UNIVERSITY of STIRLING

‘A retrospective case note analysis of the recognition and management of deteriorating patients prior to critical care admission’

Sharon Oswald

Matriculation no: 1423498

Submitted to the **University of Stirling** for the

Doctor of Nursing

December 2017

Abstract

This study explores the use of early warning scores (EWS) in deteriorating patients. These are widely used tools to measure vital signs and highlight abnormal physiology in acutely unwell patients. Measurements of the process in the management of the deteriorating patient includes time to first assessment of such patients. The level of clinician involved in the subsequent management is also investigated to determine whether escalation of care was appropriate. This work is a retrospective case note analysis of the recognition and management of deteriorating patients prior to critical care admission.

Research Questions

1. What violations in the optimum process are associated with sub-optimal recognition and management of deteriorating patients and delayed critical care admission in patients triggering early warning scores in acute care wards?
2. Are there independent variables which can predict the delay in the recognition and management of deteriorating patients and subsequent critical care admission?

Methods

The literature was reviewed to determine the optimum process of recognition and management of deteriorating patients in acute care wards. A data collection tool was then specifically designed and locally validated to extract objective data from the case records. A sample of 157 patients admitted to critical care from acute wards over a 6 month period were included in the study. The case records were then retrospectively reviewed and information was extracted using the data collection tool.

Results

The accuracy and frequency of early warning scores were measured and findings demonstrated that 59% of Early Warning Scores (EWS) were miscalculated. The most frequent of those miscalculated were the intermediate scores (4 or 5) (error rate - 52%) followed by the higher scores (6 or more) (error rate - 32%). The least frequently miscalculated were the lower scores (0 -3) (error rate 15%).

Descriptive data from the sample such as age, ward, diagnosis, time of hospital admission, time and day of transfer / EWS triggering were included. From the total case records reviewed, 110 patients had abnormal Early Warning Scores (4 or more) and were included in the inferential data analysis.

The independent variables related to the processes objectively measurable in the recognition and management of deteriorating patients were included. After descriptive analysis the independent variables were cross-tabulated with the dependent variable using Pearson chi-square. The dependent variable was identified from the literature. This was whether time from triggering an abnormal EWS to critical care admission was delayed more than 6 hours. The subsequent predictor variables were then entered in to a binary logistic regression model for statistical analysis using SPSS version 21 software.

Binominal Logistic Regression Analysis identified three significant variables predicting delay of the recognition and management of deteriorating patients.

- Frequency of EWS measurement not increased appropriately
- Length of stay prior to critical care admission 12-36 hours
- If no consultant review during 6 hours of abnormal EWS

Implications for Future Practice

This study highlights areas of risk in the detection of patients' clinical deterioration in acute wards. These findings should guide quality improvement to prevent unnecessary morbidity and mortality. As a key area of patient risk included the lack of frequency and accuracy of EWS measurements, staff education is required to ensure staff are given the appropriate knowledge to understand the use of the tool. Regular review of the frequency of measurement is also required as this was statistically significant in the delay to critical care admission. The high risk time from admission of 12-36 hours needs further investigation. This study also highlights the need for senior decision makers to be involved in the care of deteriorating patients to improve outcomes.

Acknowledgements

I would like to express my grateful thanks to all who have assisted and advised me throughout this work:

- Firstly, I would like to thank both of my supervisors: Dr Kath Stoddart & Dr Ashley Shepherd who have supported me throughout. They have provided constructive and detailed feedback with encouragement, understanding and patience. Without their support I would have been lost on my thesis journey.
- I would like to thank Professor Angela Wallace and the Department of Nursing team, NHS Forth Valley for encouraging and enabling me on to this programme.
- I would also like to thank the Medical Directorate management team for their ongoing support of my professional development.
- I am very grateful for the joint funding provided for course fees from the University of Stirling and NHS Forth Valley
- I would like to thank Graham Stevenson, ward clerk critical care and the quality improvement team for their help in retrieving the large number of case notes.
- I would like to thank Nadine Dougall, previously employed at the NMAHP unit for her help and guidance on statistics
- I would also like to thank Dr Fiona McIlveny and ANP's Lisa Fabisiak and Linda Mitchell for their help in developing the data collection tool.

On a more personal note I would like to thank my husband Dave who has always given encouragement. He has always accepted, without complaint, when we have had to change plans to meet the pressures of my work and the clinical doctorate. I would also like to express thanks to my friends, family and colleagues for their ongoing support during the process and for putting up with me when I felt I would never get to this point.

Contents **Page**

List of Figures **Page**

List of Tables

List of Appendices **Page**

Chapter 1: Introduction

1.1 Background: Rationale for research in this field

Healthcare is a high-risk industry. Urgent, unanticipated admission to critical care from acute care wards is an untoward occurrence which constitutes a serious adverse event (National Patient Safety Agency 2007). As a nurse consultant in acute care I was aware of anecdotal evidence locally and nationally, through patient safety collaborations, that care of patients prior to critical care admission was poor. There was however no clear evidence to support these claims. The discussions around individual cases were often informal, random and some unstructured. This was not only locally recognised but seemed to be replicated in many health care organisations apparent from the discussions and presentations at national patient safety conferences.

There was no strategic collaboration to explore this potential phenomenon within my organisation. No formal structure or tools were available to consistently review any individual cases which were highlighted. It was my aim to investigate the care of patients prior to transfer to critical care from acute wards. The outcome was that the review of cases would support or disprove the unsubstantiated claims of poor care prior to critical care admission. It also provided an opportunity to explore and deepen the understanding of the processes involved in the recognition and management of deteriorating patients and where, if at all, this went wrong. If poor care prior to critical care exists, where does this happen within the process? How often does it occur? What impact does this have on the time to critical care admission? All of the previous questions prompted the research.

The study was conducted in a large Scottish district general hospital serving a population of 300,000 with 860 in-patient beds. The critical care unit is a combined unit. It incorporates seven intensive care beds (level three) and twelve high dependency beds (level two). These levels of care are defined by the intensive care society as: Level Three - Advanced respiratory support (connected to a ventilator via endotracheal tube (ETT) or tracheostomy) or Two or more organ systems are being supported (except basic respiratory and basic cardiac); Level Two - One organ supported Level one; Epidural or/and General observations requiring more monitoring than can be provided on a general ward (The Intensive Care Society 2009). There is no coronary care unit on the study site centre, therefore any level two cardiac patients are admitted to critical care or transferred to larger centres with invasive procedure facilities. All patients requiring non-invasive ventilation are also admitted to the critical care unit as there is no provision to provide this service on the acute wards. This may provide some variance from other larger teaching hospitals and explain the large number of patients admitted to critical care without physiological abnormalities triggering EWS. In patients with known chronic disease, parameter limits can be altered so they do not trigger the EWS. These patients can often have chronic abnormal physiology suggesting some patients may not have triggered on EWS despite abnormal physiology.

The Early Warning Score (EWS) chart used in the research was implemented in 2012, the year prior to the study starting. It is worth noting that this implementation was not supported by planned staff education on the use and background of the tool which raises questions around the accuracy of the charts. An illustration on how to complete the tool is provided in appendix 1. This demonstration of how to complete the EWS chart was devised by a senior nurse to help provide guidance to staff on how to complete the chart, but it is however, miscalculated. This highlighted to me that the tool was perhaps not easy to complete and was error provoking. My study was required to explore this hypothesis.

An overview of the thesis format now follows.

1.2 Structure of the thesis

The structure of this thesis is outlined and sets the scene for the area of research that follows. The thesis consists of nine chapters. The literature review is introduced in chapter two and is split into sections relating to key themes emerging from the evidence. The first of these themes is about the strong evidence which relates physiological instability to poor patient outcomes. This then leads to the emergence of the term 'sub-optimal care' where the evidence suggests the failure to recognise and manage deteriorating patients can lead to increased, and potentially preventable, morbidity or mortality. As the researcher is a nurse consultant and nurses play a key role in caring for acutely unwell patients, the literature around nursing and deteriorating patients is also explored. The overarching aim of the research explores the care of patients prior to critical care admission from acute wards. Unplanned critical care admissions from general wards are an adverse event therefore, the evidence on adverse events in healthcare is examined. The associated national drivers for improvement are also reviewed.

In chapter three the methods, aims and objectives of the study leading to the main research questions are identified. The design of the study and the sample are explained followed by an overview of the data collection and analysis processes. The ethical considerations relating to the research are identified and discussed in chapter four. The measures undertaken to maintain ethical principles during the study are also described in that chapter. The results of the research are discussed in chapter five. The descriptive statistics are displayed in bar charts and are followed by an explanation of the process of refining the data for inferential statistical analysis. The rationale for the chosen inferential analysis method and the subsequent results are detailed in chapter six.

Discussion of the results arises in chapter seven which is sectioned into the themes emerging from the study results. Further discussion occurs in chapter

eight which explores the results using a model adapted from Reason's (1990) theory of human error. Chapter nine concludes the thesis, intimates the strength of the study and recognises limitations. Recommendations for practice and future research are made. To begin the research process a review of the national and international literature around the topic was undertaken and is detailed in the next chapter.

Chapter 2: Literature Review

2.1: Introduction to the Literature Review

A systematic overview methodology was chosen for the literature review (Grant and Booth 2009). It was undertaken using a systematic search of all relevant research literature. Analysis and synthesis of the research findings was undertaken thematically. The retrieved studies were critically appraised against recognised criteria to identify relevant and robust primary research. Critical appraisal of all reviewed observational studies was undertaken using questions from the STROBE statement checklist to determine rigour and quality, an example is provided in appendix 14.

Search methods used to gather appropriate literature were the OVID electronic databases CINAHL, Medline, Cochrane reviews and the knowledge network. Key phrases included sub-optimal care, early warning scores, adverse events, recognition of deteriorating patients, failure to rescue and unplanned admissions to critical care. These were then entered using key words and title tabs. The search was limited to full text and English language then duplicates removed. The concept of Medical Emergency Teams was also searched. An illustration of the search trail on the Medical Emergency Teams has been presented (appendix 12) using PRISMA guidance (Moher et al 2009). A summary of this literature has been provided. (appendix 13). Key guidelines sites such as the National Patient Safety Agency (NPSA), Royal College of Physicians (RCP), Department of Health (DH), Scottish Intercollegiate Guidelines Network (SIGN), National Institute Clinical Excellence (NICE) were all searched. Searching of reference lists of key articles and expert advice from national documents assisted in the location of relevant studies.

The aim of this literature review is to critically appraise current knowledge and evidence surrounding the care of deteriorating patients in acute settings prior to unplanned critical care admission or cardiac arrest. The literature review is presented in key themes the first relating physiological abnormalities to poor patient outcome. This is then followed by an exploration of the literature in to the emergence of the concept of 'sub-optimal care'. A focus on nurses' contribution to the care of the deteriorating patient is then undertaken followed by a review of the evidence around Medical Emergency Teams (MET). This literature review is concluded by a review of adverse events and the key national drivers in the care of deteriorating patients. A summary of the gaps exposed within the literature are identified to support the requirement for further research within this area of patient safety.

The recognition and management of deteriorating patients is a very broad topic. It involves many aspects of patient care, multiple health care professionals and numerous systems or processes. This review is therefore divided in to the key themes emerging from the literature. The first theme is focused around the significance of abnormal physiology in the identification of clinical deterioration and the potential implications to patient outcomes if unrecognised.

2.2: Relating Physiological instability to poor patient outcome

Physiological instability or abnormal vital signs such as heart rate, respiratory rate or blood pressure suggests altered physiology. It is well recognised that abnormal physiology is associated with adverse clinical outcomes. The higher physiology deviates from normal, the higher the risk of mortality such as cardiac arrest (Cei et al 2009, Duckitt et al 2007, Goldhill et al 2005, Buist et al 2004, Goldhill and McNarry 2004, Subbe et al 2001).

In 1990 Schein et al highlighted the clinical antecedents of cardiac arrest. Evidence around cardiac arrest outcomes had previously focussed on survival rates but Schein et al (1990) highlighted common physiological derangements prior to cardiac arrest. From a relatively small sample size of 64 patients who suffered a cardiac arrest, 86% showed evidence of physiological abnormality prior to the event. The data recorded from the sample in Schein et al (1990) in the 48 hours prior to cardiac arrest exposed the most common significant physiological abnormalities prior to the cardiac arrest. The results were statistically significant showing 70% of patients had physiological abnormalities prior to cardiac arrest. A quarter of the sample studied were categorised as expected to die and therefore their suitability for inclusion in the study is questionable as physiological abnormality would be expected prior to death. The data was displayed descriptively without further statistical analysis to detect significance or relationships of variables to outcomes. Schein et al (1990) did however highlight that cardiac arrest was not a sudden or unpredictable event. This is a key finding which precipitated further research in to the recognition and management of physiological abnormalities in preventing cardiac arrest.

Franklin and Mathew (1994) drew upon the work of Schein et al (1990) to direct their study regarding the prediction and prevention of cardiac arrest. They retrospectively reviewed the case records of 150 patients who had suffered a cardiac arrest. The researchers investigated the physiological abnormalities

preceding the event and investigated whether abnormal physiology was recognised and documented and whether escalation to the physician was undertaken. The study concluded that physiological abnormalities were present up to six hours prior to cardiac arrest. The investigation of patients showing abnormal physiology was followed by an evaluation of the physician's assessment and interventions. These judgements were simplistic as they were only judged by one investigation for each clinical scenario such as whether arterial blood gas was taken due to mental status change or respiratory distress or whether electrocardiography was recorded if patients had chest pain. These alone determined whether care was appropriate or inappropriate. The care of patients is complex and cannot be judged on only one investigation. This weakens the strength of the evaluation process and the validity of the subsequent published results by Franklin and Mathew (1994).

Franklin and Mathew (1994) reviewed the escalation from physician to intensive care. The qualitative interpretation of care by the intensive care physician was simplified to whether he/she instituted appropriate resuscitative measures prior to transfer to critical care. These measures were identified as endotracheal intubation and/or administration of vasopressors. Patient deterioration is often multifaceted therefore to base quality of intervention on two measures is open to criticism. Franklin and Mathew's (1994) results were descriptive but did demonstrate data on the frequency of failures during the process of recognition, response and intervention of patients showing evidence of physiological deterioration. Although weak in design with lack of supporting evidence such as data collection tools or data display, Franklin and Mathew (1994) did highlight areas of concern requiring further investigation.

The two studies previously reviewed (Schein 1990, Franklin & Mathew 1994) had cardiac arrest as an outcome however subsequent research investigated the concept of physiological instability in patients admitted to intensive care. It was theorised by them that predictability and preventability of clinical deterioration

may be identified prior to intensive care admission. In the late nineties several studies were undertaken to investigate this theory. Buist et al (1999) defined unplanned intensive care admission and/or cardiac arrest collectively as critical events and measured the median duration of physiological instability as 6.5 hours with a range of 0 to 432 hours. They recognised that they had not explored the quality of patient care although they expanded the clinical instability criteria from just recorded vital signs to include biochemical and haematological abnormalities. Although Buist et al (1999) focused on objective data, they did not depict stages of delay in recognition or escalation. Exploring stages in the process had previously been introduced by Franklin and Mathew (1994). This helped provide a deeper understanding of where delays may occur.

From the late 90's onwards, the quality of care prior to admission to intensive care or cardiac arrest became the focus of investigation. Two studies, which to this day, are often referenced in subsequent research or national documents are now discussed, compared and critiqued. These papers founded the now frequently used phrase of 'sub-optimal care' relating to preventable clinical deterioration leading to critical care admission or cardiac arrest.

2.3: The emergence of the term ‘sub-optimal care’

Sub-optimal care in general wards prior to intensive care admission was first identified by McQuillan et al (1998). However, the qualitative nature of the enquiry of the care of patients prior to intensive care admission invited some subjectivity. A major drawback in reliability was that only two senior clinicians were appointed as assessors. These senior clinicians disagreed in their opinions of quality of care in approximately a quarter of the patients’ cases. The ambiguity was in their ‘expert’ views on the quality of care patients received and also their personal interpretation on the timing of critical care referrals in each case. The reviewers were aware of the patient outcomes. Knowing negative outcomes in advance may have influenced their opinions on quality of care, potentially precipitating bias (Curtis & Drennan 2013). In McQuillan et al (1998) the reviewers’ personal opinion was the basis of the study’s results. Having only two assessors with obvious diverse views limited the study’s findings. Increasing the number of assessors may have allowed for a majority consensus of opinion and reduced ambiguity by increasing the inter-rater reliability and validity of results. It is argued that the method of using expert reviewers is unscientific and subjective (Torgerson 2003, Donabedian 2005, Garg et al 2008).

In the McQuillan et al (1998) study a large number of patients’ data could not be used for statistical analysis or to present findings as no agreement in clinical decision-making could be reached. It was also evident that this was not a multi-professional approach as both clinicians were intensive care doctors. Patient care is multi-faceted, it incorporates many health professionals therefore it would seem pertinent that the assessment of such care is undertaken by a multi-professional team and not unilaterally.

McQuillan et al (1998) also used objective physiological markers to assess severity of illness and calculate a standardised mortality ratio using the validated and internationally recognised scoring system (Knaus et al 1985). Although more

scientific in approach, the severity of illness of individual patients was not the aim of the study. Their aim was to investigate the prevalence of sub-optimal care prior to admission and examine its nature, causes and consequences by reviewing process measures rather than outcome measures. In summary, the patients who it was agreed received sub-optimal care prior to admission to intensive care had poorer outcomes in comparison to those whom it was agreed had care ranging from excellent to adequate. From the evidence reported by McQuillan et al (1998) about the cohort grouped as receiving sub-optimal care it is not clear what constituted this decision as no clear criteria are outlined. The data was then skewed negatively by categorising those participants in which a decision could not be agreed on by the assessors in to the sub-optimal category.

Despite the many weaknesses of McQuillan et al's (1998) study it continues to be referenced as seminal work within the field of acute care. Perhaps this is due to the lack of further research on the topic. Whilst there is no doubt that care could always be improved, the interpretation of the results in their study should be viewed with some caution.

Another highly cited piece of work to highlight potentially avoidable deaths or admissions to intensive care was a study by McGloin et al (1999). For six months a team of two nurses and one doctor reviewed case records. Compared to McQuillan et al (1998) who categorised participants in which decisions could not be agreed by the reviewers to the category of sub-optimal care, McGloin et al (1999) gave favour to the side of acceptable care when disagreement occurred. They used only 'clear cut cases' in identifying sub-optimal care and reinforced this with definitions of what they deemed to be sub-optimal care. Their results were very different from McQuillan et al (1998). From a total of 477 deaths and 98 intensive care admissions, it was suggested by McGloin et al (1999) that 38% of these received sub-optimal care prior to their end point of critical care admission or death. McQuillan et al (1998) however found 54% of the 100 participants received sub-optimal care with a further 26% where no consensus

of opinion could be made; suggesting only 20% of patients received acceptable care. Late referral and delayed admission to intensive care was measured at 50% by McGloin et al (1999) and at 69% by McQuillan et al (1998). Of those admitted to intensive care McQuillan et al (1998) suggested 41% were avoidable. McGloin et al (1999) discussed that earlier intensive care admission could have been undertaken in some cases but they did not quantify this or use the term preventable. They also did not state whether these were only in the sub-optimal category or whether the group of acceptable care may have also had earlier intensive care admission. McQuillan et al (1998) claim to know from a retrospective review whether deterioration could have been avoided. Their assumption was that intervention would have been successful but, realistically, intervention or treatment is not always effective and may not have prevented deterioration. McGloin et al (1999) were blinded to the outcomes of the patients in their study unlike McQuillan et al (1998) reducing possible bias. McGloin et al (1999) also set out criteria on sub-optimal care allowing a greater understanding of their findings.

