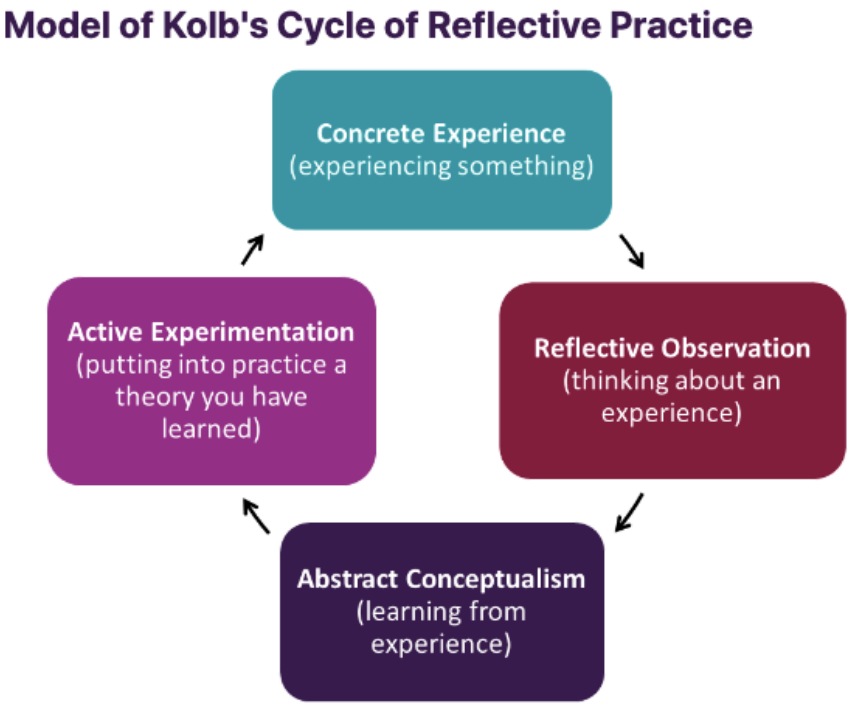

Figure 25 Model of Kolb's Reflective

The four reflective stages are as follows:

1) Concrete Experience

This stage required you to experience something. When it comes to a written reflection, this step usually involves a description of your experience and your thoughts at the time.

2) Reflective Observation

This stage required you to think about the experience. Here you will begin to reflect upon that experience. The emphasis is on you, your feelings and the links to your skills, knowledge, and prior experience.

3) Abstract Conceptualism

This stage is all about learning from your experience. It requires you to analyse and explain your reflection. Here you should focus on the meaning of your reflection and other possibilities. You can acknowledge both things that went well - and things that didn't. You may identify areas for further exploration.

4) Active Experimentation

This final stage is about putting your learning into practice. This is about translating your analysis and explanation into plans and actions moving forwards. You should ensure any goals set are specific, measurable, achievable, realistic, and targeted.

Practice

Concrete Experiences and Finding the Study Focus

I am a senior critical care nurse of over 15 years' clinical, and 5 years' research experience being an honorary critical care researcher for a large university which is where I can draw my '**Concrete Experiences'** from. I have had roles within the Critical Care Outreach Team as well as starting my nursing career as a general nurse on the general wards. I have witnessed and been a participant of many patient deterioration events. Some of which have been well managed and some that I reflect on with an element of regret and wish that outcomes could have been different. I often ask questions as to if I could have done some differently, or if I should have advocated more strongly. But when I think about patient management, events with poor outcomes, whilst more prominent, are not a true reflection of actual working life and my experience.

Because of this clinical experience and the focus of my first research department, I have designed and developed several research projects which feed into the SUFFICE study and have influenced my research interests. Early in my research career I wrote up a piece of work which was an observational qualitative service evaluation describing *barriers* to escalation of care such as chain of communication, sensitivity, and specificity of Early Warning Scores (EWS) and patient and non-patient related factors. I then completed a Qualitative Evidence Synthesis which mapped how human factors affect escalation of care. This work highlighted to me the variety and number of influences on escalation and the Human Factors that can positively or negatively affect this.

Reflective Observation

Whilst I was finding my research direction and navigating my early research career, I developed an interest in Human Factors methods. This literature described a shift in patient safety views, to what can be learnt from successful events. This was something that I had reflected on previously, that negative events whilst prominent may not represent the breadth and true reality of my nursing career. The ethos behind this view is that it seems at odds to try and measure something (patient safety) by its absence and was a point that prompted some critical reflections. An appreciation that successful events are largely unrecorded and captured within most hospital processes (such as rescuing a deteriorating ward patient) has driven me to understand how staff create safety and rescue patients from deterioration.

Abstract Conceptualisation and The Philosophical Approach to Inquiry

My approach to research has been influenced by many formative elements of my career and represents the '**Abstract Conceptualisation'**. I very much believe that nursing is both a science and an art. Driven and shaped by patient's and people's personal experiences. However, I also have a need to see data that also captures reality and methods that can represent this in a systematic way. My ICU career has taught me to evaluate and seek data to help me deliver the best care to my patients, but without losing the skill of humanisation.

Deciding on Study Methodology

It has become increasingly clear to me that I don't sit either in a purely Positivist or Post-positivist paradigm and being forced to do so makes me feel uncomfortable. The problems within healthcare that I am interested in sit in the real world, meaning they are unpredictable, chaotic, complex, and influenced by human behaviour. I have struggled with the theoretical nature of research paradigms and often fail to see how more abstract theories have real impact. I have led a pragmatic career, which is often about finding ways to make things work and being creative in the process. This is an approach that no doubt influences how I approach my research career. Given my philosophical standing, and the complexity of the problems I wish to address I decided on a mixed methods study underpinned by Pragmatism.

Active Experimentation and Study Rigor

Given my concrete experiences within the field of which I am researching, I must acknowledge the possible bias that I may carry with me into my research methods. This has been something that I had been considering since designing this study and was a question that was raised by a reviewed in my transfer viva ("How will you mitigate bias given your background?") I had been concerned that to an examiner or reviewer, that my background may be viewed to undermine or bias the quality of my observations in the clinical area or influence the way in which I interviewed clinical staff knowing I too had similar experiences to them. I set about facing this issue head on and used this as a driver for writing this reflective piece. I wanted to be open and honest about how my experiences have shaped me and my research and provide a transparent document which describes this.

Bias was an ever-present factor in my mind so I was forever testing myself and my approach for any signals that this may be present (**Active Experimentation**). I was tuned in to how this was, may and could affect my research journey. I used a reflective strategy which was to always "make something strange" and to ask "why" three times. This ensured that I considered all elements of what I had witnessed and dismissed nothing as unimportant. The three "whys" forced me to get a deeper understanding of behaviours and events which went beyond my own thoughts. To answer the third why, I would ask staff I was observing to explain. Having been slightly fearful of this possible bias I began to see how my background, insight and experiences may also help in my research. This lived experience of my phenomena has often given me greater insight into the discussions and events observed often being able to detect minute details. This may have also made participants more open to disclosing information or concerns. Another clear benefit was that I was able to remove myself from situations which I deemed sensitive or stressful for clinical staff, reducing any negative of my presence within the clinical setting.

Conclusions

The research journey has taught me many things about myself, the world of academia and the real world. At first, the process appears to be rigid and unforgiving. In my opinion, for research to be successful it needs to be flexible and creative to ensure its ability to navigate real world problems. The philosophical underpinning of research is as much about the research as it is about the problem under investigation and using methods that work for that context for that group of people. The research process is about matching philosophy, theory, and the real world to create a harmony of science.