The retrospective nature of both these studies relied on accurate record keeping and this is recognised as a weakness by both McGloin et al (1998) and McQuillan et al (1999). The data collection was less subjective in McGloin's work (1999) as criteria were outlined to define what was identified as sub-optimal care. Multi-professionals, rather than doctors alone, were recruited to examine the data which seems appropriate as the recognition and care of patients is multi-professional in practice. McGloin et al (1999) also had a larger sample size and the results appear more reliable and less subjective in nature than those of McQuillan et al (1998). Similarities cannot however be overlooked. It was clear from both studies, despite some ambiguity and concerns about methodology that there was some evidence suggesting that the recognition and management of deteriorating patients in acute care was an area of concern.

Other areas of research in critical care admissions focused on patient outcomes. Goldhill and Sumner's (1998) findings confirmed that mortality rates remained very high after successful resuscitation from cardiac arrest. Goldhill et al (2004) in a prospective observational study demonstrated that the longer the in-patient length of stay prior to intensive care admission, the higher the mortality rate. Goldhill and Sumner (1998) also found that mortality was higher in those patients admitted to intensive care from general wards than those admitted from theatre or the emergency department. However, in both studies, information on the cause or possible preventable aspects of the patient's care prior to the cardiac arrest or critical care admission was not elicited and this is recognised by the authors.

The exposure of sub-optimal care prior to critical care admission (McGloin 1999, McQuillan 1998) and the evidence of poor outcomes of patients transferred to intensive care from the general wards (Goldhill and Sumner 1998, Goldhill et al 2004) provided enough evidence for this to become a national priority (DOH 2000, DOH 2007, NICE 2007, DOH 2009).

It is evident that the processes involved in recognition and management of deteriorating patients' needs further review to elicit a deeper understanding of when delays occur. McGloin (1999) and McQuillan (1998) do not give any insight in to where there was a failure to follow process or how frequent there is a failure in the process of the recognition and management of a deteriorating patient. They do not make clear distinctions as to whether there was a failure to recognise abnormal physiology and escalate appropriately or whether response from medical staff was delayed. It is also not clear from their studies whether there was an appropriate level of clinician involved in the decisions to manage the patient at the time of deterioration. Some research moved to profession specific studies in the management of the deteriorating patient. The literature focusing on nursing aspects of deteriorating patients is reviewed in the following section.

2.4: Nursing Focus on Deteriorating Patients

Both McQuillan (1998) and McGloin (1999) claimed that nurses failed to monitor, recognise or report physiological abnormalities although their comments were generalised and not quantified therefore lacked objectivity. Since then several studies (Wheatley 2006, Hogan 2006, Andrews and Waterman 2005, Minnick and Harvey 2003, Kenward and Hodgetts 2002, Cioffi 2000), have focussed on the nursing role in the recognition and management of the deteriorating patient. In the qualitative studies, some key themes emerged such as nurses related to 'knowing their patients' and detecting changes in behaviour or appearance by gut instinct rather than physiological abnormalities (Cox et al 2006, Cioffi 2000, Kenward and Hodgetts 2002, Minnick and Harvey 2003).

Cioffi (2000) undertook an exploratory interview based study of 32 registered nurses and suggested that they used past experiences, knowledge and pattern recognition to recognise clinical deterioration. Andrews and Waterman (2005) in a grounded theory study concurred that nurses have 'intuitive knowing' but suggested they required support in articulating clinical concerns to medical staff. Whether this means that nurses are not recognising what is concerning them about their patients from the 'intuitive knowing' theory or whether they are poor at communication skills, is not clear. The concept of nurse intuition is much debated (Paley 2002, Paley et al 2007, Lynecham et al 2008). However, those debates lie beyond the aims of this study.

Studies by both Wheatley (2006) and Hogan (2006) suggested there was an increasing reliance on machinery and that monitoring of vital signs was often delegated to unregistered nursing staff. They intimate that registered nurses saw routine observations as ritualistic and task orientated.

As previously stated, it is well recognised in a body of research that abnormal physiology is associated with adverse clinical outcomes (Cei et al 2009, Burch et al 2008, Duckitt et al 2007, Goldhill et al 2005, Buist et al 2004, Goldhill and McNarry 2004, Subbe et al 2001). In that body of research, it was shown that physiological abnormalities determined the severity of illness which led to the development of early warning scores.

Early Warning Scores (EWS) enable ward staff to combine their routine observations and produce an aggregate physiological score, the higher the score the sicker the patient (Sharpley and Holden 2004). EWS systems or modified early warning scores (MEWS) provide set criteria to simplify and inform the decision to call for help. EWS were implemented to help provide a framework which healthcare staff could use to establish when a patient's physiological parameters are outside the accepted range (Odell 2002).

The publication Comprehensive Critical Care by the Department of Health (DH 2000) recommended the use of early warning systems as best practice for clinical observations. Since this publication the adoption and implementation of EWS charts grew hugely in the UK. EWS were designed to recognise physiological instability and aid decision-making to trigger escalation. Along with an early warning score, either a protocol or guideline to activate responders is recommended by the National Institute for Health and Clinical Excellence (NICE 2007) and the National Patient Safety Alliance (NCEPOD 2007). This is broadly known as track and trigger systems. A variety of tools have been created and implemented in the UK in response to national recommendations (NICE 2007). However, many identify difficulty in using such tools and have reported poor compliance (Smith & Oakey 2006, Kenward et al 2001, Chellel et al 2002). Problems in using different tools and their reliability and accuracy have also been reported (Subbe et al 2001).

Many studies have continued to provide evidence of the validity of EWS to predict patient outcomes (Subbe et al 2001, Goldhill & McNarry 2004, Goldill et al 2005, Duckitt et al 2007, Groarke et al 2008), Cei et al 2009). Smith et al (2012) found that a EWS of three or more was an independent predictor of major adverse events. Many areas out with acute wards now also promote EWS such as the Emergency Department (Subbe et al 2006, Day et al 2010) and pre-hospital care (Burch et al 2008).

Studies looking at aspects of nurses' measurement and recording of physiological data have emerged since 2000. Some quantitative data found that respiratory rate was often not recorded, Chellel et al (2002) measured this at 55% of 1873 patient records in a point prevalence study. Kenward et al (2001) had previously shown positive effects of staff education on the importance of accurate respiratory rate recording. Kenward et al (2001) demonstrated an increase in the recording of respiratory rate from 27% to 89% in a before and after educational intervention from a case note review. A prospective observational study undertaken by Buist et al (2004) used logistic regression analysis to depict abnormal physiology which could predict mortality. From a large sample of 6303 patients abnormal physiology was recorded in the general medical, general surgical and orthopaedic wards. Six clinical observations were statistically proven to be significant predictors of mortality. The strongest predictor was a decrease in respiratory rate. One criticism though, which could skew the relevance of the data, was that the study included patients who were not for resuscitation and those expected to die. It would be likely that respiratory rate may drop in a patient who is dying. Those who are critically ill but not for intervention may well show vastly abnormal physiology prior to death but this is not relevant in recognising deterioration in a potentially reversible acute illness.

In 2006 Smith and Oakey reviewed 3739 sets of EWS and found 21.9% had been incorrectly calculated. This resulted in 24.4% of patients, who should have triggered recognition of abnormal values, did not. They also found that the more

diverse the physiology was from normal then the more likely it was to be miscalculated. No qualitative exploration was undertaken by Smith and Oakley to understand why the higher scores were causing calculation errors and this is worthy of further investigation to protect patient safety. Mohammed et al (2009) demonstrated improvement of EWS accuracy by introducing computer aided scoring. The intervention aided the accuracy and speed of calculations but they did not however, quantify what such equipment resource implications were for the organisation.

As the qualitative studies suggest that intuitive clinical concern is more important to nurses than physiological abnormality, the question of a lack of appreciation of the significance of physiological abnormalities by nurses is raised. Research to quantify the problem of physiological monitoring inaccuracies, measure the recorded recognition of abnormal values and recorded escalation by nurses is required to understand any nursing contribution to sub-optimal care. This should not be done in isolation but be part of research looking at the multi-professional approach to caring for the deteriorating patient.

As a possible solution to improving the recognition and management of deteriorating patients some NHS organisations have implemented Medical Emergency Teams, outreach teams or Rapid Response Teams. These are multi-professional mobile teams which can be activated by ward staff to assist in the management of deteriorating patients. The literature review will explore the evidence of their effectiveness in practice.

2.5: Medical Emergency Teams

The concept of Medical Emergency Teams (MET) can be traced back to 1990 in the Liverpool Hospital, Australia and although studies found their initiation reduced cardiac arrests and facilitated earlier Intensive Care admission, their proliferation in the UK was not evident until the late nineties (Goldhill 2001, Barbetti & Lee 2008). MET respond to an increasingly ill population of hospitalised patients by moving critical care from a structurally isolated area to the hospital ward. MET are structured so that any member of the hospital staff can activate them, dispelling the traditional hierarchical mechanisms in an aim to encourage rapid and effective referral (Bellomo et al 2003).

Many studies have been undertaken to evaluate the use of MET and similarly named concepts (Iyengar et al 2009, Jones et al 2006, Story et al 2004, DeVita et al 2004, Kenward et al 2004, Belloma et al 2003, Ball et al 2003, Cretikos & Hillman 2003, Buist et al 2002, Salamonson et al 2001). Buist et al (2002) carried out a non-randomised population based study both before and after implementation of the MET team. Their results were impressive showing a 50% reduction in cardiac arrest calls and a decrease in overall mortality. It is noted however that a three-year gap between implementation and evaluation occurred. In this time a large education programme and audit was undertaken which may have contributed to the success of the project. Generalisation may be criticised for the lack of applicability to other settings without such intense educational resources. The ongoing audit may have contributed to some Hawthorne effect.

Bellomo et al (2003) carried out a similarly designed study evaluating four months of cardiac arrest data prior to implementation of the MET team and evaluated afterwards. They too allowed a year for education and preparation. The results showed a statistically significant drop in the number of cardiac arrest calls and overall mortality. From both studies it could be assumed therefore that it is not only the implementation of a MET which has an impact on mortality and cardiac

arrest calls but the education and development of staff in the recognition and management of acutely unwell patients which influences outcomes.

Mercer et al (1999) warn of de-skilling general ward staff by implementing MET. Gibson (1997) adds that not only could ward nurses become de-skilled but also that care may become more fragmented with ward nurses becoming disenfranchised from critical care issues. Gerrard & Young (1998) argue that MET must provide an educational role to prevent this. From the evidence examined surrounding MET implementation, the most impressive results are from the studies which have allowed the team to become well established before evaluation. The more successful of the evaluations (Buist et al 2002, Bellamo et al 2003) have also implemented education programmes to raise awareness of the care of the acutely unwell patient. This should be recognised as this is an opportunity not always generally available due to resource. The education could have had more impact on the results than the MET team implementation.

A recurring theme throughout the literature involving MET is the barriers to their implementation (Hillman et al 2003). Kenward et al (2004) evaluated the impact of MET one year after implementation and in contrast to other findings, reported no statistically significant reduction in cardiac arrest calls or mortality. They claim that such teams require a 'bedding in' period and ongoing education. This view was previously expressed by Salamonson et al (2001) who found over a three-year period the use of MET increased progressively. Some studies suggested that staff were reluctant to call the MET in fear of broaching the traditional system. In particular, nursing staff were reluctant to activate the MET against the medical staffs' orders (Santamaria et al 2010, Story et al 2004, De Vita et al 2004). Similarly, Kerridge and Saul (2003) suggest the delay of implementation of such teams is that it challenges traditional systems and hierarchies.

Although no adverse clinical outcomes have been suggested by the introduction of MET, the concept has been challenged on the basis of the quality of the

evidence. This prompted a Cochrane review (McGaughey et al 2009) which found only two studies were robust enough to meet the RCT inclusion criteria. From those two studies there was no clear evidence that MET had reduced the outcome measures of in hospital mortality, unplanned ICU admissions or readmissions, length of hospital stay or adverse events (Hillman 2005, Priestley et al 2004). The summary of the Cochrane review suggests there is minimal indication to recommend the adoption of such teams, they recommend further multi-site RCT's to determine MET effectiveness (McGaughey et al 2009).

What was evident from the literature was that a change in culture is required. Patients with abnormal physiology are at risk of further deterioration and must be assessed and managed promptly to maximise patient safety and reduce adverse events. Such adverse events include unplanned admission to critical care. To develop a knowledge of adverse events in hospital this review extends to explore how this is represented in the literature and looks at the key national drivers to implement change.

2.6: Significant Adverse Events and the Key National Drivers

In 2000 the incidence of adverse events and review of deteriorating patients began to be widely recognised, driven by the UK government document 'An Organisation with a Memory' (DOH 2000). This government paper promoted a whole new way of thinking around adverse events. The underpinning concept was adapted from Reason's (1990) Human Error Theory and promotes learning from adverse events and near misses within the health service. Reason (1990) suggests that two approaches to the problem of human fallibility exist: the person and the system approaches. The person approach focuses on unsafe acts; errors and procedural violations of those at the sharp end such as nurses and physicians. These unsafe acts are derived from aberrant mental processes and variability in human behaviour. The system approach is based on the assumption that humans are fallible and that errors are to be expected. Errors are therefore seen as consequences rather than causes. It postulates that when an adverse event occurs, the important issue is not who blundered but how and why the defences failed. This resulted in the promotion of adverse event reporting and reviews within healthcare (DOH 2000). The relationship of Reason's theory (1990) to sub-optimal care is explored further in the discussion sections (chapters 8.1, 8.2, 8.3). Since Reason's theory (1990) was adopted by the Department of Health (DOH 2000) as a means of analysing cause it is referenced frequently in further literature relating to adverse events in healthcare (AoMRC 2007, Bion & Heffner 2004, Rothschild 2005, Perneger 2005, Amalberti et al 2006, McKeon et al 2006, Varipo et al 2008, Gluk 2008, Flin et al 2009, Duthie 2010). It is therefore the adopted approach within my study to discuss the results (chapters: 8.1, 8.2, 8.3).

Vincent et al (2001) undertook a large retrospective case record review to examine adverse events in hospitals. The aim was to obtain an overview of the number of adverse events encountered during hospital admission. Their study included a review of over 1000 nursing and medical notes in two sites (both acute

hospitals in London). They found that 10% of patients admitted to an acute hospital experienced an adverse event during their hospital stay, a third of which were judged preventable. In those who suffered an adverse event, 19% resulted in moderate impairment, 6% to permanent impairment and 8% contributed to death. Each adverse event led to longer lengths of stay and a higher cost to the NHS. The adverse events were noted in each speciality, the highest was in general surgery, with 39% of all adverse events. This was followed by orthopaedics having 34%, general medicine with 21% and obstetrics 6%. The investigation panel incorporated a nurse as project manager with four research nurses. The senior clinical representation was one general medical physician and five obstetricians. The panel included five members whose speciality was tangential which calls into question their expertise and therefore the validity of their clinical judgements in other specialities. It is also notable that the number of adverse events within the investigators own speciality was significantly lower than all others, which raises issues of bias. Such bias could be attributed to the awareness of the context and complexity of clinical emergency situations within their speciality. This situational awareness is not transferable to other specialities and bias may be unintentional but related to their specific expertise in their speciality. In contrast the lack of clinical knowledge and complexities in the other clinical specialities may have influenced decisions.

More specific to sub-optimal care, Seward et al (2003) undertook a feasibility study to assess the viability of establishing a confidential enquiry into deaths following medical emergency admission. Using mixed methods, they reviewed 200 case records of patients who had died within seven days of admission. Those who were admitted for less than one hour and those admitted for palliative care were excluded. Quantitative data was collated including time to medical contacts, time to investigations and time to interventions. The data was gathered and tested using a proforma developed and agreed by a steering group. The second part of the research was qualitative and like similar earlier studies, allowed some subjectivity of expert opinion. The researchers did however have clear criteria for the two assessors to give their opinion. They narrowed the options of the

reviewers as to whether they felt the death was expected or unexpected. Even during this deliberation some subjectivity was exposed. Both assessors agreed death was the natural course in 33% of the patients however in 26% of the patients, the reviewers disagreed as to whether the death was expected. Further ambiguity occurred when the unexpected deaths were additionally split as to whether care was satisfactory or not. In the 'not satisfactory' subset both assessors agreed on only 14 of the 39 patients. Within the other 25 patients, only one of the two reviewers suggested poor care issues were present. Addressing the differences in opinion Seward et al (2003) comment that medicine is not an exact science with few absolute standards of care. They do however claim that the study does demonstrate the potential for retrospective assessment of the quality of care. Assuming the quantitative data was valid, there was a clear difference of opinion about a significant number of patients in the qualitative analysis. It would be unlikely that the analysis of the qualitative data would stand up to scrutiny as a feasible method of retrospectively reviewing the quality of patient care as the authors claim.

The National Confidential Enquiry in to Patient Outcome and Death (NCEPOD 2005) is a UK published national report of adverse events focused on deteriorating patients. Questionnaires were given to the referring physicians and intensive care units on the adults admitted to an intensive care unit over one month. A significant number of cases were reviewed (1677) but no detail of the questionnaire is given in the report or any insight in to what may have been asked of the individuals. If self-reporting of quality of care was requested, then the reliability of replies could be uncertain and pose ethical limitations. Despite a multi-professional group of advisors being tasked to review questionnaires and related case records, no evidence of any review tool was provided. It is therefore unclear as to how some of the published results were achieved. This reduces the validity and quality of the research. Data of type and source of intensive care admission is self-explanatory but other key findings are descriptive, generalised and vague. An example of such is that they refer to care being delayed or inappropriate but without data it lacks substance and is less meaningful to the

reader. The literature referred to in the document is that previously reviewed in this chapter (McQuillan 1998, McGloin 1999, Seward et al 2003 and Schein et al 1990). The research is cited in NCEPOD (2005) but not critically analysed and the previously highlighted methodological or design weaknesses were not recognised.

Although the care of the deteriorating patient is quite clearly a matter of urgent patient safety to reduce preventable morbidity and mortality, no further evidence about the processes of the recognition and management of deteriorating patients is available in the last decade. The lack of evidence means that we do not not know if sub-optimal care is of continuing concern to the NHS. A published national document from the NCEPOD released in 2007 reflected on the NCEPOD (2005) study and made key recommendations but added no further evidence at that time. As a significant patient safety issue, the topic of recognition and management of deteriorating patients requires further investigation.

Many national documents have been published to provide guidance to acute care teams on the optimal management of deteriorating patients (National Institute for Health and Clinical Excellence (NICE) 2007, Department of Health (DH) 2009, Royal College of Physicians (RCP) 2007 and 2012, Scottish Intercollegiate Guidelines Network (SIGN) 2014). These guidelines offer ‘expert opinion’ gathered from previous evidence but no new research is referenced. Some guidance relates to adverse events but is not research based, rather it is centred on individual case reviews using expert opinion.

The National Patient Safety Agency (NPSA 2007a) reviewed reported adverse events in NHS England and Wales. After reviewing the cases they then generated key themes emerging from those reviews such as; ‘often clinical or physiological deterioration is not recognised or acted upon’. However, given that only reported incidents were reviewed the magnitude of the problem may be undervalued. Following this the NPSA (2007b) then attempted to analyse 576

reported deaths from 2005 using a triangulation approach. An advisory group was established and work including focus groups, semi-structured interviews with clinical staff, aggregate root cause analysis and ethnographic analysis. Only 16 clinical staff were involved in the semi-structured interviews and no senior medical staff were involved. The focus groups had larger numbers of medical and nursing staff but no detail was given as to their experience or responsibilities. Previous evidence suggests that there is a lack of early senior involvement in the deteriorating patient (McQuillan 1998, McGloin 1999, NCEPOD 2005). National guidance documents also promote early senior review (NICE 2007, DH 2009, RCP 2007 & 2012, SIGN 2014). In the NPSA (2007b) analysis it would have been worthy to have senior medical staff in the focus groups to gain some insight from those with overall responsibility for patient care. The ethnographic analysis was not fully explained and therefore the quality of the research could be questioned. Field notes of 60 hours of observation were analysed in conjunction with the semi-structured interviews. What the groups' observation focus was, is not clearly identified or explained in the paper.