My awareness of my own possible biases, allowed me to develop a framework, addressing some of my concerns.

Appendix 2 Examples of populated Case Report Forms

	A	B	C	D	E	F	G	H	I	J	K	L
1						Observation Type		Soft Signals used	Soft signals used	Soft signals used	Escalation linked to protocol	
2	Escalation event number	Is patient Covid-19 +VE	Is Covid-19 pathophsyiology present?	Was EWS used to intitiate escalation?	Trigger score	Routine	Reactive					Reason for escalation
3	RTH001P1											
4	RTH001P2											
5	RTH001P3											
6	RTH001P4											
7	RTH001P5											
8	RTH001P6											
9	RTH001P7											
10	RTH001P8											
11	RTH001P9											
12	RTH001P10											
13	RTH001P11											
14	RTH001P12											
15	RTH001P13											
16	RTH001P14											
17	RTH001P15											
18	RTH001P16											
19	RTH001P17											
20												
21												
22												
23												

Figure 26 Categorised and Quantitative Data Collection Form

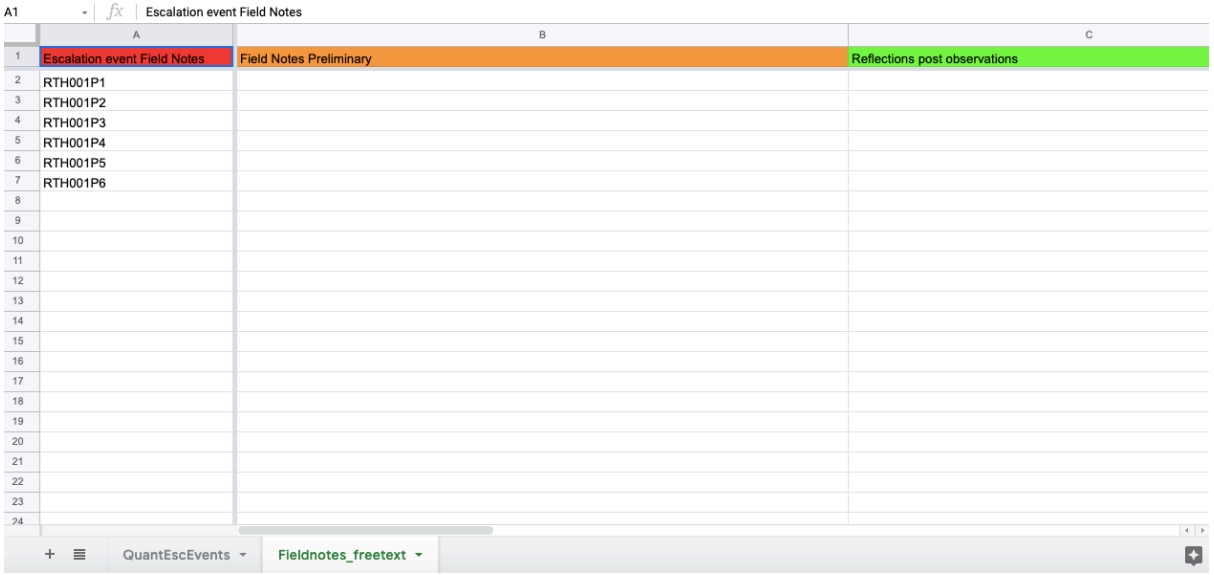

Figure 27 Phase 1 Qualitative Narrative Data Collection Form

A	B	C	E	H	J	K	M	O	P	R	S	T	U
Patient study	Include_Excl	Time from ad	Trigger score	LOS	Age	Covid-19 pos	Gender	Home Team	Admission Dx	PmHx	Charleston C	CFS	MMS score (t
RHW002P2	Include	5.025405093	8	18.09865741	75	Not Detected	Female	Surgical	Hartamnns proc	COPD, Anxiety	4	4	7
RHW002P6	Include	2.079143519	7	5.11	64	Not Detected	Male	Surgical	Cholecystitis	Diabetc, HTN, sa	2	1	7
RHW002P17	Include	5.03	8	18.1	75	Not Detected	Female	Surgical	Elective reversal	Hartmanns, Dive	4	4	7
RHW002P20	Include	6.5	8	14.9	28	Not Detected	Male	Surgical	Traumatic pancr	Nil	0	2	7
RHW002P21	Include	23.57	9	35.11	81	NULL	Male	Medical	CAUTI	AF, CKD, Cystect	6	4	7
RHW002P22	Include	2.21	8	11.37	40	Not Detected	Female	Surgical	Cholecystitis	Nil	0	1	7
RHW002P23	Include	1.16	9	7.67	41	NULL	Male	Surgical	Abdo pain	Obesity, sleep ap	0	6	6
RHW002P24	Include	0.96	7	20.69	25	NULL	Male	Surgical	Pancreatitis	ETOH	0	4	7
RHW002P25	Include	2.12	7	9.35	72	Not Detected	Male	Surgical	Hatmanns proce	Colorectal cance	5	4	7
RHW002P26	Include	2.11	7	5.23	58	NULL	Male	Surgical	Elective hernia r	Astma, bronchie	2	2	7
RHW002P29	Include	5.35	8	6.43	70	Not Detected	Male	Medical	Haematuria	Nephrectomy, TU	5	4	7
RHW002P32	Include	3.21	7	6.03	71	NULL	Male	Medical	Meck pain	IHD, MI, asthma	4	2	7
RHW002P34	Include	2.19	7	9.17	56	Not Detected	Male	Surgical	Pancreatitis	HTN, BPH, TB	0	2	7
RHW002P35	Include	2.28	7	7.83	54	NULL	Male	Surgical	Abdo pain	Mesenteric thro	3	2	7
RHW002P40	Include	2.02	7	16.45	56	Not Detected	Male	Surgical	Intestinal Volvul	Learning difficult	1	4	7
RHW002P65	Include	3.64	8	17.06	30	Not Detected	Female	Surgical	MRCP	Cholangitis, CBD	0	2	7
RHW002P66	Include	12.86	7	38	77	Not Detected	Male	Medical	CAP	AF, vasculitis, HF,	7	6	6
RHW002P72	Include	3.54	9	5.78	34	DETECTED	Male	Medical	Liver disease	ETOH, Hep C	3	5	7
RHW002P74	Include	2.12	7	11.37	40	Not Detected	Female	Surgical	Elective CBD exp	Sphincterectomy	0	2	7
RHW002P76	Include	2.01	8	20.6	68	NULL	Male	Trauma	Infected r knee p	Astha, Dperessio	2	4	6
RHW002P78	Include	2.6	8	18.09	55	Not Detected	Female	Surgical	Deterioration po	Tongue scc,	3	3	7
RHW002P83	Include	12.97	7	22.15	51	Not Detected	Male	Medical	Stem cell transpl	Lymphoma, DVT	3	4	7
RHW002P84	Include	2.34	7	14.83	60	NULL	Female	Surgical	Pancreatitis	Hiatus hernia, ep	2	2	7
RHW002P85	Include	6.5	8	14.9	28	Not Detected	Male	Surgical	Haemorrhage of	Nil	0	4	7
RHW002P86	Include	2.14	8	11.08	66	NULL	Female	Medical	Intermitten feve	T2DM(no tabs), t	4	4	7

Figure 28 Excerpt from Retrospective Care Record Review Descriptive data case report form