Root cause analysis reports were undertaken from 51 adverse events reviewing the timelines and the causal factors to the adverse events. The different methods of gathering qualitative data were then triangulated to produce key themes in the contributing factors associated with the failure to recognise and manage deteriorating patients. Limitations of the study were recognised: the small number of staff and sites were accepted as a weakness. The concept of 'social desirability bias', particularly in focus groups, was highlighted as staff may not have wished to divulge negative personal experiences in managing patient care. No further qualitative evidence in the contributing factors to the management of deteriorating patients has been attempted by the UK national patient safety teams.

The last published national confidential enquiry related to this topic in 2012 (NCEPOD) reviewed all cardiac arrests over a 14 day period. NHS England, Wales and Northern Ireland contributed to the data. Similar methodology was used to that of NCEPOD (2005). A section of this review was dedicated to the care of patients 48 hours prior to cardiac arrest. Physiological abnormalities prior to cardiac arrest showed similar findings to those of the Schein study back in 1990. They demonstrated that most patients showed evidence of physiological deterioration prior to cardiac arrest (70%). It is however a lower number than Schein (1990) who suggested 86%. The sensitivity of the physiological abnormalities is acknowledged to be extreme (far from the normal range) in NCEPOD (2012) which may explain the difference of 16% less than Schein (1990). NCEPOD (2012) recognise that more subtle criteria could be used to recognise and intervene at an earlier stage to prevent cardiac arrest.

Similar to previous studies (Schein 1990, Franklin and Mathew 1994, Buist et al 1999) the duration of physiological abnormality was measured prior to the adverse event with 62% of patients showing clinical instability for more than six hours. Those with a shorter length of stay prior to cardiac arrest had shorter periods of instability prior to the event. Those who had longer stays in hospital often showed longer periods of clinical instability despite more opportunity for review and intervention. These findings are similar to previous research (Golhill and Sumner 1998, Goldhill et al 2004) which highlighted that mortality is higher in those who have a longer length of stay prior to intensive care admission or cardiac arrest. Another key finding from the NCEPOD (2012) report was that often when resuscitation from cardiac arrest was likely to be futile or anticipatory care planning for end of life was in place many patients did not have ‘Do Not Resuscitate’ decisions made. This finding was noted despite evidence in case reviews of missed opportunities for decisions to be made prior to the event. End of life decisions are relevant in the enquiry into the care and management of deteriorating patients as active intervention is not always appropriate or desired by patients.

Despite the research in the 1990's (Schein 1990, Franklin and Mathew 1994, McQuillan et al 1998, McGloin et al 1999) and the many recommendations since (NICE 2007, RCP 2007 & 2012, DH 2009, SIGN 2014); sub-optimal care or the failure to recognise and act on physiological abnormality may still remain.

Reviewing the adverse events of unplanned admission to critical care can be supported using theories of accident causation. There are many theories and some of these were considered to support my research (Kohn et al 2000, Weick 2004). Heinrich's Domino Theory suggests that factors can be visualised as a series of dominoes standing on edge; when one falls, the linkage required for a chain reaction is complete. Each of the factors is dependent on the preceding factor. This is a very person focused theory which suggests accidents are predominantly the fault of the person and unsafe acts (Waterston 2014). It also suggests that one error will always cause accident (domino effect) however in healthcare errors can occur without injury. For example, my findings suggest EWS scores can be miscalculated with no significance in causing harm to patients.

The aim of my research was to look at the process in the recognition and management of deteriorating patients rather than the individuals. Heinrich's Domino Theory was therefore discounted as a suitable theory to underpin my findings. Human Factors Theories are commonly adopted in healthcare, Amalberti (2006) suggest error results from physiological and psychological limitations of humans. He suggests that errors are caused by fatigue, heavy workloads, cognitive overload, poor interpersonal communication and flawed decision making. Croskerry (2009) adds that learning from past events or retrospective investigations cannot faithfully construct the context in which decisions were made from and subsequently, which actions followed. I agree that Human Factors Theories to explain errors cannot be explored from a retrospective design. This framework was therefore unsuitable for my study.

A model was found to suit my research methods. It is an organisational accident model for use in the understanding of the chain of events which can lead to an accident or adverse event. (Reason in 1990). The system approach is based on the assumption that humans are fallible and that errors are to be expected. Errors are therefore seen as consequences rather than causes. It postulates that when an adverse event occurs, the important issue is not who erred but how and why the defences failed.

When describing the system approach Reason (2000a, 2000b, 2013, 2016) describes defences, barriers and safeguards as being like Swiss cheese, that is, full of holes. Unlike Swiss cheese which is static, the holes are constantly opening, shifting and changing location. He suggests that a hole in one slice does not constitute disaster but when holes in many layers line up, a pathway of accident opportunity arises. The holes arise due to active failures and latent conditions. Active failures are unsafe acts committed by people who are in contact with the patient or system. Latent conditions arise however from the decisions made by those at a strategic level such as healthcare management. The method, is essentially, to examine the chain of events that leads to an accident or adverse outcome, and then look back at the conditions in which staff were working and the organisational context in which the adverse event occurred (Reason 1990, Vincent et al 1998).

This approach has been used in the studies of accidents in industry, transport and military fields. Reason's approach was therefore the chosen model used to relate to the concept of delayed recognition and management of patients at risk of clinical deterioration in general wards as it allows review of the chain of events leading to critical care admissions rather than the individuals.

2.7: Summary of the Literature Review

The literature review has exposed that there is no up to date objective evidence exploring the recognition and management of deteriorating patients in general wards prior to critical care admission. Research is required to further explore if sub-optimal care remains present in our acute hospitals. Given the criticisms of previous work which relied on expert opinion it would be very worthwhile to obtain objective data on the process of recognition and management of deteriorating patients. Research has been limited since initial work revealed the phenomenon of sub-optimal care and any recent confidential national enquiries have not incorporated recent research (NCEPOD 2005, NPSA 2007a, NPSA 2007b, NCEPOD 2012).

The use of EWS and nurses understanding of the importance of recognition of abnormal values requires a quantitative enquiry. Initially we must investigate whether EWS scores are accurate and timely from an objective quantitative study. Following the outcomes such a study it may then be necessary to undertake qualitative enquiry to understand why this may be the case. We do not know if there are still issues around EWS measurement until a quantitative analysis of EWS accuracy and frequency is undertaken.

Preventable morbidity and mortality is unacceptable and therefore further investigation in to the recognition and management of deteriorating patients is required. Patient care is multi-faceted and often complex. The processes involved in the recognition and management of deteriorating patient includes measurement, recognition, escalation and intervention and is spread throughout the patient journey. It is also a multi-professional responsibility. The whole process and all disciplines responsibilities should be the focus of new research. The aim to highlight and quantify any acts, omissions or system failures in the process of the recognition and management of patients who deteriorate in general wards.

Chapter 3: Methodological Framework

3.1: Research Methods

The purpose of this chapter is to discuss and explore the research methodology and research methods to support my study. The aim of my research was to investigate current practice in the recognition and management of deteriorating patients in acute care wards. The chosen study design is discussed including the choice of the methodology and reasoning for that choice. A description of the sample with an explanation of inclusion and exclusion criteria follows. The data collection tool is described and its development to meet the needs of the research are clarified. Relevant ethical considerations are also discussed prior to presentation of the results.

3.2: Aims

The overall aim of the research was to highlight potential failures in the process to manage deteriorating patients in acute care wards. It is anticipated that the findings from this study will influence future care by exposing areas for improvement in the recognition and management of deteriorating patients in acute care wards. To achieve the aims there was a need to review the care of patients prior to critical care admission. The purpose of the study was to identify any independent predictors which influence the likelihood of delay in recognition and management of deteriorating patients in acute care wards.

3.3: Objectives

- From the literature review identify the processes undertaken in the recognition and management of deteriorating patients
- Identify any failures in the optimum process of recognising and managing deteriorating patients to determine any independent factors which may predict delay in critical care admission
- Examine any relationships among clinically significant variables which may be an independent predictor of delay in critical care admission

3.4: Research Questions

1. What violations in the optimum process are associated with sub-optimal recognition and management of deteriorating patients and delayed critical care admission in patients triggering early warning scores in acute care wards?
2. Are there independent variables which can predict the delay in the recognition and management of deteriorating patients and subsequent critical care admission?

3.5: Null hypothesis

There is no association between the independent variables and the dependent variable (time from triggering EWS to admission to critical care to either 6 hours or less or more than 6 hours)

3.6: Methodology and Study Design

The purpose of this chapter is to discuss and explore the appropriate research methodology which enabled my research to be carried out. To determine the appropriate research design and intended methodology for this research it was important to consider the main philosophical positions.

The qualitative paradigm is associated with interpretivism, an epistemological position which means that the emphasis is on understanding the social world through interpretation of that world by those involved (Bryman & Bell 2004). It is also associated with an ontological view called social constructivism which holds that social phenomena are produced by those who make it up and that human behaviour in the social world can only be understood when the context in which it takes place and the thought processes that give rise to it are studied (Parahoo 2014). The qualitative paradigm and naturalistic methods of inquiry deal with the issue of human complexity by exploring it directly. They emphasise understanding the human experience as it is lived usually through subjective qualitative materials (Polit & Beck 2006), this is a major limitation as subjectivity lacks reliability and validity. Qualitative studies are often small in size, seeking to describe peoples' experiences. However, small in-depth sample sizes could be criticised for their inability to be transferable to the whole population. Many qualitative researchers reject the scientific notions of objectivity, replicability, generalisability, reliability and validity and adapt their own terminologies such as truth, value, applicability and consistency (Burns & Grove 2003).

Whilst qualitative research designs do have strengths within social and personal interaction enquiries, my research questions were objective. They were not aimed to explore lived experiences therefore qualitative methodology was not appropriate for my study. The qualitative paradigm was not utilised during the research as it did not support the questions, aims or objectives.

The quantitative paradigm has historically been the dominant one (Burns & Grove 2005) and is associated with positivism, which is an epistemological position that supports the application of methods of the natural sciences to the study of social reality and beyond. It is also associated with objectivism, which is an ontological position that implies that in our social world there is an existence, a reality that is totally independent and objective of the individuals that make it up (Bryman & Bell 2004). The view of science, which says that the factual basis of scientific knowledge is established through systematic observation and measurement, is known as empiricism (Polit & Beck 2010). The key attributes of scientific observation are accuracy and replicability, only when observations are appropriately summarised and confirmed by others do they form the factual bases of scientific knowledge (Polgar & Thomas 2000). In relation to theory, research in this paradigm tends to involve a deductive approach in which the emphasis is on the testing of hypotheses using a scientific method, measurement and statistical analysis (LoBiondo-Wood & Haber 2006).

A quantitative approach was therefore undertaken for the study. The choice of the methodology was based on the purpose of the research and the topic. Previous studies within the chosen subject have been criticised for being subjective, relying on personal opinions (McQuillan et al 1998, McGloin et al 1999). To avoid such criticism, this research involved only objective structured observation and measurement values. This approach is concerned with applying a set of rules or conventions that will allow us to produce scientifically valid knowledge (Polgar & Thomas 2000).

The study is non-experimental, often known as observational. These study types can be correlational (ex post facto) or descriptive. Descriptive research aims to observe describe and document aspects of a situation. It may describe relationships among variables without establishing causal connections, known as descriptive correlational research (Polit & Beck 2010). This study moved beyond

description of phenomena to identify any possible correlation between variables. This means that purely descriptive research was not an appropriate method.

Correlational studies aim to identify significant relationships and correlation between variables (Polgar & Thomas 2000). Variables can be active, such as a treatment or intervention or an attribute independent variable which is a measure of a characteristic (Morgan et al 1999), the first more suited to experimental designs whereby the second was appropriate for this study as there was no active variables only measurable characteristics. Correlational methodology was therefore the chosen design for the study.

Observational, non-experimental, correlational studies have previously been used to investigate deteriorating patients (van Galen et al 2016, Garry et al 2014, McQuillan et al 1998, McGloin et al 1999). Some studies undertaken prospectively and some retrospectively. Prospective designs are thought to be stronger than retrospective designs but are costly and time consuming. Retrospective designs link phenomenon observed in the present to phenomenon occurring in the past, trying to ascertain causative factors (Polit & Beck 2010). As discussed later in ethical considerations, it was not a viable option to undertake this study prospectively. A retrospective design was therefore adopted.

An observational study was undertaken, and correlational data analysis used to identify interrelationships among clinically significant variables. These variables are drawn from the process measures in the context of recognising and managing deteriorating patients in acute care wards. It is often difficult to draw cause and effect as correlation does not always prove causation and this is recognised as a weakness in the study design as other pre-existing differences may offer an alternative explanation of outcomes (Curtis & Drennan 2013). In healthcare this is particularly relevant as patient care is multi-factorial and complex. This study excludes any qualitative measures which may influence

decisions in managing the deteriorating patient. It is however recognised that other influences may have contributed to the delays noted in the recognition and management of deteriorating patients. Previous studies (McQuillan et al 1998, McGloin et al 1999) comment on factors such as quality of care or appropriateness of decisions but such aspects were out with the aims of this study and were not considered part of the research.

The dependent variable was derived from the strong evidence in the literature which depicted that physiological abnormality was frequently seen for up to six hours prior to cardiac arrest or critical care admission (Schein 1990, Franklin & Mathew 1994, Buist et al 1999). It is therefore six hours which was chosen to measure from triggering EWS to critical care admission that was measured in the study. It is recognised however that many patients may have been appropriately managed in the wards who were also triggering. It is also recognised that there may have been some initial response to interventions which would have caused delay from initial trigger on EWS to critical care admission.

3.7: Sample

Sampling methods vary but all involve a subset of the population. The population is an entire set of persons, objects or events which the researcher aims to study (Polgar & Thomas 2000). The sample frame for this study included all patients admitted to critical care from acute care wards within a six-month period in one district general hospital serving a population of 300,000. The weakness of using only one study centre is recognised. The sample was therefore a non-probability purposive sample. Bias from this type of sampling is recognised however, I the researcher aimed to reduce bias by including all the accessible population of cases that met the specified criteria.

An adequate sample size reduces the probability of sampling error (Polit & Beck 2010). Whilst the sample size was relatively small in comparison to some of the larger studies referenced in the literature review, this sample was the best representation possible within the time frame of the clinical doctorate programme.

3.8: Data collection

In quantitative studies researchers usually decide in advance what data they will collect and how they will collect it. Key dimensions include structure, quantifiability, obtrusiveness and objectivity (Polit & Beck 2010). A data collection tool was specifically designed to collect information from the case records of the population. The tool reflects local policy in the optimal process to recognise and respond to deteriorating patients. This aimed to determine where any violations occur. No qualitative data was included within the tool. Objective information included both accuracy of calculation of early warning scores and appropriateness of the timing of measurements. Information was collated on the time of escalation and time of review. The grade of the health professional who reviewed the patient was identified to determine the hierarchical level of clinician involved in each patient interaction. This was incorporated to enquire whether the response was appropriate to the clinical needs of the patient determined by the EWS and guided by local escalation policies (see appendices 3.1 – 3.4). The data collection tool also recorded whether a review took place or not and determined whether this was escalated by altered physiology causing a high EWS. The data collection tool recorded whether the patient was seen routinely or if there was no recorded review at the time of deterioration.

The tool was structured so the same information was gathered from all medical records. This structured data collection leads to easily quantifiable data. The objectivity of the data was determined using measurements which were not subjective. No patient identifiable information was collated during the study.

Case records are an economical and convenient source of information, but limitations include incompleteness and accuracy (Polit & Beck 2006). This did provide limitations to the rigour of the study as some data was missing due to poor documentation.

The data collection tool was tested for inter-rater reliability. Inter-rater reliability measures the degree of agreement and is assessed and scored to determine consensus between raters (Curtis & Drennan 2013). The inter-relater reliability tests demonstrated stability of the data collected attributable to the objectivity of the information requested.

As a pilot prior to final data collection, a group of one doctor and three nurses used the tool to test inter-relater reliability. Ten case records were reviewed, and data extracted by all group members. The data collection entries demonstrated consistency as only objective information was sought and no questions required subjective opinions of the group achieving reliability and construct validity.

The group also fed back on user friendliness in the design of the data collection tool. The consistency of data entry was robust, but the layout of the tool was constructively critiqued. Version one (appendix 3.1) was deemed to be in reverse order of the case note order. Initially the tool looked retrospectively from critical care admission to initial trigger on early warning scores. This was felt to be less useful in evaluating the case records by the team of reviewers. Version two (appendix 3.2) of the data collection tool therefore aligned the data collection from triggering on early warning scoring through to the critical care admission. Thereafter small changes were added to reflect options not initially predicted. In version two it was noted that some options required to be altered. This included adding an option of not applicable in the secondary escalation as it became clear that this did not always occur.

The consultant review section also required to have options added. The medical notes indicated that patients were reviewed routinely and not subsequent to an escalation call. It was felt necessary to differentiate those details due to the aims of the study of analysing whether the optimum processes of escalation occurred during deterioration. This was separated from routine consultant review which could occur by chance. A consultant review by chance would not equate to appropriate escalation processes. This led to version three (appendix 3.3) of the data collection tool but again options required review. The grade of reviewer was noted to be required to allow measurement of whether optimum process were followed. This relates to whether the appropriate grade reviewed patients depending on the level of physiological abnormality. The optimum process would be that any EWS score of six or more should be reviewed by a middle grade doctor or above. It is also best practice that consultants should be contacted if patients trigger for more than one hour without improvement. These additional details were added to the data collection tool subsequently leading to version four which was used for final data collection (appendix 3.4).

Once the verification process had been completed by the group and the final version of the data collection tool was agreed to be fit for purpose, I then attained the data from case note review.

3.9: Data analysis process

Quantitative data can be classified according to the level of measurement. Data can be classified in to categorical or numerical variables. Categorical data can then be separated in to nominal or ordinal. Nominal data involves using numbers to categorise attributes, the numbers assigned however, do not have quantitative meaning (Polit & Beck 2010). This study included some nominal data such as age and diagnosis. Ordinal measurement ranks objects based on their relative

standing on an attribute. The ordinal scale is different from the nominal scale in that the numbers signify the order or hierarchy of the variables (Curtis & Drennan 2013). Ordinal data was used during the study when measuring the grade of reviewer. The junior staff were grouped as Advanced Nurse Practitioner or foundation year one doctor. The middle grade staff were then grouped together and finally the consultant level staff were grouped as the highest level of hierarchy (appendix 4).

Numerical data measures the amount of something on a numerical scale. There are two types of numerical data namely discrete and continuous variables. Discrete data count how many or how often and are answered in whole numbers (Burns & Grove 2005). In this study discrete data collected included how often EWS were miscalculated, how often EWS frequency was not increased and how often patients were reviewed within an hour by the first responder or within six hours by a consultant. Continuous or scale data have an infinite number of values such as time (Curtis & Drennan 2013). Time was measured within the study which involves an absolute zero however due to the abnormal distribution of this variable it was then manipulated to a categorical variable prior to statistical analysis.

The data analysis below initially describes the sample and its characteristics. Independent variables were described and presented in figures (see results chapter). The research questions determined further statistical evaluation. Correlational descriptive statistics described the intensity and direction of the relationship between two variables, it did however do no more than describe. Some descriptive statistics were used to identify frequencies, but inferential statistics were used to seek relationships between the variables with the aim of making predictions.

The inferential statistic provided a means of determining how reproducible the obtained results were, by enabling access to a probability. The probability

associated with the value of an inferential statistic depicts the likelihood of chance or significance (Polgar & Thomas 2000). Inferential statistics involve testing hypotheses and bivariate tests are frequently used however this level of statistical analysis is not enough to measure the relationship between the multiple independent variables in this study (Robson 1993). A multivariate statistical analysis was therefore used. Multivariate statistical analysis methods are more complex and can deal with three or more variables simultaneously. There are various multivariate techniques including multiple regression, analysis of covariance and discriminant function analysis. The analysis specifically suited to the type of data in this study is the technique of logistic regression (Polit & Beck 2010). Logistic regression is useful when a researcher needs to predict the presence or absence of a characteristic or outcome based on a set of predictor variables. It is used to predict a dichotomous (two category) dependent variable when the independent variables are either dichotomous or interval (Bowling & Ebrahim 2005). Logistic regression transforms the probability of an event occurring into its 'odds'. It examines the relationship of the independent variables to the transformed dependent variable yielding an 'odds ratio' (Polit & Beck 2006).

To undertake such sophisticated statistical analysis, I utilised the SPSS Version 21 software package. A statistician was consulted through the university network for advice and support on data analysis and presentation.

Chapter 4: Ethical Considerations

4.1: Research Ethics Committees

NHS Forth Valley research and development were provided full details of the study and correspondence confirmed that the research did not need NHS R&D approval. The East of Scotland Research Ethics Service were also informed of the study and verified that the study did not require ethical review under the terms of the Governance Arrangement for Research Ethics Committees. Ethics application was then sent to University of Stirling School of Nursing, Midwifery and Health Research Ethics committee and was subsequently approved. Since approval was given this is now the Faculty of Health Sciences and Sport (see appendices 5-7 for verification of ethics application and approval process).

4.2: Confidentiality, Data Handling and Anonymity

Confidentiality was given great consideration throughout the research process. Caldicott Guardian approval was granted by NHS Forth Valley (appendix 8) and Caldicott principles were maintained at all times. The requirements of the Data Protection Act of 1998 (Gov.uk 2013) were followed at all times when handling patient information and referred to the best practice guidelines issued by the European Commission in the Researchers Code (UKRIO 2009).

To ensure confidentiality was maintained the following measures were taken

1. Data was collected by myself only, using Caldicott principles
2. Access to any patient identifiable data was limited to myself
3. Electronic data was secured on an NHS password protected computer which only I as researcher had access to. Any paper records were locked

securely in a filing cabinet which only I as researcher had access to. These paper or electronic records did not contain any patient identifiable data

4. No person-identifiable information was used after data collection. Cases were anonymised when information was transferred from case records to the data collection tool
5. Only the records relating to the study were viewed with no information unrelated to the study viewed within the case records, adhering to Caldicott principles
6. I adhered strictly to the NHS code of confidentiality & NMC code of conduct throughout the study
7. My supervisors only had access to anonymous data

4.3: Informed Consent

Individual informed consent was not gained for this study as per Caldicott principles. The decision to conduct analysis of patients' notes without gaining individual consent may have contravened the ethical principle of self-determination (autonomy), the right to full disclosure and the respect for human dignity. However, as the data collection was retrospective the principles of autonomy after the event do not apply. The ethical principle of justice was adhered to as there was no intervention, therefore no unfair treatment. There was no bias in the sample population, therefore no inequalities. The overriding principle to this ethical dilemma was directed to the 'greater good' as the study could provide evidence to support developments in improving the processes to recognise and manage acutely unwell patients in acute care wards. The results could potentially contribute to the reduction of unnecessary morbidity and mortality.

4.4: Potential Risks and Safeguards

The study did no harm to participants as the data collection was retrospective and therefore unobtrusive. Prior to the study start I was aware that potentially I could have found data collection emotionally difficult if sub-optimal care was identified and patients had suffered unnecessarily due to poor clinical practice. There was no safeguard to prevent this. Support was provided to me by both academic and clinical supervisors. To overcome this, I maintained focus on the overall benefits that could be achieved by finding areas for quality improvement and enhancing care for a larger population in the future.

It was agreed that if during data collection, consistent poor practice by an individual practitioner was identified, then clear reporting structures were required. Such reporting structures were agreed with the directors of those services (appendix 9.1 - 9.2).

4.5: My Role as researcher

Data collection was undertaken when patients were either recently deceased, discharged or still in hospital beyond the adverse event. I remained non-judgemental and was aware that during data collection the staff involved in the patients' care could potentially be present in the clinical area at that time.

The environment I collected data from was out with my own area of clinical practice therefore I gained consent of the appropriate management prior to entering. The agreed designated area for any data collection from remaining in-patients' clinical notes was identified as a multi-disciplinary room, located away from the patient care areas to respect patient privacy and dignity. This was also unobtrusive to any ward activity.

4.6: Summary of Ethics

Respecting the ethical principles of Beneficence and Non-maleficence: the study did not benefit individuals or did no harm to participants due to the retrospective observational design. As the data collection was retrospective the principles of autonomy after the event do not apply. The ethical principle of justice was adhered to as there was no intervention, therefore no unfair treatment. There was no bias in the sample population and therefore no inequalities and no person-identifiable information used in the study respecting confidentiality. An agreed reporting structure was outlined for any acts which constitute poor practice and could place future patients at risk from an individual clinician.

The overriding factor was for the ‘greater good’ as the findings could inform developments in improving the processes to recognise and manage acutely unwell patients in acute care wards in the aim to reduce unnecessary morbidity and mortality.

Chapter 5: RESULTS: Descriptive statistics

5.1 EWS Accuracy

Descriptive data was collected from the medical notes of all 157 patients. It was found that 30% of patients did not trigger on early warning scores prior to critical care admission (see Fig.1). Those who did not trigger on EWS later exited the study prior to inferential statistical analysis. The dependent variable is based on time from triggering on the EWS to admission to critical care; those who did not trigger were subsequently not included in the final analysis.

When measuring the accuracy of EWS scores all 157 patient records were included demonstrating that 59.2% (no. = 93) of patients did not have an accurate calculation of the early warning score. The calculation was analysed irrespective of the aggregate score (Fig.2).

Cross-tabulation demonstrated that scores of 4 or 5 were the most frequently miscalculated followed by scores of more than or equal to 6 (Fig.3).

Fig. 1: Early Warning Score (EWS) proportion

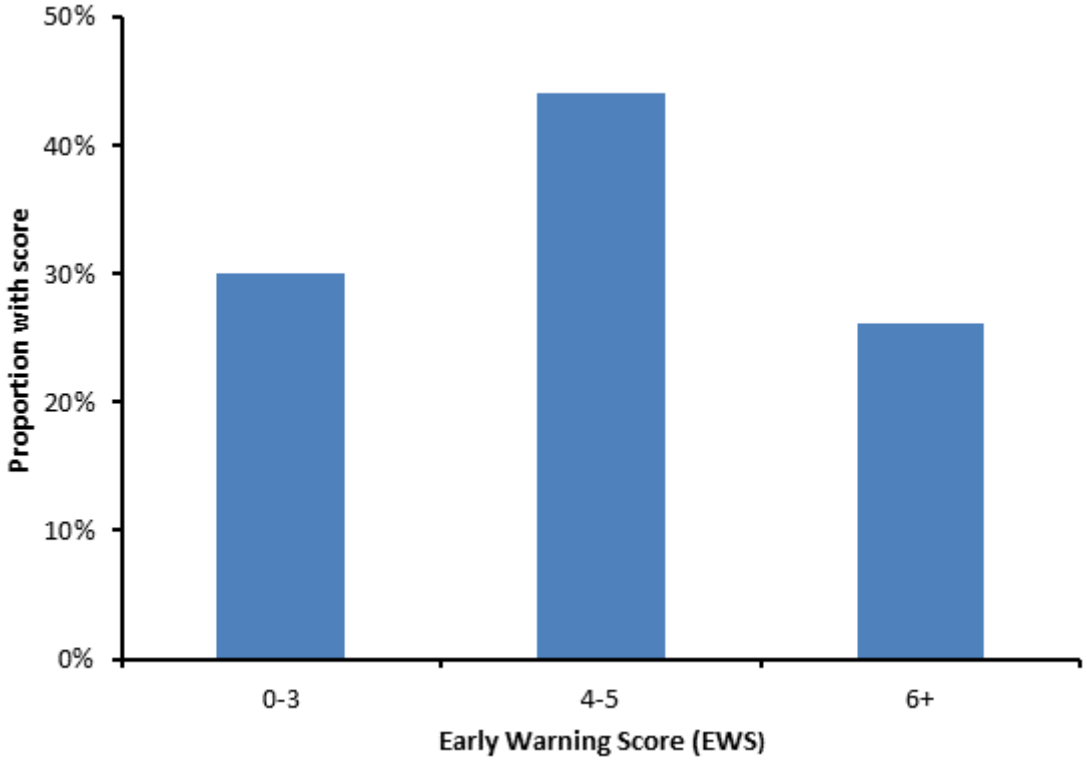


Fig. 2: Proportion of correct and incorrect EWS calculations

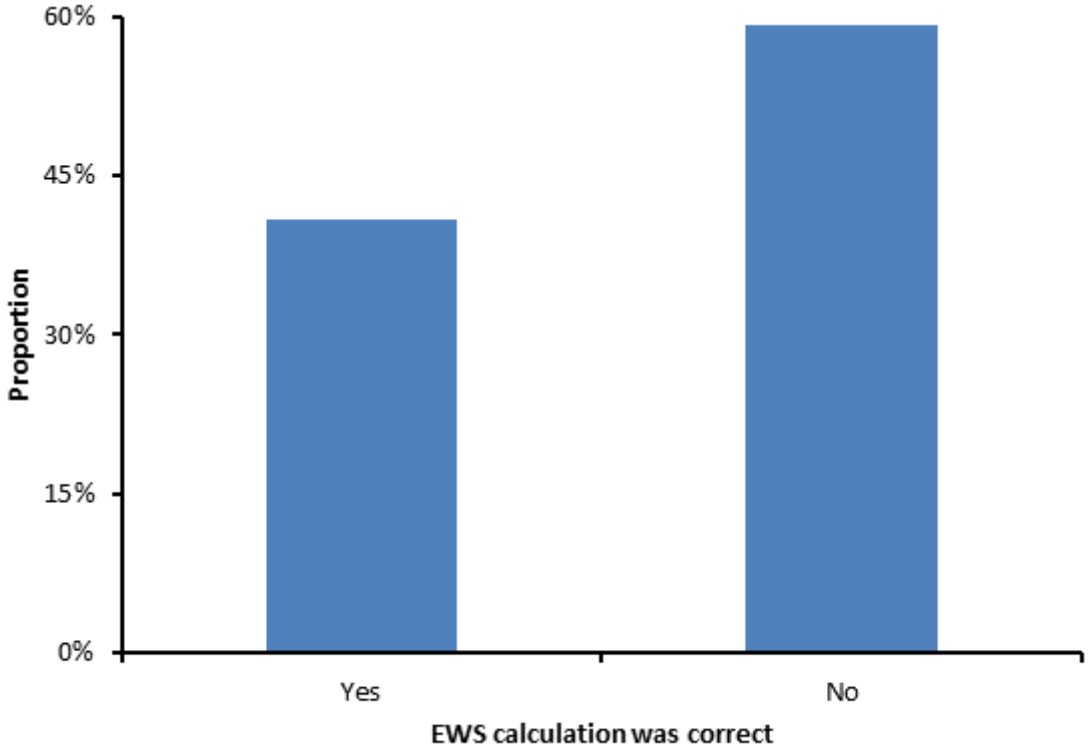
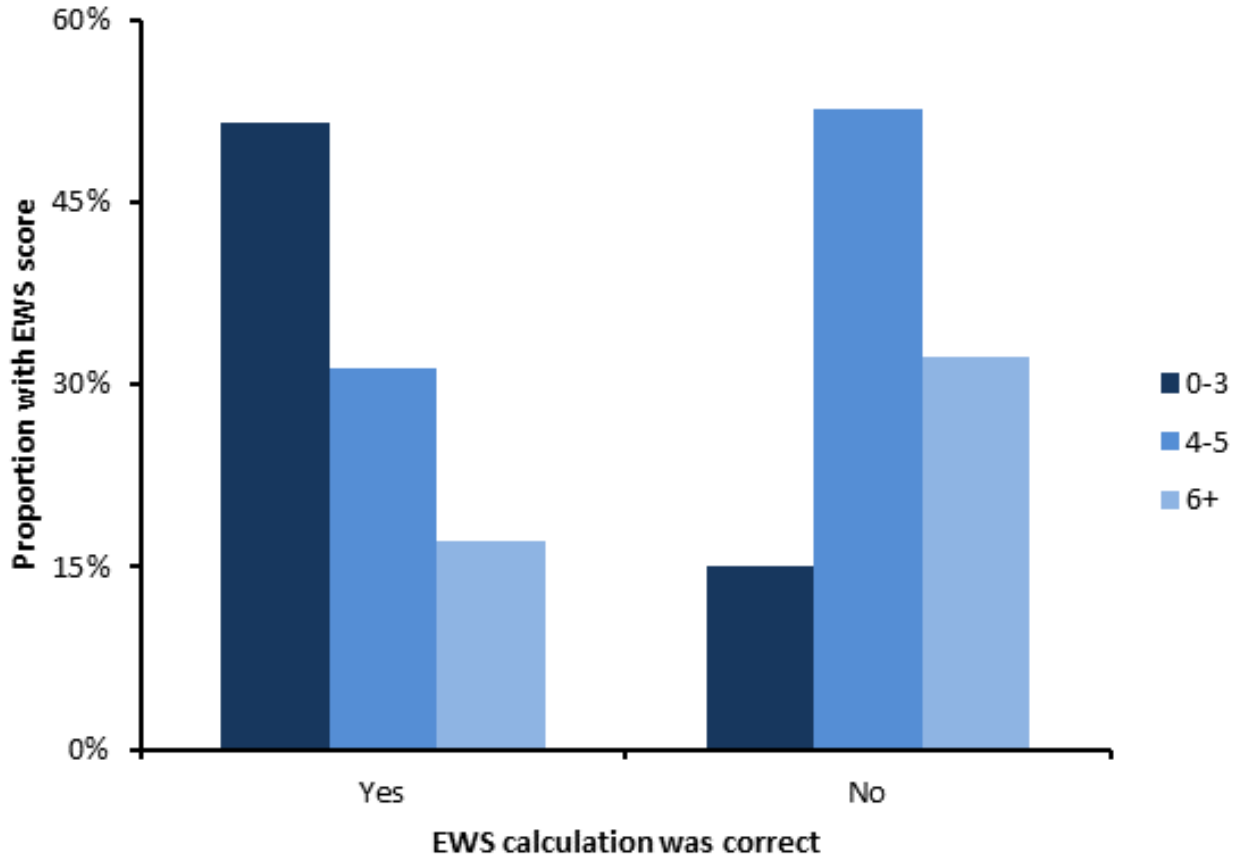


Fig. 3: EWS score by whether or not EWS calculation was correct



5.2: Frequency of EWS Measurement

If the EWS score is found to be out with normal limits (4 or more) then the frequency of EWS recordings should be increased in line with local guidelines. From the total 157 patients, 110 had EWS out with normal limits (4 and above). The results of whether EWS measurement was appropriately increased in those patients is displayed below (Fig.4.) This was then cross-tabulated with the EWS values to determine which EWS values were most frequently not increased (Fig.5).

Fig. 4: Proportion of whether or not EWS frequency was appropriate

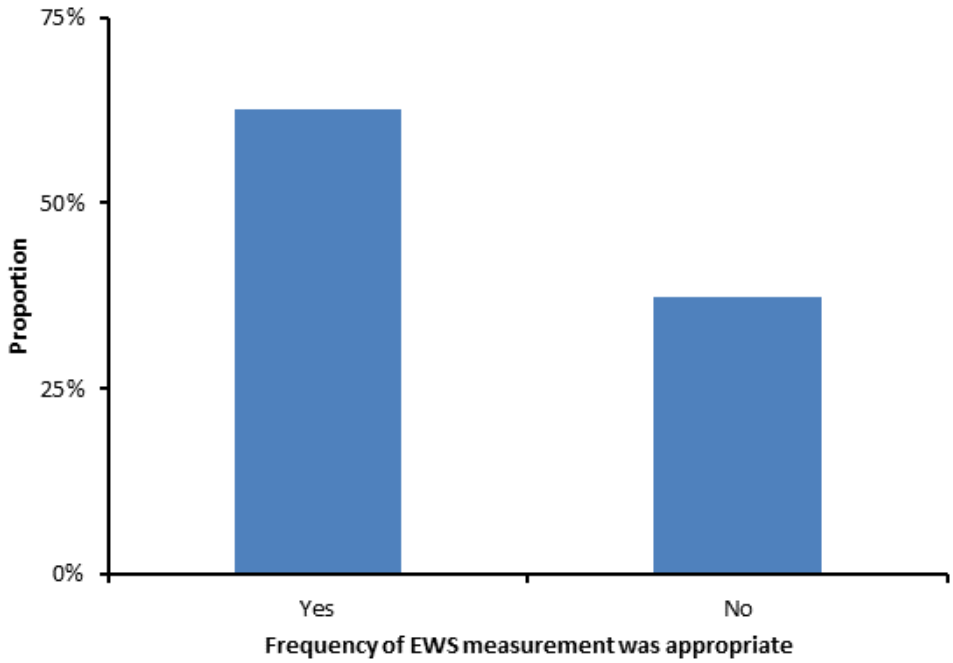
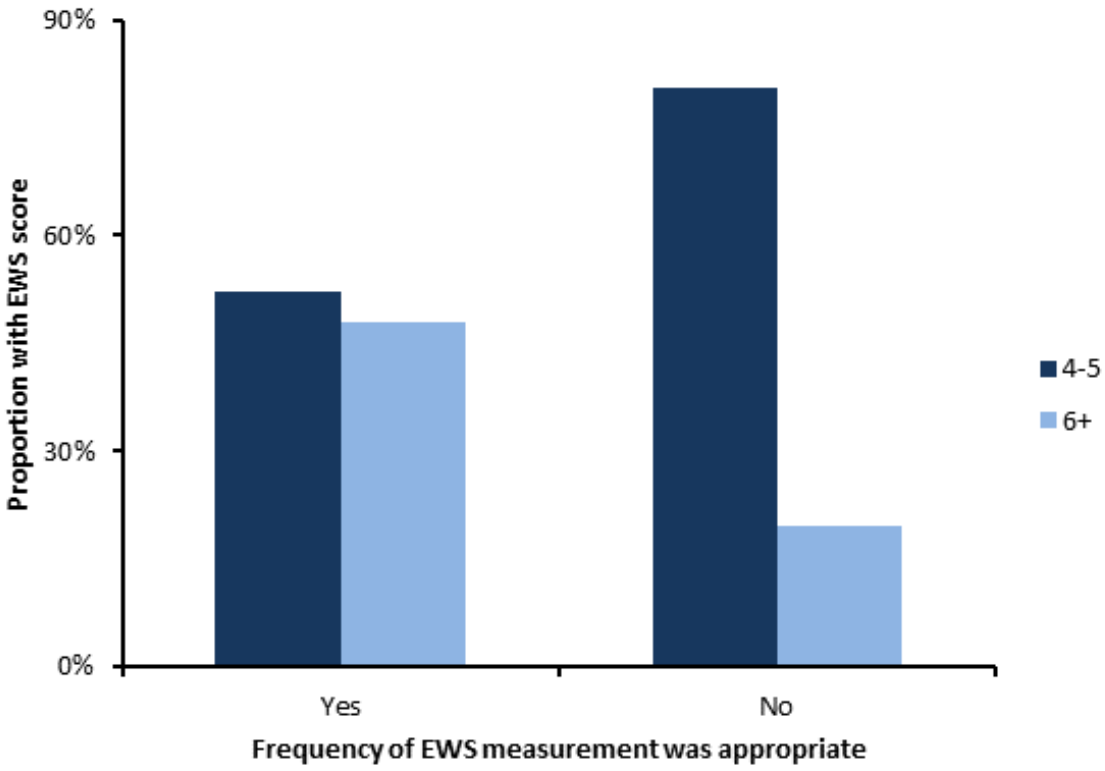