24 hrs pre-tri	Rationale for care grading	Trigger event a	Rationale for care grading	>24hrs	Rationale for	Trigger_Event_R	Overall care sco
4	Admitted for Hartmanns prcedure.	4	triggered and referred to ICU outreach. Reviewed again by physio	4	Trigger even unr	Nil	4
4	Admiiited for cholecystitis and AF. Had interventional drainag	4	On co-amoxiclav and given gent in the morning for suspected seps	4	Trigger event re:	31/10/2020 17:17	4
		4	Obs not checked within 1 hour.	4	Trigger event re:	17/09/2020 06:12	4
4	Admitted following a punch 12 days ago. Abdo shows liver he:	4	Obs checked within 1 hour and reviewed medically within 1 hour. r	4			4
3	26/11: TURBT 11/12: Left ureteric stumpectomy 17/12: repea	3	Obs checked regulalry overnight. Seen by medic am (06:00) first de	4	trigger resolved	21/12/2019 01:18	3
4	13/1: Elective lap CBD exploration + cholecystectomy (gallstor	4	Obs checked within 1 hour. Nursing handover documentation Patie	4	Trigger event re:	15/01/2020 21:50	4
		3	Obs not rechecked within 1 hour. Received patient's care by day staff. Patient was met alert and oriented. On cpa				3
3	Patient admitted on the 01/11 with history of 1 day sudden o	4	VBG [/] IVI [/] IVAbx. Seen by ICU no evidence of sepsis. Obs not ch	4	Trigger episode resolved by 10/11/20		4
		4	Obs checked within 1 hour. Seen prior to trigger event by reg due	4	Trigger event reoslved by 22/11/201		4
3	Elective open incisional hernai repair (midline laparotomy and	3	Obs not checked within 1 hour. Desaturating throughout the morr	3	Trigger event resolved by 20/12/201		3
4	23/11/2019 - Admitted through A&E with 3way cathetehr blo	4	Obs rechecked within 1hour.	4	Trigger event reolved by 29/11/2019		4
3	Admitted with a lump in neck.	3	Obs checked within 1 hour. Seen by CCOT within 1 hour. ABG [/] IV	3	Trigger event resolved by 09/12/201		3
3		3	Obs not checked within 1 hour. Review within 1 hour of EWS. Note	3	Trigger event reoslved by 22/12/201		3
4	Hartmaans procedure for perforated bowel and ressection of	4	Obs checked again within 1 hour. Seen by medical FY1 who went o	4	Trigger event resolved by 27/12/201		4
3	Recurrent volvulus.	3	Obs checked within 1 hour. Patient taken over in bed. Appears co	3	Trigger event resolved by 29/01/202		3
3	Ascending cholangitis Cholecystectomy in 2015 Impacte	3	Patient shivery-set of observations taken and patient spiked temp.	3	IVABx [/] IVF [/] o2 [/] BC [x} UO [/]		3
4	dmitted following a rapid decline in his renal function. This AK	4	Obs not checked within 1 hour.	4	Trigger event resolved by 01/11/202		4
3		3	Obs not checked within 1 hour. Seen by Outreach based on previou	3	Trigger event re	olved by 18/01/202	3
4	13/1: Elective lap CBD exploration + cholecystectomy (gallstor	5	Obs checked within 1 hour. IVABx [/] VBG [/] BC [/] IVF [/] o2 [/] UC	4	Triggger event resolved by 17/01/20		4
4	B - Admitted on the 28/11 after a 2 day history of severe right	4	Obs checked within 1 hour. Seen medically within 1 hour. Referrec	4	Trigger event resolved by 3/12/2019		4
4	04/12/2019: Admission into xx after week 5 of chemoradiothe	4	Code red call early am. Obs checked within 30 minutes. Observatic	4	Trigger event resolved by 09/12/201		4
4		3	Obs checked within 1 hour. has been unwell today but reports tha	4	Trigger event resolved by 09/09/202		4

Figure 29 Excerpt from Retrospective Care Record Review for Quality-of-Care judgement and qualitative data

Overall Care Assessment	Sepsis considered?	Sepsis 6 completed (1 1, 0=0)	Missing Sepsis 6 criteria	ICU Support	Good documentation	Good planning	Relative involved in care	Observations checked within 1 hour	Escalation protocol followed	Patient re-reviewed by medical team
0	1	0	BC	1	0	0	1	1	1	1
4	1	1		1	1	1	1	1	1	1
4	0	0		1	1	1	1	ICU	1	1
3	0	0		1	1	1	1	1	1	1
4	1	0		1	1	1	1	0	1	1
4	1	1		1	1	1	0	1	0	0
4	0	0		1	1	1	0	1	1	1
4	1	0	UO	1	1	1	0	1	1	1
4	1	1		1	1	1	0	1	1	1
4	0	0		1	1	1	1	1	1	1
4	0	0		1	0	1	1	0	0	0
4	1	1		1	1	1	1	0	0	1
4	1	1		1	1	1	0	1	1	1
4	0	0		1	1	1	1	1	1	1
4	0	0		1	1	1	0	1	1	1
4	1	0	UO	1	1	1	1	1	1	1
3	0	0		1	1	0	1	0	0	1
4	0	0		1	1	1	0	ICU	0	1
4	0	0		1	1	1	1	0	0	1
1	1	1		1	1	0	0	0	0	1
4	1	1		1	1	1	0	1	1	1
3	0	0		1	1	1	0	0	0	1
3	1			1	1		0	0	0	0
4	0	0		1	1	1	1	1	1	1
2	1	0		1	0	0	0	0	0	0
3	0	0		1	1	0	1	0	0	1

Figure 30 Excerpt of CRF

Appendix 3 Phase 2 Notes Review Screening SOP

Purpose

The aim of this Standard Operating Procedure (SOP) is to clearly define the screening procedure for medical records during the SUFFICE study. The purpose of the screening is so that notes reviewed contain a genuine rescue event from which learning can be made.

Target population:

1. define participants for notes review as "severely unwell patients who are not transferred to ICU and do not die in hospital". Also exclude patients with DNACPR in place
2. "severely unwell" defined as NEWS $\geq$7 at any point during their admission

Method

Rules	Rationale	Include or exclude
Admitted between 1st November 2019- 31st October 2020	Aim to capture consecutive admissions Will cover seasonal variation Aiming to capture Covid-19 patients	Include
All patients admitted to OUH and RBH	Chosen research sites	Include

Adult patients	Inclusion criteria state Adult patients 18 years or over Exclude all children as not appropriate to the research question Ethical approval for adults only	Include
IT screening by ward	ED, Theatre. Critical care, CICU, AICU, PICU, HGH Critical Care	Exclude
Were on specialist wards or HDU including: ED Maternity Gynaecology Theatre direct Day case Palliative care Stroke ward Radiology Cardiology wards/lab HDU Theatre recovery Transfer lounge Neuro	High care wards may have different escalation protocols (may be on respiratory ward but not in HDU area) Specialist wards (gynae) not generalisable to general hospital population Stroke wards likely to have care limitations in place Neuro wards have patients that are very specialised, and results would not be generalisable Inclusion criteria state medical, trauma or surgical hospital population	Exclude
Patients triggering 7 or above Early Warning Score	NEWS or above likely to warrant an ICU admission or review If not admitted to ICU, then likely an indication of adequate illness ward management (rescue event)	Include

Incomplete observation sets	Only consider complete observation sets	Exclude
Patients who were not admitted to ICU (following trigger event)	Aiming to not confound rescue event with an ICU admission Would be unable to confidently say rescue was because of good ward or good ICU care	Include
Survived to discharge	Aiming to remove patients who didn't go to ICU because they were not appropriate and were nearing the end of their life This would not be a rescue event but a tolerance of deranged physiology and therefore not escalated or for full active treatment	Include
Died within 1 month of trigger event	Indicates a level of frailty which may not have resulted in full active treatment	Exclude
DNACPR at time of trigger event	This would not be a rescue event but a tolerance of deranged physiology and therefore not escalated or for full active treatment	Exclude
Had a defined ***rescue event***		Include

Appendix 4 Data Extraction Rules

Variable	Source	Interpretation rules
Age at hospital discharge	Recorded on ICU discharge documentation or calculated from date of birth	n/a
Sex	Record in medical record	n/a
Admission diagnosis	ICU admission form	Surgical – required surgery prior/during ICU admission Medical – no surgery required Trauma – admitted with trauma-related problem
Type of admission	Medical notes	Emergency (Acute presentation) Elective (pre-booked medical procedure)
Length of ICU/hospital stay **Days to death**	Recorded in medical record (electronic or paper)	n/a
Trigger event	Vital signs charts	First episode of a EWS score ≥7
Referral to ICU	Medical and nursing notes	n/a

Suspicion of sepsis	Medical and nursing notes, discharge coding,	Documentation of sepsis codes or documentation that suggests sepsis
Sepsis 6 completed **All aspects of sepsis 6 completed or considered:** **Administer oxygen (or SpO_2 above 94%)** **b) Take blood cultures** **c) Give IV antibiotics**	Medical and nursing documentation, laboratory data, drug chart, fluid balance chart. Documentation of the missing element is required. One patient may have two or more missing elements.	Oxygen saturations of >94% on vital signs chart; oxygen administered if saturations below 94% in nursing notes unless otherwise indicated b) Documentation in medical notes of cultures taken; cultures documented in laboratory tests c) Documentation in medical notes of antibiotic prescription; antibiotic prescription on drug chart

d) Give IV fluids (if hypotensive or plasma lactate concentration >2mmol/l) **e) Check (serial) lactate concentration.** **f) Measure urine output**		d) Normotension on vital signs chart; documentation of IV fluids given in nursing notes; documentation on fluid balance chart of IV fluid bolus e) Lactate measurement documented in medical notes, arterial or venous blood gas result documented f) Urine output documented on fluid balance chart
Manchester Mobility Score (to represent baseline)	Medical and nursing documentation	This should not represent trigger event but represent the best baseline "normal for that patient". May be based on pre-morbid status,

		but likely pre-discharge mobility
Clinical Frailty Score	Medical and nursing documentation, Frailty team assessment	If score is not present, then extrapolate using nursing sources. Check best fit with two documentation sources. Frailty score should be based on
Charlston Co-morbidity Index	Medical and nursing documentations, Frailty team assessment, discharge letter	Use CCI descriptions for each co-morbidity. Calculated using CCI calculator.
Braden score	ED initial adult assessment, nursing notes, dietetics assessment	If score is not present in ED docs, then extrapolate using nursing sources. Check best fit with two documentation sources
Definition of medical re-review	Seen by medical team within 4 hours of initial trigger event for evaluation	
Good documentation	Medical, Nursing and AHP documentation, observation charts, fluid balance,	This is a judgement made by reviewer taking into consideration multiple

		elements of the care record including completeness, detail compared to event severity, observation, indication of clinical judgement
Relative involved with care	Medical, Nursing and AHP documentation,	Evidence of communication with relatives or friends, visiting, call for concern
Delay to recognise deterioration contributing to trigger event	Preceding abnormal vital signs prior to trigger event that would warrant concern in context (judgement)	
Site A Definition of Escalation compliance	Medical review within 1 hour ***and*** Re-check of vital signs within 1 hour	
Site B Definition of Escalation compliance	Ward staff must refer all patients with a NEWS of 7 and above to Outreach or ICU	
Success Factor	A mechanism or context which has been judged to	May include (but not limited to)

	have contributed to the avoidance of an ICU admission, reversal of trigger event. These are clinical judgements based on the available data within the medical notes.	Patient surveillance Demonstration of expertise Predicting, noticing, problem detection Anomaly cases Organisational systems

Appendix 5 ACTA Interviews Participant Sampling Matrix

Interview Number	Female	Male	Years clinical experience	Surgical	Medical	Trauma	Critical care	General	Age <40years	Age >40years	Nurse	Physio	Doctor
1	X		5	X					X		X		
2	X		7	X					X		X		
3	X		5	X					X		X		
4	X		19	X						X	x		
5		X	3.5						X			X	
6	X		5		X				X		X		
7		X	8	X					X		X		
8		X	25				X			X	X		
9	X		30				X			x	X		
10	X		9					X	X				
11	X		7					X	X		X		
12	X		14					X	X		X		
13		X	11		X				X				X
14	X		4		X				X		X		
15		X	5		X				X			X	
16	X		37		X					X	X		
17	X		10		X						X		
18	X		4								X		

19	X		38							X	X		
20	X		7						X			X	
21	X		8						X		X		
22	X		6						X		X		
23		X	6						X			X	
24	X		11		X				X		X		
25	X		15		X				X		X		
26			7		X				X		X		
27			11		X				X		X		
28			7				X		X		X		
29			10	X					X		X		
30			24		X					X	X		

Appendix 6 Data Management Plan

A data management plan created using DMPonline.

***Creato**r: Jody Ede*

***Affiliation**: University of Plymouth*

***Study**: The SUFFICE Study*

***Ethics Ref:** HRA-20HRA/3828; CAG-20CAG0106*

Data Collection

Description of data and analysis

Data for SUFFICE will be generated from 4 key study phases: Phase 1 Escalation events observations, Phase 2 Retrospective Care record reviews and Phase 3 Clinical staff interviews and Phase 4 Data Integration and data analysis.

Phase 1 Escalation event observations data

Phase 1 Observation and informal interview data will centre on capturing escalation of care events and the process of rescue in the deteriorating ward patient. Data will include (but not be limited to) i) triggering patient factors: for example, age, Covid-19 status, admission reason, length of stay, Clinical Frailty Scale (derived from speaking to staff) ii) escalation event data: for example, time of escalation, the reason for escalation, time to review, management plan iii) contextual organisational data: for example, grade, profession or education level of the referrer, ward Shelford Safer Nursing Care Tool (SNCT), seniority of nursing and medical staff and Covid-19 status of ward. SNCT data, giving an indication of ward staffing levels and ward acuity or dependency, will be collected for wards where escalation events are witnessed. This data will be linked to the qualitative account of care during escalation.

Each escalation event witnessed will be allocated a study number using the system

Site of data collection-RTH Oxford or RTW Reading

Study number: 001 for event number 1

Phase identifier: P1-Phase 1, P2-Phase 2, P3-Phase 3

Combined study identifier=RTH001P1 (Oxford, Phase 1, Event 1)

Ad Hoc questions and qualitative data will be annotated during observation sessions. These data will give a rich insight into the escalation process and factors affecting it. No identifiable data will be collected. We will also collect staff contact details for potential participants for Phase 3 staff interviews which will be kept strictly confidential.

Descriptive statistical analysis will include (but not limited to) patient factors collected using the Charlson Comorbidities Index (CCI) tool and the Clinical Frailty Scale (CFS) (Wallis *et al.*, 2015). For continuous data (includes but not limited to) triggering patient factors, escalation data and contextual organisational factors) mean and standard deviation will be calculated. For categorical data (includes but not limited to) escalation type, organisational data), number and percentage will be reported. This will provide context with which to analyse the qualitative data and identify patterns within and across data collection settings.