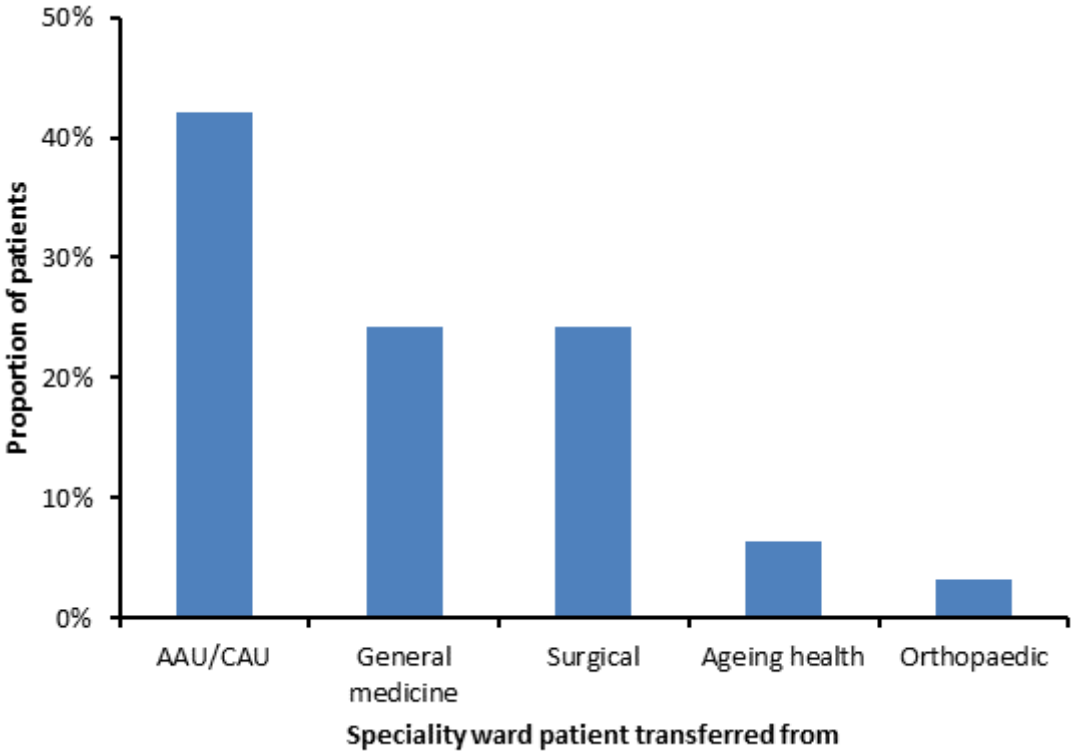
Fig. 5: EWS score by whether or not EWS frequency was appropriate



5.3: Demographics

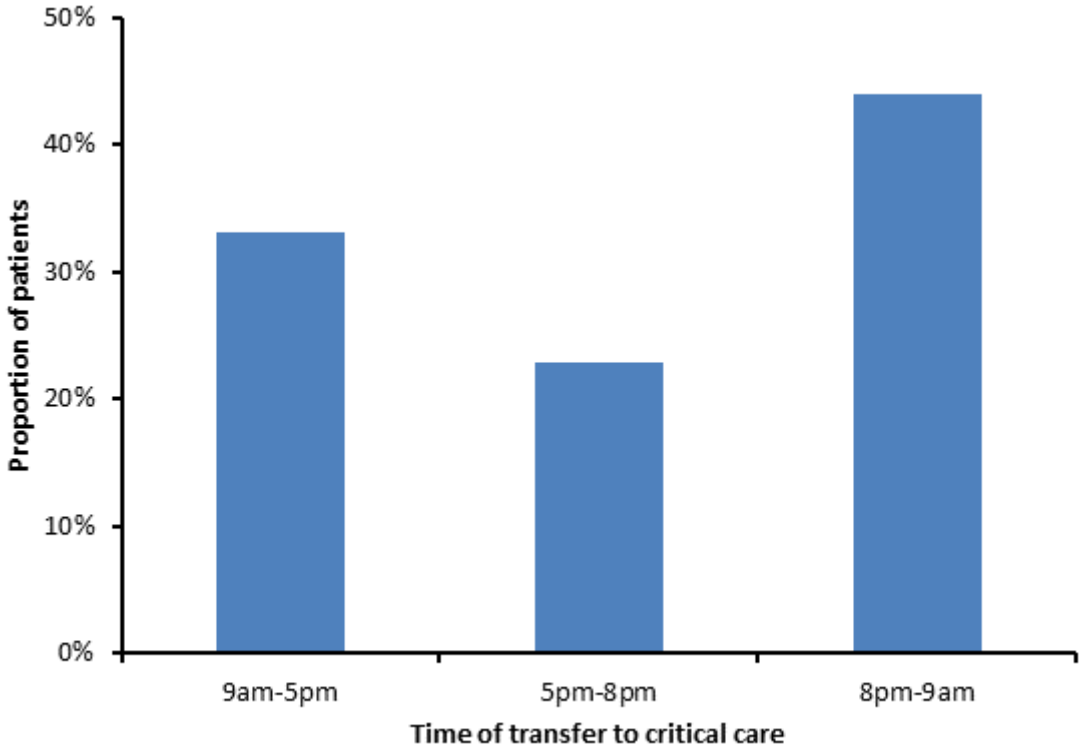
The patients admitted to critical care came from a number of wards which have been categorised into specialities (Fig. 6). Some specialist areas such as haematology, oncology or renal were also included but had no patients admitted to critical care during the data collection period.

Fig. 6: Proportion of patients transferred from specific speciality ward



Times of transfer to critical care were categorised in to three groups and represent working patterns in the NHS namely daytime (0900-1700hrs), evening (1701-2000hrs) and overnight (2001-0859) (Fig.7) Staffing levels traditionally reduce in each respective category.

Fig. 7: Proportion of patients transferred to critical care at specific time of day



The day of the week days patients were transferred to critical care was displayed to depict any specific days in which there were transfers. In particular week days versus weekends (Fig.8). The day of the week and the time of the day were then cross-tabulated to depict any patterns (Fig.9).

Fig. 8: Proportion of patients transferred to critical care at specific day of the week

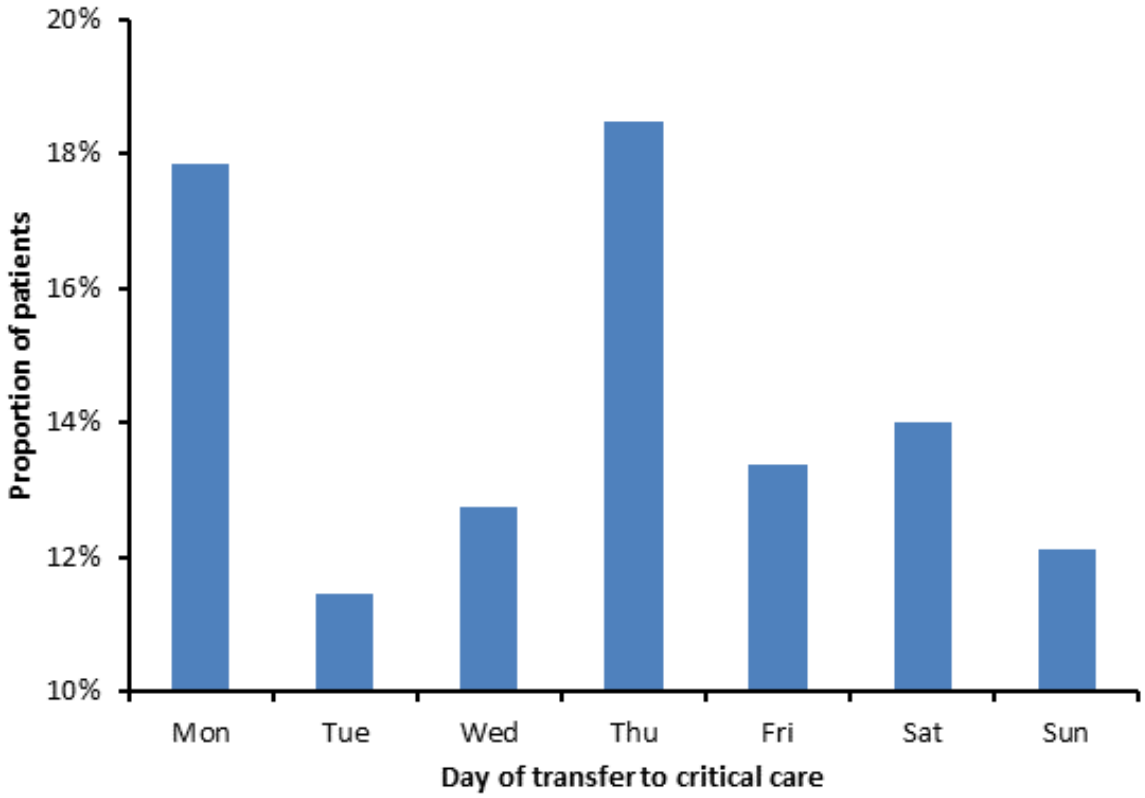
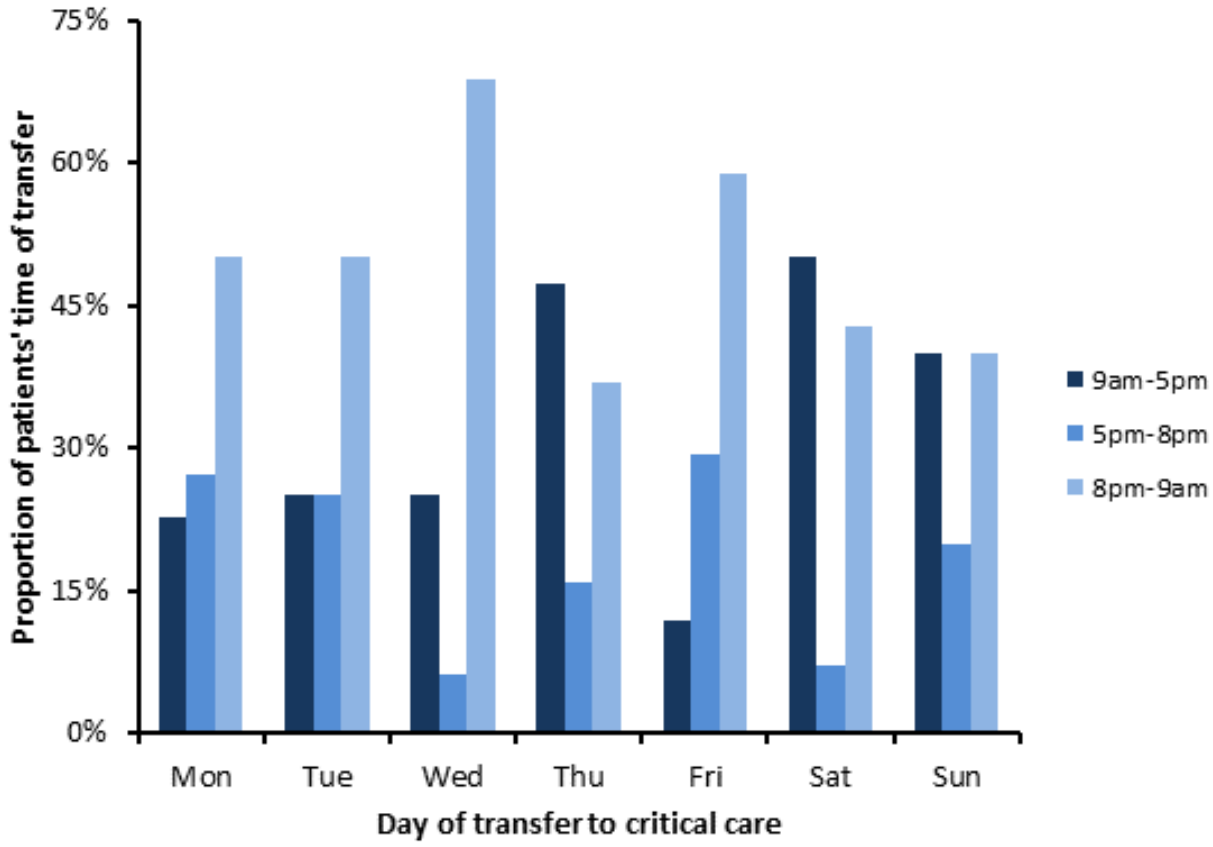
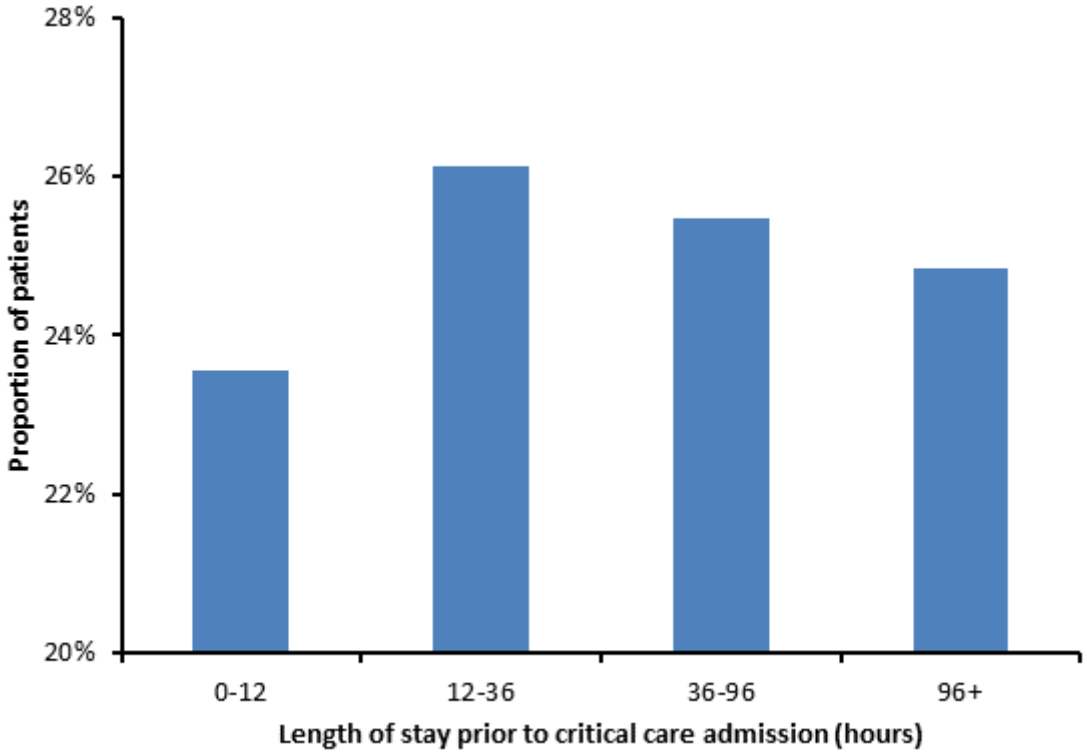


Fig. 9: Time of transfer to critical care by day of transfer



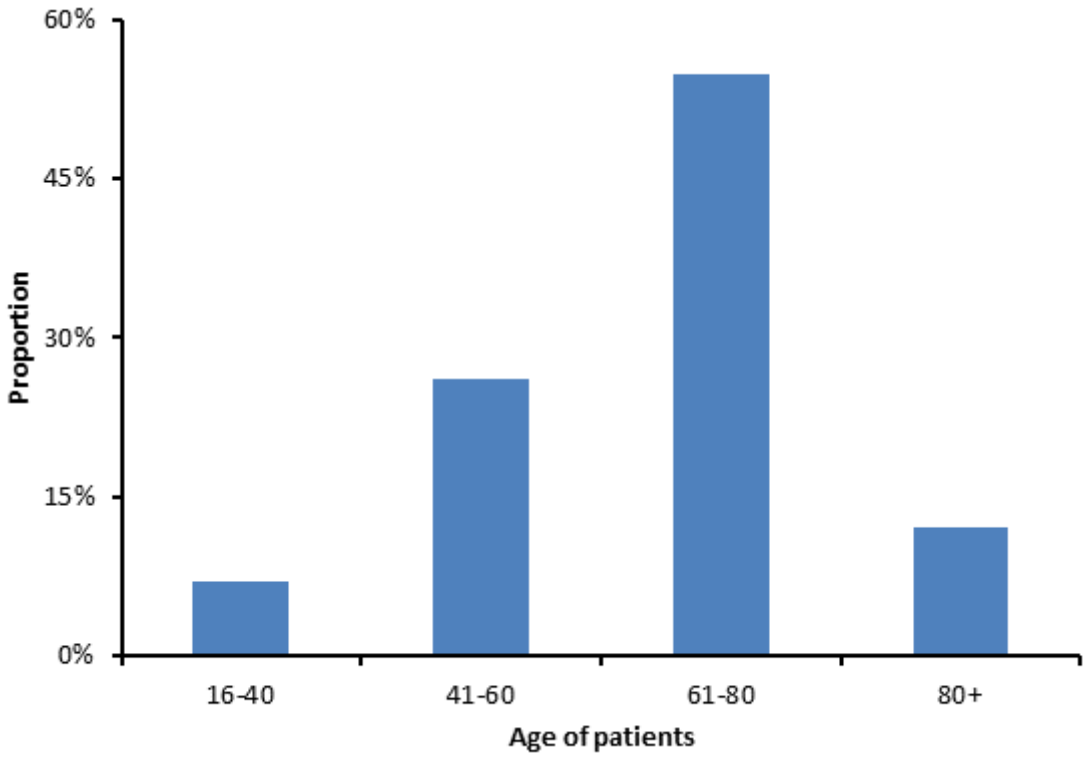
The length of stay of each patient prior to critical care admission was measured and categorised in to groups (Fig.10).

Fig. 10: Proportion of patients with specific length of stay prior to critical care admission



The ages of patients transferred to critical care were categorised as shown in Fig.11

Fig. 11: Proportion of age group of patients



Cross tabulation on length of stay prior to critical care admission demonstrated higher early warning scores were more prevalent in patients admitted to critical care between 0-12 hours from admission.

The data was then reduced to 110 patients who triggered on the early warning score total calculation of 4 or more. All patients who did not trigger on early warning scores exited from the study at this time.

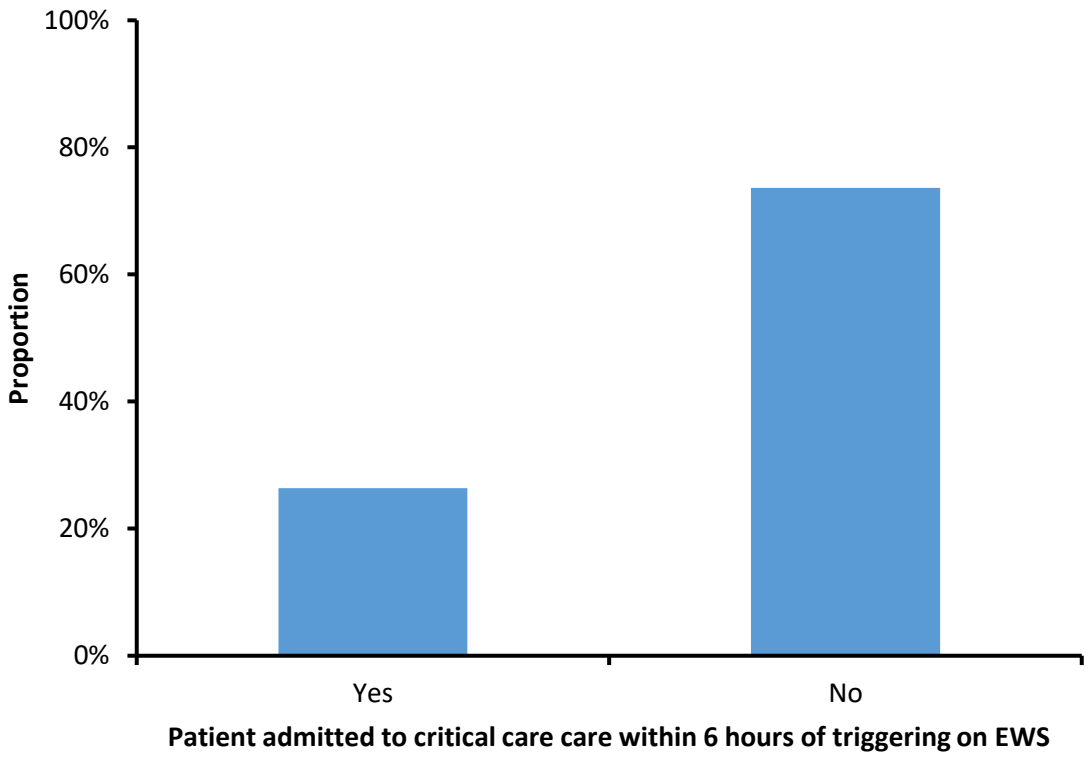
5.4 Categorising the Data

The numerical descriptive statistics demonstrated an abnormal distribution making analysis unreliable. The length of stay prior to critical care admission was initially a numerical variable but was abnormally distributed (skewed right). The time from triggering EWS to critical care admission was also abnormally distributed. These are displayed in appendix 11. The abnormal distribution led to the need to transform numerical data to categorical data. This subsequently determined the need to use non-parametric tests (Curtis & Drennan 2013). Frequency data were used within this study; that is, how often each variable occurs. Non-parametric techniques do not make assumptions on the shape of the population. They do not rely on a normal distribution and are also ideal when data has been measured using categorical data. They are however thought to be less powerful than parametric techniques (Pallant 2007). Non-parametric techniques do not require the assumption for random sampling but do need independence between cases (Sim & Wright 2000). The study met the criteria for using non-parametric techniques.

5.5: The Dependent Variable

Time from trigger of early warning score to admission to critical care was divided to become the binary dependent variable also known as binominal (Bryman & Cramer 2011). This was whether admission to critical care was less or equal to six hours or more than six hours from triggering EWS (Fig.12). The statistical technique that suited the study was binominal logistic regression.

Fig. 12: Patient admitted to critical care within six hours of triggering on EWS



The dependent variable of more or less than 6 hours was identified from the previous literature which depicted that abnormal physiology was present prior to patient deterioration as a median of 6 hours (Franklin & Matthew 1994, Buist et al 1999).

5.6: Refining the Independent Variables

Cross-tabulation was undertaken to determine association between variables. Cross-tabulation is the simplest and most frequently used way of demonstrating the presence or absence of a relationship (Bryman & Cramer 2011). Using the cross-tabulations allowed the independent variables to be individually evaluated for likelihood of relationship to the dependent variable prior to entering data for statistical analysis. A summary the significant and non-significant variables is shown Table 1 below

Table 1: Significance of association between categorical independent variables and dependent variable (patient admitted to critical care within 6 hours of triggering on EWS)

Variable	***p-value***
Assessment documented	0.416
Ceiling of care documented	0.969
Consultant contacted	0.259
Consultant plan documented	0.110
Consultant review within 6 hours of triggering EWS	**0.001**
Diagnosis category	0.817
Documentation of recognition of abnormal values	**0.006**
Escalation call documented	**0.002**
Escalation plan documented	0.234
EWS calculation correct	0.462
Frequency of observations increased appropriately	**0.006**
Grade of first reviewer	0.531
Length of stay prior to critical care admission	**0.001**
Patient reviewed within 1 hour of triggering EWS	**<0.001**
Review plan documented	0.190
Type of consultant review	**0.005**

Significance testing for all variables was performed using a chi-squared test. Inferential statistics are addressed are addressed in the following chapter.

Chapter 6: RESULTS: Inferential Analysis

Logistic regression is a multivariate analysis method that expresses the strength of the association between a binary dependent variable and two or more independent variables as adjusted odds ratios (Pallant 2007). To undertake logistic regression one categorical dependent variable must be identified. In this study the dependent variable was whether the time from triggering on early warning score to admission to Intensive care was 6 hours or less (0) or more than 6 hours (1). Predictor (independent) variables were then identified and the strength or the relationship tested by cross-tabulation and those with the strongest relationship were chosen to enter the logistic regression model. The non-significant variables were subsequently not entered in the binary logistic regression model. Logistic regression requires an adequate sample size (more than 50) and adequate cell count (5 per cell) (Pallant 2007). Failure to meet these expectations results in a violation of assumptions. These accepted levels were achieved in this study.

Pearson chi-square test is used to determine whether there is a true relationship between variables or whether this has occurred by chance (Bryman & Cramer 2011). This is a test of statistical significance calculated by comparing the actual frequencies with those that may occur by chance (expected frequencies). The further these observed values are from the expected values, the more likely that there is a significance. The chi-square test is then transformed to a p value. A p value of <0.001 suggests that there is a less than 1 in 1000 likelihood the result occurred by chance. Likewise, a p value of <0.05 suggests there is a less than 1 in 500 likelihood the result occurred by chance. A p value is thought to be significant if <0.05, this is the stated alpha level (Rumsey 2010).

The independent variables entered were:

- Length of stay before critical care admission
- Was escalation documented?
- Was EWS frequency appropriate?
- Was there consultant review within 6 hours of triggering?
- Excluded – was the first medical review within 1 hour of triggering (47% missing data)

The outcomes of the binary logistic regression are summarised in Table 2 below

Table 2: Significance of association between categorical independent variables and dependent variable (patient admitted to critical care within 6 hours of triggering on EWS)

Significant Variables	Pearson chi-square (p value)
Frequency of observations increased appropriately	**0.013**
Length of stay prior to critical care admission 12-36 hours	**0.014**
Consultant review within 6 hours of triggering EWS	**0.045**
Non-significant Variable	Pearson chi-square (p value)
Was escalation documented	0.051

The binary logistic regression analysis with the predictor variables showed some significant findings. This therefore rejects the null hypothesis that there is no association between the independent variables and the dependent variable (time from triggering EWS to admission to critical care to either six hours or less or more than six hours)**.** A discussion of the results presented in chapters five and six now follows.

Chapter 7: Discussion

7.1: Introduction

Failure to recognise deteriorating patients and delaying critical care admissions is a healthcare safety issue which can increase unnecessary morbidity and mortality (NCEPOD 2012, Kause et al 2004, NCEPOD 2005). Concerns about safety originate from the growing realisation that health care is an industry that frequently, and often avoidably, harms vulnerable people (Reason 2016, Hurwitz & Sheikh 2009). Improving recognition and management of deteriorating patients is a priority for the NHS. Effective recognition and management of the deteriorating patient is an integral aim of the Scottish Patient Safety Programme and the Healthcare Quality Strategy for NHS Scotland (2010). Similar work is ongoing nationally and internationally (ACSQHC 2012, NPSA 2007b, NHS Wales 2010). In that work consistent and reliable improvement methods are suggested, however until there is an understanding into the causes of 'sub optimal care' then appropriate improvement methodology cannot begin. Improvement methodology requires the identification of a need to change (NHS Wales 2010). My research aimed to expose areas to direct improvement work in the care of deteriorating patients in acute care wards.

The first research question in this study was to identify any failures in the optimum process of recognising and managing deteriorating patients in acute care wards. This would determine any independent factors which may predict sub-optimal recognition and management of deteriorating patients and delay critical care admission. To do this the optimum process measures were evaluated to depict any failures in the system. These failures of process then became independent variables.

This study examined a group of patients admitted to critical care from general wards to determine events prior to that admission. Descriptive analysis of the data demonstrated numerous sub-optimal events during the process of recognition and management of deterioration. From this descriptive data, the subsequent research question was to identify whether any particular measures of the process (independent variables) could predict failure in the recognition and management of deteriorating patients and subsequently delay critical care admission. The study findings aligning to key areas identified in the process of recognition and management of deteriorating patients are discussed in the following sections. The process is explained before detailed discussion on each of the measures.

The first step in the process of recognition of deterioration is measurement of Early Warning Scores (EWS). As identified in the literature, EWS enable ward staff to combine their routine observations to produce an aggregate physiological score, the higher the score the sicker the patient (Sharpley and Holden 2004).

If abnormal physiological values are found, then this should be recognised, and escalation processes actioned. The first contact should be appropriate to the level of clinical instability (RCP 2007). Response should be timely with assessment undertaken and documented. This assessment should formulate a management plan and interventions should be initiated (DH 2009). Where response to interventions is unsatisfactory and abnormal physiology remains, further escalation is required. Consultant referral is required if abnormal physiology persists as he/she is the most senior clinician and has overall responsibility for the patient's care (NCEPOD 2012). In this study all 110 patients who had abnormal EWS did not respond to the interventions undertaken by the health care professionals. They did not resume normal physiological stability as all required transfer to critical care. It is out with the realms of the study as to whether this was due to poor quality decisions on treatments or interventions although it should be recognised that this may have been the case. This

research focused on the process measures involved in the appropriate recognition and management of deteriorating patients demonstrated in a process map (see appendix 10). This is reinforced by a copy of the local escalation policy relevant at the time of data collection (see appendix 2). Policies are adapted from national guidance (RCP 2012) and are localised to encompass variations in practice due to accessibility of resources between health boards.

Initial discussion of the results is framed around the first step in the process of recognition and management of deteriorating patients, the measurement and recording of physiological data. The discussion focuses on the concept that EWS measurements should be both timely and accurate (NICE 2007, NPSA 2007) and compares the study findings to the national recommendations.

7.2: Accuracy of EWS calculations

This study explored the accuracy of the EWS calculation and found that most were calculated incorrectly. Previously studies have also found miscalculation rates of 21.9% (Smith & Oakey 2006) to 42% (Mohammed et al 2009). However, I found the percentage of incorrectly calculated EWS was 59%. This finding, although alarming, was not statistically significant in prediction of delay in admission to critical care. Calculation errors in EWS were less evident in the lower scores - in those with a score of 4 or less the error rate was 15%. As the least frequently miscalculated scores were those <4, this finding concurs with Smith & Oakey (2006) who demonstrated that abnormal EWS scores (higher scores) were most frequently miscalculated. I examined miscalculations in more detail and found that the most frequently miscalculated scores were the intermediate scores (EWS 4 or 5 – error rate 52%) rather than in the highest scores (6 or more – error rate 32%). Smith & Oakey (2006) only categorised to the normal versus abnormal EWS. If this divide was replicated in my study, then

findings would concur, however the full picture of miscalculation would not have emerged. It is of note that I found that the highest scores were less frequently miscalculated than the intermediate. If the miscalculation was purely a numerical addition error, then it would be logical that the highest scores would have more miscalculation. I believe that perhaps within this pattern of miscalculation, there may have been misinterpretation or lack of knowledge on how to use the chart.

The EWS charts were reviewed in all cases up to 48 hours prior to critical care admission if applicable (alternatively, all the admission time for those with a length of stay less than 48 hours). Within that timeframe, all EWS entries on each chart were assessed. Approximately half of the total EWS entries had data missing. There was no clear trend of missing data, rather this varied across the parameters required and the wards where the patients were admitted from. Missing parameters varied and included the two oxygen saturation points required if applicable, respiratory rate, the age trigger of >70, blood pressure, temperature, conscious level and heart rate. There was no evidence to support that the lack of respiratory rate measurement was most frequently omitted. This has been previously highlighted in the literature (Chellel et al 2002, Kenward et al 2001). There were some cases where each respiratory rate entered was identical which would raise concerns over the reliability of the measurement. There were also cases where all respiratory rates were all recorded as even numbers. This could arouse suspicion that respiratory rate was measured for less than a minute and multiplied. However, due to the retrospective design this cannot be proven. The recording of respiratory rates is worthy of further investigation in a prospective observational study.

The literature previously reviewed (Kenward et al 2001, Buist et al 2002, Bellomo et al 2003) all emphasised improvement in EWS measurement with education programmes to deepen knowledge of the use and understanding of the chart. This was not a resource available within my study centre at the time of data collection and therefore may have impacted on the high error rate results.

Recognition of abnormal values and evidence of escalation forms part of the recognition and management of deteriorating patients. My data demonstrated that 66.4% of abnormal physiology was recognised and documented. If abnormal physiology is recognised, the frequency of EWS calculations should be increased. Local and national policies guide the increased frequency times however, the general concept is that the higher the EWS score, then the more frequently the EWS should be measured. The next section focuses on the frequency of EWS measurements.

7.3: Measurement of the frequency of EWS recordings

The first significant finding to emerge from my research was that if there was not an appropriate increase in the frequency of observation recording then this could predict a delay in critical care admission. Local and national policies determine how frequently physiological observations should be recorded (appendix 2). This is directed by the level of early warning score; the higher the physiological abnormality the more frequently EWS should be recorded. EWS measurement is predominately the role of nursing staff in the UK.

Morris & Davies (2010) published the results of their audit on EWS compliance. They identified poor compliance with EWS completion including missing data or omitted or incorrect scores. They also noted a lack of increase in the frequency of observations but did not quantify the data clearly or evaluate the impact of this. In my study the frequency of observations was only appropriate in 69% of the sample. Despite the inappropriate frequencies being a smaller percentage than those who followed local policy, poor compliance in increasing the frequency of EWS monitoring was significant in predicting delay to critical care admission. This has not been documented in the literature to date. The EWS value which most frequently failed to result in an appropriate increase in frequency of measurement

was the intermediate values (EWS 4 or 5). These were also the scores most frequently miscalculated (error rate 52%). The results revealed that 80% of the EWS values 4 or 5 did not have appropriate increase in frequency of measurements. The scores of 6 or more demonstrated less deviation from optimum process appropriately increasing the frequency of EWS measurements in 80% of the cases (error rate 20%). They also had a lesser calculation error rate than the intermediate scores (error rate 32%). The results suggest that patients scoring 4 or 5 therefore are very much at risk of sub-optimal care.

These results demonstrate a clear deviation from the optimum process in recognising deterioration. The abnormal physiology when calculated to a score of 4 or more should trigger escalation to an appropriate doctor or advanced nurse practitioner for rapid assessment.

7.4: Escalation of care to appropriate healthcare professionals

The process to escalate care should be prompted by abnormal EWS values or clinical concern. Not only must the responder be informed of the patient's deterioration, but they should also undertake patient assessment and must initiate appropriate action. The quality of actions was purposely excluded due to the subjectivity exposed in previous studies (McQuillan et al 1998, McGloin et al 1999). Instead my research looked at the objective data on timing of response from escalation to review. This demonstrated failures to meet expected response times. The local policy where this study occurred promotes first response within 20 minutes from escalation. Allowing time for patient assessment prior to the associated documentation which is often retrospective to the review, a further 40 minutes were provided. This subsequently provided a variable of whether patients were reviewed and initial assessment documented within one hour of activation of escalation. I found that only 34% met this target with 19% not reviewed within an hour from triggering EWS / escalation being activated.

A significant amount of data was missing. There was no documented assessment time by first responders in 47% of the study participants. Initially in cross tabulation the time to first review looked significant in predicting delay to critical care admission however, due to the large amount of missing data this was not entered into the logistic regression model. Poor documentation is a recurring theme and is discussed in more detail later. After initial assessment and intervention, the patient should be reassessed. Hierarchical escalation to more senior clinicians is the expected action if patients do not clinically improve and this is discussed in the next section.

7.5: Involving the Senior Decision Maker during Patient Deterioration

The senior decision maker responsible for the care of the patient in an acute hospital is the named consultant physician or surgeon. Early involvement of consultants in the management of deteriorating patients is promoted by national guidelines (NCEPOD 2012, DH 2009, RCP 2007, NCEPOD 2007). It is an expectation that NHS Boards comply with best practice guidance. I found that only 18% of patients were reviewed by the consultant within the six-hour period of deterioration and 66% of patients were not reviewed by consultants during the 6 hours of deterioration. Data was missing in 16% of study participants where it was unclear from the case records if the consultant had been involved. This again highlights poor documentation. The data analysis however found that there was a statistically significant correlation between whether a consultant reviewed a patient and delay to critical care admission. If consultants were not involved during the patients' deterioration, then this had a negative impact on time from triggering EWS to critical care admission. Both McQuillan et al (1998) and McGloin et al (1999) suggest a lack of early consultant input was significant in their results, but they did not quantify how frequently this occurred. In their studies there was no clear evidence to correlate the lack of consultant input to the delayed critical care admissions that they both claimed. Although all the national

guidance advocates early senior clinician involvement in deteriorating patients there is no clear underpinning evidence currently available to determine the impact on patient outcomes. My research highlights the need for early consultant involvement in the recognition and management of deteriorating patients to prevent delay in critical care admission. As part of my study I also looked at non-human factors which may be associated with poor recognition and management of deteriorating patients and the following section explores the organisational and environmental factors influencing the time of critical care admission.

7.6: Organisational and Environmental Factors Influencing the Time of Critical Care Admission

Organisational and environmental factors which may influence delay in critical care admission were also explored in this study. The data therefore included other independent variables such as what day or time patients were transferred to critical care. These two variables were used to determine whether reduced staffing ratios commonly seen in the evening, overnight or at weekends influenced the timing of critical care admission. The time of day or day of the week when patients were first triggering on EWS or the day or time of transfer to critical care were not significant in predicting any delays in the process. In addition the age or diagnosis of the patients and the ward patients were transferred from were categorised and cross tabulated but were not predictors in delay to critical care admission. This finding supports the notion that delay in transfer to critical care is not specific to any clinical area or to reduced staffing levels but is a whole system problem.

A statistical significance in the delay of transfer to critical care was shown in patients with a length of ward stay between 12-36 hours. Although there is no clear reason for this variable to be significant, this finding could be related to

common NHS organisational processes. The time between 12 hours and 36 hours is often after the first review and consultant assessment. I would suggest that these patients are initially assessed and treatment initiated but then become less of a priority than the new patients arriving to be assessed. This is not an active failure but mirrors the numerous competing demands of modern acute care receiving units (RCP 2007).

The time from admission between 12-36 hours can also often be a time of transfer of care from assessment to speciality wards. The handover process could potentially have some influence on the recognition and management of deteriorating patients. The British Medical association (BMA 2004) worked jointly with the National Patient Safety Association and the General Medical Council to emphasise the effect handover can have on patient safety. They highlight that the transfer of care is often a time of high risk to patient's clinical care and they offer guidance on safe handovers to improve patient safety. Handover of care may have contributed to the recognition and management of deteriorating patients however, this could not be explored in the study. Time of transfer may have been difficult to determine due to the retrospective methodology and possible poor supporting documentation.

The data from both descriptive and inferential analysis demonstrates that there are many deviances from the accepted standard of practice throughout the time patients show evidence of deterioration. Unplanned critical care admissions resulting from the lack of recognition and management of deteriorating patients is considered an adverse event in healthcare (Vincent et al 1998).

Chapter 8: Interpretation of results though Reason's model

8.1: Overview of Reason's Model

Reason (1990, 1995, 2000a 2000b, 2013, 2016) suggests that two approaches to the problem of human fallibility exist: the person and the system approaches. The person approach focuses on unsafe acts; errors and procedural violations of those at the sharp end of care delivery such as nurses and physicians. These unsafe acts are derived from aberrant mental processes and variability in human behaviour. The system approach is based on the assumption that humans are fallible and that errors are to be expected. Errors are therefore seen as consequences rather than causes. It postulates that when an adverse event occurs, the important issue is not who erred but how and why the defences failed.