Phase 2 Retrospective Care Records Review data

Up to 400 care records will be reviewed from ward patient admissions (350 records from patients who survived and 50 records from deceased patients). Each care record review will be allocated a unique study identifier using the above system. In a Level 1 care review, care will be portioned into care time segments (24 hours before trigger event, 24 hours around trigger event and 24 hours post trigger event). Each time segment will have the quality of care graded by the reviewer allocating scores, from 1-5 (1-Very poor care, 2-Poor care, 3-Adequate care, 4 Good care, and 5- Excellent care) (n=350). Safer Nursing Care Tool (SNCT) data will be used to give greater contextual information surrounding each patients' trigger event (see phase 1 methods for tool description). Descriptive patient data and care data for trigger event collected during the Level 1 review will centre around i) patient factors- collected using the Charlson Comorbidities Index (CCI) (Roffman *et al.*, 2016) tool which is extensively used and is validated for standardising comorbidities extracted from care records and the Clinical Frailty Scale (CFS), a validated tool predicting hospital outcomes based on frailty scores suitable to collect data in the notes review process ii) escalation event data- reason for trigger or escalation, trigger score.

Data for Level 2 reviews (In-depth reviews) will generate in-depth chronological accounts of Covid-19 and non-Covid patient care, deterioration management, timings/details of interventions and EWS (pre/post event). A proportion of notes reviews will be conducted on deceased patients to provide a comparator and context to rescue success factors (see Appendix 5).

Phase 3 Staff interviews data

Each interview will be allocated a unique study identifier as above. Qualitative interview accounts of staff experiences when detecting, communicating, or managing an escalation event. See data collection for full interview method.

Phase 4 Data Integration and data analysis

This mixed methods study will utilise multiple analysis techniques on both qualitative and quantitative data. Data from each phase (Phase 1, Phase 2, and Phase 3) of data collection will be analysed in steps. Step 1 analysis includes a preliminary analysis (likely one month into data collection or when one third of the data is collected) and step 2 involves an analysis following data collection completion. The third key step of data analysis in mixed methods studies is the 'mixing of data' (Creswell and Plano Clark, 2011) during a data integration phase. It is possible however that the data analysis method may evolve as data emerges through the study (Dixon-Woods, 2011) and this plan provides an initial guide.

A Framework Analysis method was chosen as a thematic analysis method to compliment a framework analysis variant in Phase 3 Applied Cognitive Task Analysis. This is an increasingly popular method in applied research and has many advantages over other qualitative analysis methods such as providing a clear structured output in the form of a Coding Matrix (Gale *et al.*, 2013). Framework Analysis is traditionally applied to interview data but can also be applied to observational and textual data such as diaries (Pope, 2000; Gale *et al.*, 2013). It was felt that a coding matrix would allow ease of comparison across data sets and within case data. There are 5 key steps to be taken within a Framework Analysis (Ritchie, J. & Spencer, 1994) are

- Familiarisation
- Identifying a thematic framework
- Indexing (selecting the interesting fragments-coding)
- Charting/Summarising (key difference between this and content analysis) Tell the story of those fragments
- Interpretation

It is likely that qualitative data will be entered either into an excel spreadsheet or into a qualitative coding programme such as NVivo software.

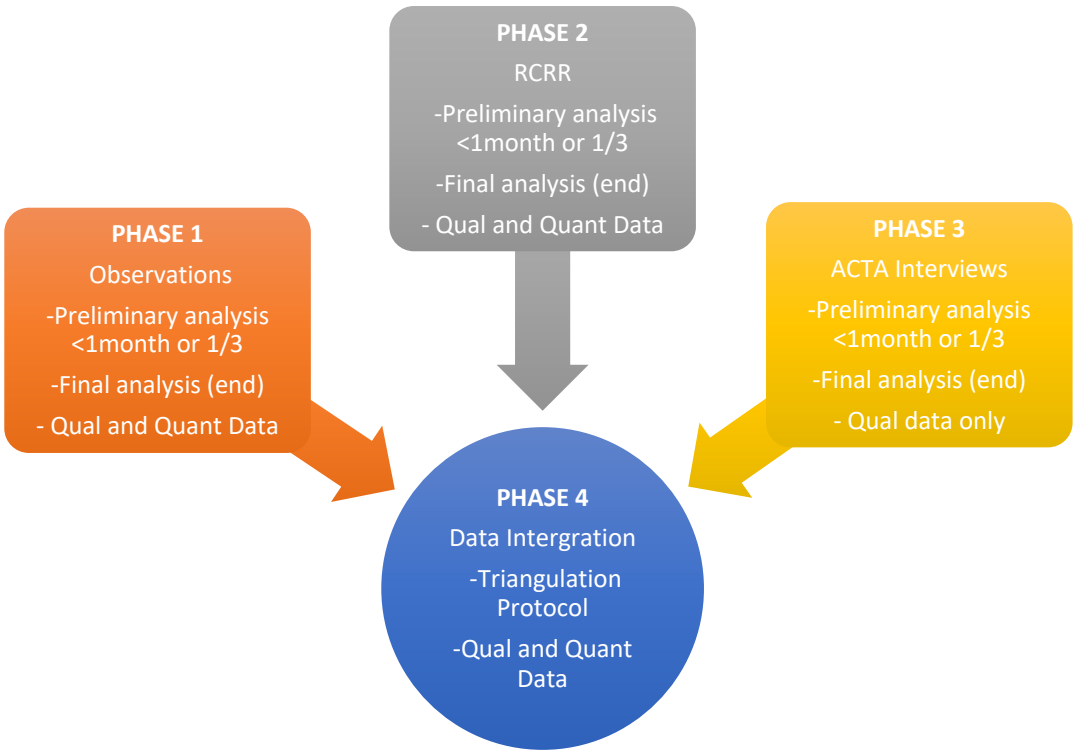

Figure. 1 Detailing the three key stages of data analysis for all four study phases.

Data Collection

Phase 1 Escalation event observations data

I will utilise non-participant observations to capture between 200-400 escalation of care events, in Covid-19 negative and positive patients, to understand interactions between doctors and nurses in hospital wards, their clinical input during an escalation event, identify event success factors and compare rescue events for both groups of patients. Observation sessions will be conducted for no longer than 4 hours at a time, but participants may be observed on multiple occasions. I will use observations to collect data on how often escalation occurs, how staff decide to escalate and how patient illness is managed. Fieldnotes data will be anonymised and entered into fieldnotes using an electronic, password protected device.

Stage 2 Retrospective Care Records Review data

I will review care records (including nursing and medical documentation) of up to 350 ward Covid-19 positive and negative patients, who improved and did not need to be admitted to the intensive care unit. This may indicate aspects of care contributed to the patient's condition improving (success factors). I will decide if a patient's care was good or poor and what success factors were present, by using a data collection tool used in NHS care reviews (Royal College of Physicians, 2016). I will also look at several care records (Up to 50) for ward patients who became unwell, were admitted to the intensive care unit, and died (giving a total of between 200-400 care record reviews). This will allow me to identify differences in

care in patients who survive or die following an unwell episode. This is an integral methodology to utilise to understand the care and outcomes (survival and death) for both Covid-19 negative and positive patients during a deterioration and rescue event. Data will be anonymised and entered into fieldnotes using an electronic, password protected device.

Phase 3 Staff Interviews data

I will talk up to 30 expert doctors and nurses to identify how they achieve escalation of care, what are escalation success factors in Covid-19 positive and negative patients, and how these could be applied effectively in healthcare. The interviews will be conducted either face to face or telephone. To ensure adherence to social distancing rule during the pandemic, telephone interviews will be encouraged. The interview process follows a topic guide (designed in collaboration with Rob Hutton- ACTA author) based on original interview guides (Militello and Hutton, 1998). The interview topic guide may iterate (Piper *et al.*, 2018) once data from Phase 1 and Phase 2 have been analysed. The topic guide focuses questions on specific areas of clinical expertise used in care escalation. Interviews may last up to 90 minutes and digitally recorded. I will also explore the results from the first two stages during the interviews to enable greater understanding of these data. Data from interviews will be transcribed and anonymised. The interview schedule is as follows:

***Task diagram*:** Participants are asked to list six key escalation tasks. Aims to get the interviewee focused on escalation tasks and creates a process map (ordered diagram of escalation).

Knowledge Audit: Identifies how expertise is utilised during escalation. Escalation questions are organised around expertise categories: diagnosing, predicting, situational awareness, perceptual skills, workarounds, improvising, meta cognition and recognising anomalies (Militello and Hutton, 1998)

Simulation Interview*: The* Interviewee is posed an escalation of care simulation (like one that may occur in clinical practice). The simulation allows the participant to enter a “character” which may then prompt clinical expertise, which may be otherwise difficult for the participant to recall or interviewer to elicit.

Phase 4 Data Integration and data analysis

See above for details.

Documentation and Metadata

Data interpretation manual

A data interpretation manual gives definitions of data collected and analysed within this study and will be contemporaneously completed as the study progresses. This

document will be used during the data collection, to ensure consistency in interpretation of phenomena of interest and elaborate on terms or phrases for example:

Escalation of care*: any communication relating to the recognition of patient deterioration*

Outlier**:** *any patient who is cared for on a ward not normally associated with their lead medical team (i.e., a medical patient on a surgical ward)*

Quantitative Data dictionary

A data dictionary identifies variables to be collected during the study and units to be measured or recorded. This is to ensure that the data collection documentation is accurate, consistent, and replicable.

Decision audit

A decision audit will be completed which details the key decisions made about study methodology or other governance or financial issues. This will detail the date of the decision, decision label, rationale for why that decision was made and the member of the team (supervisor or student) who made that decision. Decisions will be grouped into pre-study, data collection, analysis, and dissemination.

Coding Audit

A coding audit will be completed during the analysis of the qualitative data to enhance confirmability (results are reflective of the source data). This will detail coding decision made by individual coders or decisions made by consensus. Broadly this will consist of the coding process, evolving codes into themes, why some codes were linked and why they formed the basis of that theme.

Ethics and legal compliance

Consent

Phase 1 Escalation event observations

Staff will be notified of the study through prior correspondence (invitation email), have access to the study Participant Information Sheet and in which they may choose to opt-out from being observed. Participants will be allowed as much time as wished to consider the information or other independent parties to decide whether they will participate in the study and relatives will be informed about the

study through posters displayed on the ward, and personal explanations by the researcher and / or nurse being observed where relevant.

Staff who demonstrate an interest in participating in the study, will have written versions of the Participant Information Sheet and Informed Consent presented to them detailing no less than: the exact nature of the study; what it will involve for the participant; the implications and constraints of the protocol; any risks involved in taking part. It will be clearly stated that the participant is free to withdraw from the study at any time for any reason without prejudice, and with no obligation to give the reason for withdrawal. Staff participants being shadowed for Phase 1 must sign and date the latest approved version of the Informed Consent form. A copy of the signed Informed Consent will be given to the participant. The original signed form will be retained at the study site. The research team member who obtained consent must be suitably qualified and experienced and have been authorised to do so by the Chief/Principal Investigator.

It is possible that whilst shadowing medical staff and observing an escalation event, nursing or allied health professionals will also need to be observed and verbally consented. This is to ensure the collaborative process of rescue is captured within the data. Consent will be assumed for staff having who have had access to the study PIS and invitation email and who have not specifically asked to Opt Out of the observations. Nursing or AHP staff that are observed (as part of the observations) will be asked to provide verbal agreement to being observed on initial contact (during an escalation event) so as not to interrupt the clinical workflow when managing a deteriorating patient. This will be done out of professional courtesy and to ensure that staff feels empowered to stop the observations if they so choose.

No personal information will be collected from or about staff or patients during the observations. If a staff member wished to participate in the staff interviews for Phase 3, contact information will be collected and stored in a password protected document and destroyed 3-6 months after the study has ended. All other data will be kept for a minimum of 5 years as per GDPR regulations.

Phase 2 Retrospective Care Records Review

Survivors: To answer the research question, this study requires a significant number of patient episodes. The group of patients whom this study is seeking to understand are patients whose outcomes are required as part of the eligibility criteria (i.e., score a 7 and above on an EWS, not been admitted to ICU and survived to hospital discharge). Data extracted from medical documents during the review will be anonymous and patients will not be identified. There is also an urgency to compare rescue events in both Covid-19 positive and negative patients. We are currently unsure how (Covid-19) patients are detected as deteriorating, how

mental models of illness (patterns of deteriorations) differ for these patients and how their deterioration is managed. Lessons from these patients may be applied to non-Covid patients superseding safety process currently in existence. Confidentiality Advisory Group (CAG) approval will be sought to allow for researcher access to patient notes. Data extracted from notes will then be anonymised, summarised, and stored securely.

Deceased: It is not possible to obtain consent from deceased patients for access to their medical records. Approaching next of kin has the potential to cause distress and concern. Additionally, the Confidentiality Advisory Group acknowledge that consent by next of kin is not valid where they are neither the legal personal representative nor the person administering the estate. It would not be practicable to ensure contact with only these representatives.

Phase 3 Clinical Staff Interview

The Staff participants for Phase 3 must personally sign and date the latest approved version of the Informed Consent form before any study-specific activities are undertaken. Written and verbal versions of the Participant Information Sheet and Informed Consent will be presented to the participants detailing no less than: the exact nature of the study; what it will involve for the participant; the implications and constraints of the protocol; any risks involved in taking part. It will be clearly stated that the participant is free to withdraw from the study at any time for any reason without prejudice, and with no obligation to give the reason for withdrawal.

The participant will be allowed as much time as wished to consider the information, and the opportunity to question the Investigator, or other independent parties to decide whether they will participate in the study. Written Informed Consent will then be obtained by means of participant dated signature and dated signature of the person who presented and obtained the Informed Consent. The person who obtained the consent must be suitably qualified and experienced and have been authorised to do so by the Chief/Principal Investigator. A copy of the signed Informed Consent will be given to the participant. The original signed form will be retained at the study site.

Phase 4 Data integration and data analysis

As above.

Participants risks and burdens

Phase 1 Escalation event observations data

Risks: There are no participant risks in taking part in this study. It is possible that poor care may be identified that will require escalating through the correct clinical governance channels. This will be made explicitly clear in the PIS and will be revisited at the time of consent. The time from the point of contact to the actual observation session will be as short as possible.

Burden: Participant's time-burden when being observed by a researcher will not be insignificant. This will be made explicitly clear in the PIS and will be revisited at the time of consent. The researcher collecting the data is a very experienced ICU nurse in both clinical and research terms and will make it clear that participants can request that the observations be put on hold, ask the researcher to move away or stop altogether at any point. It is hoped that this strategy will minimise the clinical burden to staff. The study was also reviewed by a very experienced research panel as part of the Covid study approval process. The panel was overwhelmingly supportive of this study, including the Director of the Biomedical Research Council (BRC), indicating the Trust burden is dramatically outweighed by the benefit of the study.