Reason (2000a, 2000b) and Dekker (2007) claim that the person approach remains the dominant mechanism in healthcare and are critical of its usefulness. Reason (2000a, 2000b) depicts weaknesses in the system suggesting that focussing on the individual origins of error isolates unsafe acts from the context of the system. He suggests that blaming individuals is more convenient and is in the interests of managers to distinguish a 'persons unsafe acts' from any organisational responsibility. He claims that errors are not random mishaps but are most often recurrent patterns and advises that the same set of circumstances can provoke similar errors independent of the individuals involved. He also suggests it is often the best people who make the worst mistakes. This view is shared by Armitage (2009) as he suggests experts are compromised by the mental storage of information as novel processes become mastered through repetition and become automated, leaving room for error.

When describing the system approach Reason (2000a, 2000b, 2013, 2016) describes defences, barriers and safeguards as being like Swiss cheese, that is, full of holes. Unlike Swiss cheese which is static, the holes are constantly

opening, shifting and changing location. He suggests that a hole in one slice does not constitute disaster but when holes in many layers line up, a pathway of accident opportunity arises. The holes arise due to active failures and latent conditions. Active failures are unsafe acts committed by people who are in contact with the patient or system. Latent conditions arise however from the decisions made by those at a strategic level such as healthcare management. The method, is essentially, to examine the chain of events that leads to an accident or adverse outcome, and then look back at the conditions in which staff were working and the organisational context in which the adverse event occurred (Vincent et al 1998).

It is essential to determine some of the cognitive processes which underpin the theory of human error. Cognitive processes that predispose to error originate from the same cognitive processes and behaviours that do not lead to error (Dekker 2011). Reason (1990) defines errors of action and planning as a slip (a potentially observable error which results from failure in the execution regardless of the original plans' accuracy). An example of which may be a nurse who walks into the wrong room to attend a patient. It is an error in the human automation process where there is no conscious control and the individual's normal routine is disturbed, even although the initial plan is correct. Slips are thought to be inherent in expert practitioners who master processes and become automated (Armitage 2009). If practitioners are only capable of handling one complicated high-level activity at a time but the auto-mode allows for multi-tasking, then expert practitioners can often undertake several routine activities simultaneously (Duthie 2010). Introducing higher level activities, whilst a practitioner is multi-tasking increases the cognitive burden and raises the risk of an active failure (Reason 1990).

A lapse is simply forgetting something for example when we enter a room and perhaps momentarily do not remember what our initial plan of action was or when we forget to do something at a specific time, a simple lapse.

The third category is mistakes, human performance is stratified into three levels: skill based, rule-based and knowledge based. Reason (1990) suggests that active failures may occur within any of these three levels. Skill based errors occur when highly skilled practitioners functioning in auto-mode lose focus due to distractions or preoccupation. Rule based errors occur when a situation is inappropriately assessed and new rules are inappropriately applied to the setting. Knowledge based errors occur when an individual is in an unfamiliar environment or situation, but applies familiar problem-solving methods, forced to process information consciously they may not have the appropriate knowledge, skill-set or experience to do.

Comparing the evidence gained from my study in the context of Reason's model (1990), I would suggest that most of my findings can be aligned to the system approach. Exploring the active failures of those involved in direct contact with patients demonstrated numerous procedural violations. The findings in my study are discussed in relation to Reasons model of human error (1990) and the Swiss cheese model described earlier (Reason 2000a 2000b, 2016). This discussion is constructed using the chronological order of events in which care should take place when a patient shows signs of deterioration (see process map appendix 10).

8.2: Adopting Reason's Model to Explore the Study Results on the Accuracy and Frequency of Early Warning Scores (EWS)

In this study recording timely and accurate EWS was identified as a failure to follow process despite the belief that their introduction in hospitals would simplify the decision-making aspects surrounding altered physiology and calling for help (Sharpley and Holden 2004).

The accuracy of the calculation of EWS was poor and the lack of increase in the frequency of observations was noted to be statistically significant in delaying transfer to critical care. This immediately identifies failures in two stages of a process and system to expedite successful recognition and management of deteriorating patients. The physiological parameters must be recorded in a timely, reliable and consistent process (this process should be approved at a strategic level). Any deviance from this accepted standard of practice (an active failure) will immediately emerge as a hole in a layer of Swiss cheese. Vincent et al (1998) suggests errors arise primarily from informational problems such as inattention whereas violations are more often associated with poor motivation, poor role modelling from senior staff or inadequate management in general.

The high numbers of inaccurate EWS or lack of appropriate increase in frequency could be described as a routine violation (those that are widespread and frequent) whereby such violations become part of the normal way of working (Hurwitz and Sheikh 2009). Vaughan (1996) and Amalberti et al (2006) suggest such violations are a result of an accepted culture of repeated violations from optimum processes, highlighting that social routines mask the issues. Violations set in gradually over time with individuals becoming lax in their performance. They refer to this as 'normalisation of deviance', which is maintained by the tolerance of the behaviour and the absence of reaction from senior management. Hurwitz and Sheikh (2009) postulate that two assumptions are made by those who develop and implement protocols in healthcare. First, they assume that the

rules will be followed and second, that those using the rules have both the competence and motivation to follow them.

It may be argued that the nurse has made a knowledge based mistake, a failure of intention caused by a deficit of knowledge regarding the importance of frequency of observations or of how to accurately record EWS (Meurier 1999). Poor models of staff education or inadequate dissemination of information of the standards expected in completing EWS is however not an active failure but a latent condition. Latent conditions are ‘the resident pathogen’ (Reason 1990) which can precipitate error-provoking conditions within the workplace. They can create long lasting gaps in the defence mechanisms (another hole in another layer of the Swiss cheese). Other examples of latent failures are conditions of work, heavy workload, a stressful environment, inadequate supervision and rapid change within an organisation (Vincent et al 1998). All of these could be extrapolated into the daily activities in an acute care environment but were out with the aims of my study.

8.3: Adopting Reason's Model to explore the process of recognition, escalation and response in deteriorating patients

Recognition of abnormal values and documentation of escalation was identified to be poorly compliant with local guidelines. It is difficult to ascertain whether failure of the nurse to trigger action when finding abnormal physiology is a knowledge based mistake or violation. If violation, then is it a routine violation (frequent and becoming normal practice), an optimising violation (cutting corners) or an exceptional violation (extreme time pressures or stress prevent the rule to be followed). Inadequate knowledge or experience, inadequate supervision, heavy workload or a stressful environment would unfold underlying latent failures. If the nurse was unable to contact the responder due to lack of equipment (no available telephone, causing delay) then this could be perceived as a situational violation but if she could not find the information required to know who to contact then it becomes another latent condition as it exposes inadequate systems of communication (Hurwitz and Sheikh 2009). This information was out with the parameters of my study as the data collection was retrospective and situational awareness or other influencing factors at the time of deterioration were unknown.

Response time to first review of deteriorating patients was within acceptable parameters (less than 1 hour) in only 34% of the sample. There was evidence of delay (beyond an hour) in 19% of the sample. However, in almost half of the sample (47%,) there was no documentation of time rendering this invalid for statistical analysis. We cannot presume that poor documentation equates to delay in response of the practitioner or *vice versa*. The poor adherence to healthcare documentation standards (NMC 2015, GMC 2013) within the case records suggests this may be a routine, optimising or exceptional violation. There is no evidence that this could have influenced the care of the deteriorating patient, but this is a clear violation of policy and is therefore an active failure. Left unchallenged this then becomes a latent condition.

I found a statistically significant delay to critical care admission when consultants did not review deteriorating patients. Only 18% of patients had a review by the consultant at the time of deterioration and 66% did not. This influenced the timeliness of critical care admission. Again, documentation standards fell below expectations with 16% of the data missing from the case records as documentation of times were omitted.

A length of stay between 12-36 hours was found to be statistically significant as a risk for delayed recognition and management of deteriorating patients. It cannot be aligned to any specific part of the process therefore suggests an underlying organisational error, a previously unknown latent failure. This phenomenon requires further exploration.

Applying Reason's model (1990) illuminates how healthcare providers need to look at the processes, learn from mistakes, identify knowledge deficits and tighten defence barriers. It is important not to focus on the individuals or issue blame but to look at the systems and organisational structures to identify why and how errors or violations occur.

My study provides new knowledge on the care of deteriorating patients in acute care wards. It identifies numerous violations from optimal processes and should inform future improvement work. It exposes latent failures which must be addressed to improve patient safety and reduce preventable morbidity and mortality. To conclude a summary of the key findings and the implications for practice will now be discussed.

Chapter 9: Conclusion

Implications for Practice and Future Research / Study Limitations

The overall aim of my research was to highlight potential failures in the process to manage deteriorating patients in acute care wards. It was anticipated that the findings from this study could influence future care by exposing areas for improvement in the recognition and management of deteriorating patients in acute care wards. I believe that these aims were met through the research.

The research questions were answered. I exposed what violations in the optimum process were associated with sub-optimal recognition and management of deteriorating patients and delayed critical care admission in patients triggering early warning scores in acute care wards. I also found that there were independent variables which can predict the delay in the recognition and management of deteriorating patients and subsequent critical care admission. These were – whether the frequency of EWS measurements was increased appropriately, a length of stay between 12-36 hours and whether consultants reviewed patients within six hours of triggering EWS. This therefore rejected the null hypothesis that there is no association between the independent variables and the dependent variable (time from triggering EWS to admission to critical care to either 6 hours or less or more than 6 hours)**.**

The literature depicted physiological abnormality was frequently seen for up to six hours prior to cardiac arrest or critical care admission (Schein 1990, Franklin & Mathew 1994, Buist et al 1999). Relating to my experience in clinical practice, I did consider that in retrospect the target of six hours may not be a realistic goal from first triggering EWS to admission to critical care. Since completion of the initial study, the data was re-analysed with a target of twelve hours from trigger to critical care admission. This reflects the National Intensive Care Evaluation criteria who define an unplanned critical care as; an admission that could not

have been deferred for at least 12 hours (Arts et al 2002). The results of this analysis show that two of the independent variables remain statistically significant in predicting delay to critical care and are displayed in the table below.

*Table 3: Significance of association between categorical independent variables and dependent variable (patient admitted to critical care within **12 hours** of triggering on EWS)*

Significant Variables	Pearson chi-square (p value)
Consultant review within 6 hours of triggering EWS	**0.002**
Frequency of observations increased appropriately	**0.042**

From my findings, areas requiring further investigation have been identified. A recurring theme which emerged from the research was the tendency of all levels of healthcare professionals to deviate from optimum processes. This deviation was evident in every identified stage of the recognition and management of deteriorating patients. The normalisation of deviance suggests a culture that accepts poor practice. This is a latent failure at an organisational level and must be addressed to reduce unnecessary morbidity and mortality. Research to explore why health professionals do not comply with optimum processes should be undertaken. The recurring finding that documentation was poor also depicts a deviance of optimal process which requires exploration.

Although my research did not identify that the traditional reduced staffing levels in evenings and overnight had any significance in the delay of critical care admission, I recognise these categories of time were a broad generalisation. I did not relate staffing levels in individual cases of delay to critical care admission due to the retrospective design of the study. The deviation from optimum processes may have been influenced by the staffing levels, ward acuity, activity or ward overall patient dependency. Evidence exists that demonstrates higher staff to patient ratios can reduce failure to rescue and 30-day mortality rates.

Aitken et al (2015) found that an increase in a nurse's workload by just one patient increased the likelihood of an inpatient dying within 30 days of admission by 7%. Further research on linking outcome measures to staffing levels, staff education and morbidity and mortality is required. Prospective research exploring case studies would give insight in to external influences in any delay in the recognition and management of deteriorating patients.

The lack of accuracy and frequency of EWS measurements is substantial. Education must be a key priority for healthcare staff to promote accuracy of EWS. Any misconceptions need to be addressed to ensure a reduction in any knowledge based mistakes. As previously discussed, it is not clear from the lack of robust evidence that the utilisation of MET teams is the solution to sub-optimal care however some of the literature reviewed, did demonstrate improvement in EWS compliance when this deployment strategy was combined with on-going education (Kenward et al 2001, Buist et al 2002, Bellomo et al 2003). Future research should be undertaken to link the education supporting the implementation of any future EWS to patient outcomes.

Providing education programmes to healthcare staff is fundamental not only in the use of the EWS tool but also to promote the importance of appropriate escalation. The literature reviewed suggested that perhaps nurses undervalued the significance of physiological abnormalities (Cox et al 2006, Cioffi 2000, Kenward & Hodgetts 2002, Minnick & Harvey 2003) yet a strong body of evidence exists to relate this to poor patient outcomes (Cei et al 2009, Burch et al 2008, Duckett et al 2007, Goldhill et al 2005, Buist et al 2004). In the face of such evidence, including mine, education must incorporate the significance of EWS scores to patient outcomes and make the relationship between them clear.

Although not statistically significant in predicting delayed critical care admission, my research identified that EWS scores were frequently miscalculated. The results showed higher error rates than previous studies (Smith & Oakey 2006,

Mohammed 2009). The causes of why the error rate was so high was was out with the parameters of the study. To gain a deeper understanding of this, exploration of the underlying causative factors would be worthy of future research. Such research may expose that errors were a knowledge based mistake and could possibly identify latent conditions such as poor staff education.

One of the key findings in my research was that patients were most at risk of delay to critical care admission by purely the time they had been in hospital - patients at 12-36 hours after their admission being at the highest risk. Unlike other independent variables this was not an identified step in the process outlined in appendix ten. The lack of increase in frequency of EWS and the lack of consultant input are easier to comprehend as contributing factors in the delay to critical care admission. As I previously discussed this finding could be associated with a time after first assessment, consultant review and management plan. When these patients have treatment initiated then they are over prioritised by the new presentations requiring initial assessment. They may not have interventions reassessed and deterioration could potentially be missed.

The period of 12-36 hours after admission may also may be a time of transfer of care which potentially could increase risk. It is well known that transfer of care can result in a risk to patient care (BMA 2004). I recognise that my theories about this result are based purely on clinical experience and I have no research based evidence to support this. I do however, have an extensive familiarity of acute care nursing and can give experiential insight in to the normal processes in acute receiving units. I would encourage further investigation to understand this significant period of risk for patients.

Previous studies (Goldhill & Sumner 1998, Goldhill et al 2004) have suggested that the longer the length of stay before critical care admission, the higher patient mortality. My study did not collate data on mortality as an end point but focused on the care of patients prior to critical care admission. In retrospect I would have

included patient outcomes including length of stay in critical care and mortality. My study provided evidence that the highest period of risk to delayed critical care admission is early during patient admission not those with longer lengths of stay. I did not investigate whether this related to a higher mortality. Including this in my research may have challenged the findings of earlier studies. This comparison in patient outcomes from the length of stay prior to critical care admission would be worth investigation.

The findings from this study bear significance to future practice. Based on my results there are now identified areas in the management of deteriorating patients that can focus future improvement work. It is hoped that healthcare providers providing direct patient care and the senior management teams use the findings of this study to implement change methodologies to improve patient safety. This change implementation could potentially reduce unnecessary morbidity and mortality.

This research provides an original contribution to the evidence on the care and management of deteriorating patients. There are now significant variables which can predict delay to critical care admission in the deteriorating patient. This encompasses many of the multi-professional failures to follow optimal processes. Organisational recognition of potential latent failures must be addressed to protect patient safety and prevent unnecessary morbidity and mortality.

Study Limitations

The retrospective design of the study limited any understanding of any contributing factors which may have influenced the results such as staffing levels, ward acuity and any human factors such as communication and team work. It also does not gie any recognition to those patients triggering on EWS who were managed appropriately in the acute ward.

The study was undertaken on a single site, and while the results are informative, this is recognised as limiting generalisation of the findings. The sample size was limited to those patients admitted within a six-month timeframe due to the time constraints of the time constraints of a doctoral study.

The identification of persistent basic documentation errors such as date and time omission from case records was evident and potentially weakened this study. A consequence was that a significant independent variable could not be statistically analysed due to missing data - the independent variable of ‘time to first review’. Hypothetically, the missing data may have influenced the significance of other independent variables.

Local Impact of the Research

Many improvements have been made within the study site based on my preliminary findings. Improvement work started prior to the thesis submission and an overview of the subsequent improvement work follows. The EWS chart, which was found to be frequently miscalculated was replaced by the national early warning score (NEWS). This was implemented with structured education for all clinical staff. A team of three nurses were employed for 18 months to support ward staff in the recognition and management of deteriorating patients. This

included education around EWS and appropriate escalation. Regular audit of the EWS was undertaken by the team initially and then this responsibility was given to the senior charge nurses (SCN). The SCN now continue to review the NEWS charts accuracy and frequency weekly. This data is then entered on an organisational quality indicator dashboard. There has been great improvement in the accuracy and frequency of NEWS measurements. The quality of nurse documentation is also measured and entered on the dashboard.

Recognition of deteriorating patients and escalation policies are now a recognised core content of medical staff induction. The doctors rotate three times in the year and a session on NEWS and escalation is provided on each of the three induction days. A full educational day is provided for all new foundation year one doctors. This is a scenario-based simulation with a focus on deteriorating patients and is provided prior to their exposure to the clinical environment. Regular education days are offered in the simulation centre for all clinical staff, also with a focus on deteriorating patients. The evidence from my research has influenced my decision to lead this development. It also inspired me to work collaboratively with my local Higher Education Institution to develop a specific level nine academic module on the recognition and management of acutely unwell adults.

The deteriorating patient improvement team adopted the relevant parts of my data collection tool to continue to review all patients admitted to critical care. This has now become normal practice and is collated and fed back at a weekly hospital wide meeting. Cases that suggest any evidence of sub-optimal care are fed back to the senior nursing and medical staff. They are then asked to undertake a structured review and subsequent learning. This process also identifies any cases which would require an organisational significant event analysis. Cases are presented at both department and hospital wide morbidity / mortality and clinical governance meetings.

A focus on supporting the acute receiving unit was undertaken as it was identified that this was where most patients admitted to critical care were from. A failure mode needs analysis was undertaken by a group nurses and doctors and identified barriers in the process to recognise and manage deteriorating patients. It was evident that often the escalation process was not clear due the number of teams working in the unit simultaneously. Often nurses or junior doctors were unsure who to call. We developed clear escalation boards displaying contact details for each team. We released all nursing staff for education around deteriorating patients and used this opportunity to share patient stories on the sequence of events which delayed critical care admission. This was very powerful in providing meaning to the education sessions. The resuscitation training team have facilitated in -situ scenarios taking the simulation equipment to the ward environment to relive identified cases and learn from them. Medical and nursing staff were given the opportunity to be involved in the improvement work and as a unit team we managed to reduce our cardiac arrest rate.

As an organisation we have made many improvements, however there are still patients who have delayed critical care admission. There are still missed opportunities to recognise or act on early signs of deteriorating patients. The process of improvement in the recognition and management of deteriorating patients remains an ongoing endeavour.

Reference List

Academy of Medical Royal Colleges (2007). *Acute health care services: report of a working party of the academy of royal colleges*. London: AoMRC

ACSQHC (2012) Australian Commission on Safety and Quality in Health Care. *National safety and quality health service standards*. Sydney: ACSQHC

Aitken, L, Sloane, DM, Bruyneel, L Van den Heede K, Griffiths P, Busse R, Diomidous M, Kinnunen J, Kózka M, Lesaffre E, McHugh MD E Moreno-Casbas, MT, Rafferty AM, Schwendimann R, Scott A, Tishelman C, van Achterberg T, Sermeus W (2015) Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study*. Lancet* 383 (9931) pp.1824-1830

Amalberti, R., Vincent, C., Auroy, Y., de Saint Maurice, G. (2006). Violations and migrations in healthcare: a framework for understanding and management. *BMJ Quality and Safety in Healthcare* 15 (1) 66-71

Andrews, T. and Waterman, H. (2005) Packaging: a grounded theory of how to report physiological deterioration effectively. *Journal of Advanced Nursing* 52 (5) 473-481

Armitage, G. (2009) Human error theory: relevance to nurse management. *Journal of Nursing Management* 17 193-202

Arts D, deKeizer N, Scheffer G J, deJongeE (2002) Quality of data collected for severity of illness scores in the Dutch National Intensive Care Evaluation (NICE) registry. *Intensive Care Med*. 28(5) pp.656–659.