Phase 2 Retrospective Care Records Review data

Risks: Patients are at risk of data protection failure, as with any research study. This risk has been minimised in several ways. The researcher collecting the data is a very experienced ICU nurse in both clinical and research terms. The project is supervised by two very experienced researchers) both nursing and medical professions) and have been integral to the design of this study. Both supervisors have experience of data collection methods and can ensure data protection.

Burden: There is no patient burden associated with the care record review method.

Phase 3 Staff interviews data

Risks: There are no participant risks in taking part in this study. It is possible that poor care may be identified that will require escalating through the correct clinical governance channels. This will be made explicitly clear in the PIS and will be revisited at the time of consent.

Burden: The time burden of 60-90 minutes for interviews has been mitigated by offering participants a gift voucher to reimburse them for their time. The time from the point of contact to actual interviews will be as short as possible.

Phase 4 Data Integration and data analysis

n/a

Anonymisation

No identifiable data will be collected. All data that is entered into field notes and Case report forms will be anonymous at the point of capture.

Identification of poor care

Phase 1 Escalation event observations data

If an undetected deterioration is observed, as a clinical professional I am duty-bound to report this to the clinical team. I have significant clinical experience in the management of a clinically deteriorating ward patient having worked within an Intensive Care Outreach team. This event will be reported to local clinical management and escalated through standardised Trust systems.

Phase 2 Retrospective Care Records Review data

It is possible that this study may highlight historical deficits in care. Care will be discussed with the research team (a senior Nursing Professor and a Senior Intensive Care consultant) to decide if the event warrants clinical governance advice. The researchers involved in this study have significant experience in conducting studies using this methodology and in researching sensitive areas of care (one having conducted clinical notes reviews for NCEPOD documents). All have significant clinical experience which will add credibility to the management of any incidental findings of poor care. We have maintained study equipoise by reviewing notes from patients who had poor outcomes (admitted to ICU and died and absence of success factors rather than direct poor care) which may better highlight success factors in the group of patients who were successfully rescued. This study phase will aim to have Confidentiality Advisory Group (CAG) approval allowing access to patient data when consent is not feasible.

Phase 3 Staff interviews data

It is possible that interviews may highlight deficits in care and procedures are in place to manage this (as above). This will be made clear in the participant Information Sheet. All data from the interviews will be de-identified at the time of transcription. If any of the events during the interview causes distress, participants

will be asked to discuss this with their clinical manager to refer themselves to the Trust occupational health department. Wanting to create flexibility with staff interviews and understanding that interviewing participants whilst they are performing a clinical role can be limiting, it was decided to also offer telephone interviews.

Phase 4 Data Integration and data analysis

n/a

Intellectual Property Rights (IPR)

This has been discussed with the University of Plymouth IP advisor. Whilst there is no direct IP generated from this project, ownership of data should be considered. IP should be approached again as the framework of success factors emerges later in the study. Advice can be sought for IP arrangements if required.

Storage and Backup

Data storage

A password-protected electronic database will be held on a secure OUH server. Only recruiting researchers will have access to this database. This database will be destroyed once all data has been collected and verified.

Access and security

Access to medical records will only be required by clinical researchers from the participating site (who would already have access to the data as part of their day-to-day job), such as nurses, doctors, human factors scientists or IT staff. Electronic transfer of anonymous data once extracted will occur using encrypted medium to predefined NHS standards e.g., via encrypted online portal via the NHS secure network or via encrypted mass storage device in the custody of study personnel. Identifiable records will only be handled on NHS machines at the participating sites. The anonymised data will reside on NHS servers which conform to NHS Data Security and Protection Toolkit standards and have strict access controls and protection in place Paper records (consent forms with names of participants) will be filed in lockable drawers/filing cabinets in the Kadoorie Centre for Critical Care Research & Education or Adult Intensive Care Unit, John Radcliffe Hospital. This is a secure research facility with swipe-access doors.

Data back up by NHS site

The study data will be backed up regularly in line with the NHS IT and recovery disaster plans.

Selection and Preservation

Retention

The anonymous dataset held by the coordinating site will be held in data haven environment run by the group and conforming with NHS DSP. All paper documentation (e.g., consent forms) will be stored in a secure off-site archiving facility.

Data sharing

Pseudonymised interview data may be shared with other researchers, with participant consent and appropriate ethical approvals in place.

Responsibilities and Resources

The primary investigator is responsible for all the data management.

DMP Data Description Table

Data collection phase	Sample Number	Description of data collected
Phase 1	200-400 events	Observations Trigger event data (score, Event quality grading (detection, communication, and management) as per NCEPOD observations Clinical Frailty Scale (CFS) Safer Nursing Care Tool Data Ad hoc interviews Qualitative narrative defining escalation events captured
Phase 2		
200- 400 care record reviews	Up to 350	Level 1 Care reviews (1 hour in duration) Quality of care scores for each time period (SJR) Short qualitative narrative Descriptive patient data -Tigger event data (age, gender, score, time, day) -Clinical Frailty Scale (CFS) -Charlston Co-morbidity Index (CCI) -Safer Nursing Care Tool Data Level 2 Care Reviews (on notes graded 4-5) (4 hours in duration) In depth qualitative narrative of chronological events surrounding trigger

		Deceased notes review Level 1 and Level 2 reviews
	Up to 40	
		Kappa co-efficient scores In depth qualitative narrative of chronological events surrounding trigger Methodological validation of SJR
	Up to 50	
Review validation by second reviewer	40 (10% of Level 1 reviews) 5 (Level 2 reviews)	
Phase 3 Applied Cognitive Staff Interviews (ACTA)	Up to 30 staff interviews	Cognitive Demands Tables In depth qualitative narrative of escalation events surrounding patient deterioration and rescue

Appendix 7 In-depth Record Reviews CRF (Qualitative Data)

Level 2 Care Record Reviews

RTH002P33 Occult Sepsis (Overall Care Judgement Score 5)

Date	Trigger Phase	Vignette
23/03/2020	**Presenting complaint**	18-year-old female admitted to ED having been referred by her psychologist. Long history of anorexia and recent further weight loss (now 31kg). PMHx of Anorexia, depression and anxiety. Previous anorexia admissions (Dec 2019).
	Pre-Trigger	Hypoglycaemic on admission (3.3mmol/l), CEWS 3. Diagnosis-AKI, respiratory acidosis and high risk for re-feeding syndrome. Patient commenced on IVI and transferred to the Gastro ward. Bloods, ECG (bundle branch) and weight measured. Given 1:1 mental health nursing although was not demonstrating any suicidal ideation. Observations checked on Gastro ward 18:43 (T+T 3), 21:18 (T+T 3)
24/03/2020	**Trigger Event and following 24 hours**	06:41 Vital signs observation checked and patient triggering NEWS 9 (SpO2 99, respiratory rate 16, Temp 34, HR 38, Systolic BP 81/49, on RA). Seen by night SHO at 07:14 who reviewed ECG (Sinus bradycardia) and suggested re-check of temp and warm with blankets. Noted that patient is comfortable and not distressed. 09:13 Gastro Registrar ward round: Full review of history including most recent blood results. Noted **"Hypothermia, hypoglycaemia and low BMI last night- deadly triad for occult sepsis in malnourished patients".** Plan for ECG, Bloods, VBG (lactate 1.3), blood cultures (nil growth), C-Xray (NAD). Urine dip, broad spectrum ABX and dietetics. Full dietetic review completed and diet plan in place. Noted observation frequency not meeting hourly threshold and patient not re-reviewed by medical staff. Given evening dose of Co-Amoxiclav and continues for 7/7

25/03/2020	**>24hrs post trigger event until 3 consecutive EWS score<3**	08:32 Ward round notes patient still triggering CEWS 6 (hypothermia and hypotension). To be actively warmed, fluid bolus (250mls) and stat dose of Gentamycin as per Registrar instructions. Request frequent monitoring of observations to ensure patient is improving and repeat VBG (Lactate 0.9) 12:39 Patient was re-reviewed by FY1 in the afternoon and noted to be still hypothermic. Advised to hold Gentamycin and bloods not indicating DIC. Plan to discuss early with ICU regarding predicted re-feeding and low BP. 15:50 **FY1** Discussed with ICU who do not have capacity to review patient today? Noted to be on adult dose of Co-Amoxiclav which was adjusted for weight. Started on fluid balance monitoring (patient walking to the toilet). Should have been started previously.
26/03/2020		08:22 Ward round notes patient has possible DIC (thrombocytopenia, abnormal clotting and DIC score 4). Plan for repeat bloods and discussion with Haematology. Monitor for bruising or bleeding. 17:50 Discussion with Haematology. Unlikely HIT based on score, held Dalteparin (good rationale for why and clearly documented). DIC is a possibility. Request twice daily bloods. Given 3 x doses of Vitamin K.
27/03/2020		09:21 Temp now normalised. Electrolytes replaced. Noted rising ALT possibly due to re-feeding. Trigger event resolved by 28/03/2020.

RTH002P53 Neutropenic sepsis (Overall Care Judgement Score 5)

Date	Trigger Phase	Vignette
	Presenting complaint	89-year lady with a history of Lymphoma. PMHx Marginal Zone lymphoma and recurrent AIHA, AF. Lives near her son and has an excellent quality of life.
03/04/2020	**Pre-Trigger**	Haematology Registrar phoned by labs regarding abnormal blood test result for patient whilst she was at home (suggestive of haemolysis, HB drop, high bilirubin, high MCV). Called the patient who was mildly SOB but otherwise feeling well. Asked to attend triage in the morning by the Registrar.

04/04/2020	**Trigger Event and following 24 hours**	12:00 Seen by consultant. Attended clinic with worsening SOB. EWS score 7 (NEWS 10) (SaO2 86%, respiratory rate 32, Temp 36, HR 99, Systolic BP 87/50). Hourly observations not achieved but completed 1-2 hourly. Plan for ECG, Troponin, transfuse 2 units HB, O2 therapy, steroids, admit and monitor. Given high dose prednisolone 50mg. 13:46 Seen by ?FY1 and clerked. Further discussion results in C-Xray given possibility of COVID-19 (swab and C-Xray negative).
05/04/2020	**>24hrs post trigger event until 3 consecutive EWS score<3**	Consultant ward round. Noted blood not available and plan to give 1 unit today. Keen to give a buffer of HB as a steroid response may take some time and the cycle likely to occur again. Patient feels no more breathless that the day before.
06/04/2020		Patient feeling well with resolved trigger score. States she responds well to steroids.

RTH002P61 Pulmonary Embolism (Overall Care Judgement Score 5)

Date	Trigger Phase	Vignette
05/08/2020	**Presenting complaint**	81 year old male admitted to the surgical unit with worsening RUQ pain. Previous history of stone induced cholecystitis.
11/08/2020 to 12/08/2020	**Pre-Trigger**	11/08 12:37 Laparoscopic cholecystectomy to remove bile duct stones 11/08 Noted to be drowsy and confused post op (pre-theatre). History of Parkinsons. Patient developed post-op delirium but NEWS was broadly normal prior to event 11/08 Nil of note 12/08 08:55 Morning ward round. Main issue noted to be delirium and patient feels unwell. Plan for ABG/Catheter/Bloods 12/08 09:48 Plan to stop codeine and mitigate delirium 12/08 Nursing notes continue to describe delirium. Seen by wife and patient thought to have perked up.

12/08/202012/08/2020	**Trigger Event and following 24 hours**	12/08 20:59 Patient states he feels unwell and is only mumbling words (different nurse). Care escalated at this point (NEWS 11). Excellent nursing documentation throughout the night. See below extract. *Care taken over at 20:00pm.* *Obs stable, patient **responsive to voice**. Mumbles incoherent words.* *Blood sugar 7.1mmols, keytones 0.1mmols.* *IDC in situ, passing good amounts of urine approx 160mls/hr, concentrated.* *IV fluids finished.* *Bleeped on call doctor, FY1 XX, she is coming to review.* ***Update 21:20pm*** *Seen by FY1 XX,.* *ABG done.* *Obs rechecked, T+T=5 for RR24, GCS 13.* *Patient opened eyes once, continues to be responsive to voice.* *Ongoing monitoring.* *Wounds checked, no visible signs of infection.* *IDC remains patent.* ***Update at 23:05pm*** *NEWS=6, RR26, GCS13.* *ECG done.* *O2 reduced to 1L as per verbal request.* *FY1 discussing with SHO.* *A/w plan.* *Ongoing monitoring.* ***Update 23:30pm*** *O2 increased to 2L as per verbal request due to increase in RR.* *For CTPA.* *Additional cannula inserted.* ***Update 00:40am*** *NEWS=7* *GCS12, responsive to voice, disorientated and localising.* *Slight BP decrease and urine output decrease.* *Advised FY1, increased fluid rate to 167mls/hr on verbal advice.* *No longer for CTPA, now a/w CXR.* ***Update at 02:20am*** *CXR and CTPA completed.* *Cardiac monitoring in place.*

		SHO and FY1 currently reviewing patient. *Urine output 35mls/hr.* *Obs improved - GCS15 - fluctuating GCS noted.* *Patient now responding verbally and is able to state location.* *A/w plan.* ***Update at 03:12pm*** *Reg. advised to give Oxycodone for ?pain.* *Patient now increasingly responsive, when asked if he has pain he denied having any pain.* *Will give oxycodone as per medical plan. Patient aware.* ***Update 05:55am*** *CTPA showed multiple PEs.* *Treatment dose Daltarparin given as per drug chart.* *Regular turns overnight.* *Patient now NBM due to aspiration risk.* *Requested medications be changed to IV where possible.* *For BP review/fluid r/v when this bag of fluid finishes as medics are concerned with the risk of overloading patient.* *Referral to SALT sent.* ***Update at 07:05am*** *Pain settled with IV paracetamol.* *Continues NBM.* *Adequate urine output.* *For day team to review before administering more fluids as night team do not want to risk overloading patient.* *BP low but stable at present.* *RR settling, remains at RR22. Continues on 2L o2.* *For consultant review.* Nurse who escalated noted that patient was not himself. On Co-Amoxiclav. Given fluids and increase observation frequency. HO discussed this patient with SHO at 22:15 and plan to do an ECG to see if changes are suggestive of PE. ECG reviewed at 23:00 with SPR and SHO. ECG tachycardic. Noted due to tachycardia, tachypnoea and alkalosis CTPA requested. (Note that the literature states that patients who don't present with circulatory failure can have respiratory Alkalosis with PEs).
13/08	**>24hrs post trigger event until**	Radiologist said that CTPA not required and should rule out pneumonia with Cxray.

	3 consecutive EWS score<3	13/08 01:35 X-ray completed and NAD. CTPA done with multiple PEs. Patient given treatment dose of Dalteparin
	Success Factors Present	Sepsis 6 completed Relative involved in care Escalation protocol followed Patient re-reviewed over night MDT involvement (SHO/SpR/Radiology) Patient was confused the previous day and escalated despite normal NEWS. Subtle hints of being unwell were acted upon. (Note that the literature states that patients who don't present with circulatory failure can have Respiratory Alkalosis with PEs).