Ball, C., Kirkby, M., Williams, S. (2003) Effect of the critical care outreach team on patient survival to discharge from hospital and readmission to critical care: non-randomised population based study. *British Medical Journal* 327 (7422) 1014-1018

Barbetti, J. and Lee, G. (2008) Medical emergency team: a review of the literature. *Nursing in Critical care* 13 (2) 80-85

Bion, J.,F.and Heffner, J.E. (2004) Challenges in the care of the acutely ill. *The Lancet* 363 970-977

BMA (2004) *Safe handover: safe patients*. London: BMA

Bellomo, R., Goldsmith, D., Uchino, S., Buckmaster, J., Hart, G.K., Opdam, H., Silvester, W., Doolan, L., Gutteridge, G. (2003) A prospective before-and-after trial of a medical emergency team. *MJA* 179 (6) 283-287

Bowling, A and Ebrahim, S. (2005) *Handbook of Health Research Methods*. Berkshire: Open University Press

Bryman, A., Bell, E. (2004), *Social research Methods*, New York: Oxford University

Bryman, A. and Cramer, D. (2011) *Quantitative Data Analysis with IBM SPSS 17, 18 & 19, A guide for Social Scientists*. Sussex: Routeledge

Burch, V.C., Tarr, G., Morroni, C. (2008) Modified early warning score predicts the need for hospital admission and in-hospital mortality. *Emergency Medical Journal* 25 674-678

Buist, M., Jarmolowski, E., Burton, P.R., Bernard, S.A., Waxman, B.P., Anderson, J. (1999) Recognising clinical instability in hospital patients before cardiac arrest or unplanned admission to intensive care. A pilot study in a tertiary-care hospital*. Medical Journal of Australia* 171 (1) 22-25

Buist, M.D., Moore, G.E., Bernard, S.A., Waxman, B.P., Anderson, J.N. (2002) Effects of a medical emergency team on reduction of incidence of and mortality from unexpected cardiac arrests in hospital: preliminary study. *BMJ* 3241-6

Buist. M., Bernard, S., Nguyen, T.V., Moore, G., Anderson, J. (2004) Association between clinically abnormal observations and subsequent in-hospital mortality: a prospective study. *Resuscitation* 62 137-141

Burch, V.C., Tarr, G., Morroni, C. (2008) Modified early warning score predicts the need for hospital admission and in-hospital mortality. *Emergency Medical Journal* 25 674-678

Burns, N. and Grove, S.K. (2005) *The Practice of Nursing Research: Conduct, Critique and Utilization*, 5th Ed, Elsevier Saunders: Missouri

Cei, M., Bartolomei, C., Mumoli, N. (2009) In-hospital mortality and morbidity of elderly medical patients can be predicted at admission by the Modified Early Warning Score: a prospective study*. Internal Journal of Clinical Practice* 63 (4) 591-595

Chellel, A., Fraser, J., Fender, V., Higgs, D., Buras-Rees, S., Hook, L., Mummery, L., Cook, C., Parsons, S., Thomas, C. (2002). Nursing observations on ward patients at risk of critical illness. *Nursing Times* 98 (46) 36-39

Cioffi, J. (2000) Nurse' experiences of making decisions to call emergency assistance for their patients. *Journal of Advanced Nursing* 32 (1) 108-114

Cox, H., James, J., Hunt, J. (2006) The experiences of trained nurses caring for critically ill patients within a general ward setting. *Intensive and critical Care Nursing* 22, 283-293

Cretikos, M. and Hillman, K. (2003) The medical emergency team: does it really make a difference? *Internal Medicine Journal* 33 511-514

Croskerry, P (2009) Context is Everything or How Could I Have Been That Stupid. *Healthcare Quarterly* 12 pp. 171-177

Curtis, E.A. and Drennan, J. (2013) *Quantitative Health Research*. Berkshire: Open University Press

Day, A., Oldroyd, C., McDaniel, S. (2010) The Use of Early Warning Scores in the Emergency Department. *Journal of Emergency Nursing* 36 (2) 154-155

Dekker, S. (2011) *Patient Safety: A Human Factors Approach*. Boca Ratton: CRC Press

Dekker, S. (2007) *Just Culture: Balancing Safety and Accountability*. Surrey: Ashgate Publishing Limited

DeVita, M.A., Braithwaite, R.S., Mahidhara, R., Stuart, S., Foraida, M., Simmons, R.L. (2004) Use of medical emergency team responses to reduce hospital cardiopulmonary arrests. *Quality & Safety in Health Care* 13 251-254

DOH: Department of Health (2000). *An organisation with a memory: learning from adverse events*. London, DOH

DOH: Department of Health (2000). *Comprehensive Critical Care: A review of adult critical care services*. London: DOH

DOH: Department of Health (2007). *Emergency care ten years on: reforming emergency care.* London, DOH

DOH: Department of Health (2009). *Competencies for Recognising and Responding to Acutely Ill Patients in Hospital*. London, DOH

Donabedian, A. (2005) Evaluating the Quality of Medical Care, *The Milbank Quarterly*, 83 (4) 691-729

Duckitt, R.W., Buxton-Thomas, R., Walker, J., Cheek, E., Bewick, V., Venn, R., Forni, L.G. (2007) Worthing physiological scoring system: derivation and validation of a physiological early-warning system for medical admissions. An observational, population-based single-centre study. *British journal of Anaesthesia* 98 (6) 769-774

Duthie, E.A. (2010) Application of Human Error Theory in Case Analysis of Wrong Procedures. *Journal of Patient Safety* 6 (2) 108-114

Flin, R., Patey, R., Jackson, J., Mearns, K., Dissanayaka, U. (2009) Year 1 medical undergraduates' knowledge of and attitudes to medical error. *Medical Education* 2009 (43) 1147-1155

Franklin, C., Mathew, J. (1994) Developing Strategies to prevent in-hospital cardiac arrest: Analyzing responses of physicians and nurses in the hours before the event. *Critical Care Medicine* 22 (2) 244-247

Garg, A.X., Hackam, D., Tonelli, M. (2008) Systematic Review and Meta-analysis: When one Study is Just not Enough. *Clinical Journal of the American Society of Nephrology* 3 253-260

Garry, D.A., McKechnie, S.R., Culliford, D.J., Ezra, M., Garry, P.S., Loveland, R.C., Sharma, V.V., Walden, A.P., Keating, L.M. on behalf of the PREVENT group. A prospective multicentre observational study of adverse iatrogenic events and substandard care preceding intensive care unit admission (PREVENT). *Anaesthesia* 2014 (69) 137-142

Gerrard, C. and Young, D. (1998) Sub-optimal care of patients before admission to Intensive care. *British Medical Journal* 316 1841-1842

Gibson, J.M.E. (1997) Focus of nursing in critical care and acute care settings: prevention or cure? *Intensive and Critical Care Nursing* 13 163-166

Gluck, P.A. (2008) Medical Error Theory. *Obstetrics and Gynaecology Clinics of North America* 35 (2008) 11-17

Goldhill, D.R. (2001) The critically ill: following your MEWS. *Quarterly Journal of Medicine* 94 (10) 507-510

Goldhill, D.R. and Sumner, A. (1998). Outcome of intensive care patients in a group of British Intensive Care Units. *Critical Care Medicine* 26 1337-1345

Goldhill, D.R., McNarry, A.F., Hadjianastassiou, V.G., Tekkis, P.P. (2004). The longer patients are in hospital before Intensive Care admission the higher the mortality. *Intensive Care Medicine* 30 1908-1913

Goldhill, D.R. and McNarry, A.F. (2004) Physiological abnormalities in early warning scores are related to mortality in adult inpatients. *British Journal of Anaesthesia* 92 (6) 882-884

Goldhill, D.R., McNarry, A.F., Mandersloot, G., McGinley, A. (2005) A physiologically-based early warning score for ward patients: the association between score and outcome. *Anaesthesia* 60 547-553

Grant MJ, Booth A (2009) A Typology of reviews: an analysis of 14 review types and associated methodologies. *Health Information and Libraries Journal*, 26 91-108

Groarke, J.D., Gallagher, J., Stack, J., Aftab, A., Dwyer, C., McGovern, R., Courtney, G. (2008) Use of an admission early warning score to predict patient morbidity and mortality and treatment success. *Emergency Medical Journal* 25 803-806

GMC (2013) *Good Medical Practice*. London: GMC

Gov.uk. (2015). *Data protection - GOV.UK*. [online] Available at: https://www.gov.uk/data-protection/the-data-protection-act [Accessed 15 Jan. 2013]

Hillman, K., Chen, J., Brown, D. (2003) A Clinical Model for Health Services Research-The Medical Emergency Team. *Journal of Critical Care* 18 (3) 195-199

Hillman, K. (2005) MERIT study investigators. Introduction of the Medical Emergency Team (MET) team system: A cluster randomised control trial. *The Lancet* 365 (9477) 2091-2097

Hogan, J. (2006) Respiratory assessment: why don't nurses monitor the respiratory rates of patients? *British Journal of Nursing* 15 (9) 489-492

Hurwitz, B. and Sheikh, A. (2009) *Health Care Errors and Patient Safety*. West Sussex: Blackwell Publishing Ltd.

Iyengar, A., Baxter, A., Forster, A. (2009) Using medical Emergency teams to detect preventable adverse events. *Critical Care* 13 126-131

Jones, D., Bates, S., Warrillow, S., Goldsmith, D., Kattula, A., Way, M., Gutteridge, G., Buckmaster, J., Bellemo, R. (2006) Effect of an education programme on the utilization of a medical emergency team in a teaching hospital. *Internal Medicine Journal* 36 231-236

Kause, J., Smith, G., Prytherch, D., Parr, M., Flabouris, A., Hillman, K. (2004). A comparison of Antecedents to Cardiac Arrests, Deaths and Emergency Intensive care Admissions in Australia and New Zealand and the United Kingdom – the ACADEMIA study*. Resuscitation* 5 (16) 275-297

Kenward, G. and Hodgetts, T. (2002) Nurse concern: a predictor of patient deterioration. *Nursing Times* 98 (22) 38-39

Kenward, G. and Hodgetts, T. Castle N (2001) Time to put the R back in TPR. *Nursing Times* 97 (40) 32-33

Kenward, G., Castle, N., Hodgetts, T., Shaikh, L. (2004) Evaluation of a Medical Emergency Team one year after implementation. *Resuscitation* 61 257-263

Kerridge, R.K. and Saul, W.P. (2003) The medical emergency team, evidence-based medicine and ethics. *MJA* 179 (6) 313-315

Knaus, W.A., Draper, E.A., Wagner, D.P., Zimmerman, J.S. (1985) APACHE II: a severity of disease classification system. *Critical Care Medicine* 13 (8) 18-29

Kohn L T, Corrigan J M, Donaldson M S, (2000). *To Err Is Human: Building a Safer Health System*. Washington, DC: National Academy Press.

LoBiondo-Wood, G., Haber, J. (2006), *Nursing Research: Methods and Critical Appraisal for Evidence-Based Practice*, 6th edn., Missouri: Mosby Elsevier

Lyneham, J., Parkinson, C., Denholm, C. (2008) Explicating Benner's concept of expert practice: intuition in emergency nursing. *Journal of Advanced Nursing* 64 (4) 380-387

McGaughey, J., Alderdice, F., Fowler, R., Kapila, A., Moutray, M. (2009) *Outreach and Early Warning Systems (EWS) for the prevention of Intensive care admission and death of critically ill adult patients on general hospital wards (Review)*. London: John Wiley and Sons Ltd.

McGloin, H., Adam, S.K., Singer, M. (1999) Unexpected deaths and referrals to intensive care of patients on general wards. Are some cases potentially avoidable? *Journal of the Royal College of Physicians of London* 33 (3) 255-259

McKeon, C.M., Fogarty, G.J., Hegney, D.G. (2006) Organizational factors: impact on administration violations in rural nursing. *Journal of Advanced Nursing* 55 (1) 115-123

McQuillan, P., Pilkington, S., Alison, A., Taylor, B., Short, A., Morgan, G., Neilsen, M., Barrett, D., Smith, G. (1998) Confidential inquiry into quality of care before admission to intensive care. *British Medical Journal* 316 (7148) 1853-1858

Mercer, M., Fletcher, S.J., Bishop, G.F. (1999) Medical emergency teams improve care. *British Medical Journal,* 318 54

Meurier, C. E. (1999) Understanding the nature of errors in nursing: using a model to analyse critical incident reports of errors which have resulted in an adverse or potentially adverse event. *Journal of Advanced Nursing* 32 (1) 202-207

Minnick, P. and Harvey, S. (2003) The early recognition of patient problems among medical-surgical nurses. *Medsurg Nursing* 12 (5) 291-297

Mohammed, M.A., Hayton, R., Clements, G., Smith, G., Prytherch, D. (2009) Improving accuracy and efficiency of early warning scores in acute care. *British Journal or Nursing* 18 (1) 18-24

Moher D, Liberati A, Tetzlaff J, Altmen DG The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6 (7) e1000097.doi:10.1371/journal.pmed 1000097 (accessed: 12 December 2016)

Morgan, G.A., Gliner, J.A., Harmon, R.J. (1999), 'Quantitative research Approaches', *Journal of American Academic Child and Adolescent Psychiatry*, 38 (12) 1595-1597

Morris, A. and Davies, K. (2010) Early warning scoring systems: observations of care in practice. *British Journal of Nursing* 19 (18) 1180-1184

NCEPOD (2005) *An Acute Problem? A report of the National Confidential Enquiry into Patient Outcome and Death.* London: NCEPOD

NCEPOD (2007) *Emergency admissions: A journey in the right direction*. London: NCEPOD

NCEPOD (2012) *Time to intervene*. London: NCEPOD

NICE: National Institute for Health and Clinical Excellence (2007) *Acutely ill patients in hospital, Recognition of and response to acute illness in adults in hospital. NICE guideline 50* London: NICE

National Patient Safety Agency (2007a) *Safer care for the acutely ill patient: learning from serious incidents*. NPSA: London

National Patient Safety Agency (2007b) *Recognising & responding appropriately to early signs of deteriorating hospitalised patients.* NPSA: London

NHS Scotland (2010) *The Healthcare Quality Strategy for NHS Scotland.* The Scottish Government: Edinburgh

NHS Wales (2010) *Rapid Response to Acute Illness*. Cardiff: NHS Wales

NMC (2015) *The Code: Professional standards of practice and behaviour for nurses and midwives*. London: NMC

Odell, M. (2002) Sepsis: early detection and care. *Professional Nurse* 18 (2) 68-69

Paley, J. (2002) Benner's remnants: culture, tradition and everyday understanding. *Journal of Advanced Nursing* 38 (6) 566-573

Paley, J., Cheyne, H., Dalgleish, L., Duncan, E.A.S., Niven, C.A. (2007) Nursing's ways of knowing and dual process theories of cognition. *Journal of Advanced Nursing* 60 (6) 692-701

Pallant, J. (2007) *SPSS Survival Manual*. 3rd edn Berkshire: Open University Press

Parahoo, K. (2014) *Nursing Research: Principles, Process and Issues*. London: Palgrave Macmillan

Perneger, T. (2005) The Swiss cheese model of safety incidents: are there holes in the metaphor. BMC Health Services Research 5 (1) 71-78

Polgar, S. and Thomas, S.A. (2000) *Introduction to Research in the Health Sciences*, 4th Ed, Churchill Livingstone: Edinburgh

Polit, D.F. and Beck, C.T. (2010), *Essentials of Nursing Research*: *Appraising Evidence for Nursing Practice,*7th Edn, Wolters Kluwer Health / Lippincott Williams & Wilkins: Philadelphia

Priestley, G., Watson, W., Rashidian, A., Mozley, C., Russell, D., Wilson, J., Cope, J., Hart, D., Kay, D., Cowley, K., Pateraki, J. (2004). Introducing Critical Care Outreach: a ward-randomised trial of phased introduction in a general hospital. *Intensive Care Medicine* 30 (7) 1398-1404

RCP (2007) *The right person, in the right setting – first time: Report of the Acute Medicine Task Force*. London: Royal College of Physicians

RCP (2012) *National Early Warning Scores.* London: Royal College of Physicians

Reason, J. (1990) *Human Error*. Cambridge University Press, Cambridge

Reason, J. (1995) *Understanding adverse events: human factors. Clinical Risk Management.* BMJ publishing, London

Reason, J. (2000a) Human error: models and management. *BMJ* 172 393-396

Reason, J. (2000b) Human error: models and management. *BMJ* 320 768-770

Reason, J. (2011) A Life in Error: From Little Slips to Big Disasters. Surrey: Ashgate Publishing Limited

Reason, J. (2016) *Organizational Accidents Revisited*. Surrey: Ashgate Publishing Limited

Robson, C. (1993) *Real World Research: A resource for Social Scientists and Practioner-Researchers,* Oxford: Blackwell Publishers

Rumsey, D. (2010) *Statistics Essentials for Dummies*. Indianapolis: Wiley Publishing Inc.

Salamonson, Y., Kariyawasam, A., Van Heere, B., O'Connor, C. (2001) The evolutionary process of Medical Emergency Team (MET) implementation: reduction in unanticipated ICU transfers. *Resuscitation* 49 135-141

Santamaria, J., Tobin, A., Holmes, J. (2010) Changing cardiac arrest and hospital mortality rates through a medical emergency team takes time and constant review. *Critical care Medicine* 38 (2) 445-450

Schein, R., Hazday, N., Pena, M., Ruben, B., Sprung, C. (1990) Clinical antecedents to in-hospital cardiopulmonary arrest*. Chest* 6 1388-139

Seward, E., Greig, E., Preston, S., Harris, R.A., Borrill, Z., Wardle, T.D., Burnham, R., Driscoll, P., Harrison, B.D.W., Lowe, D.C., Pearson, M.G. (2003) A confidential study of deaths after emergency medical admission: issues relating to quality of care*. Clinical Medicine* 3 (5) 425-434

SIGN (2014) *SIGN 139*.*Care of deteriorating patients.* Edinburgh: SIGN

Sim, J. and Wright, C. (2000) *Research in Health Care*. London: Stanley Thornes (Publishers) Ltd

Sharpley, J.T. and Holden, J.C. (2004) Introducing an early warning scoring system in a district general hospital. *Nursing in Critical Care* 9 (3) 98-103

Smith, T., Den Hartog, D., Moermn, T., Patka, P., Van Lieshout, E.M.M., Schep, N.W.L. (2012) Accuracy of an expanded early warning score for patients in general and trauma surgery wards. *British Journal of Surgery* 99 192-197

Smith, A.F., Oakey, R.J. (2006) Incidence and significance of errors in patient 'track and trigger' system during an epidemic of Legionnaires' disease: retrospective case note analysis. *Anaesthesia* 61 (3) 222-228

Story, D.A., Shelton, A.C., Poustie, S.J., Colin-Thome, N.J., McNicol, P.L. (2004) The effect of critical care outreach on postoperative serious adverse events. *Anaesthesia* 59 (8) 762-766

Subbe, C.P., Kruger, M., Rutherford, P., Gemmel, L. (2001) Validation of a modified Early Warning Score in medical admissions. *Quarterly Journal of Medicine* 94 521-526

Subbe, C.P., Slater, A., Menon, D., Gemmell, L. (2006) Validation of physiological scoring systems in the accident and emergency department. *Emergency Medical Journal* 23 641-845

Torgerson, C.J. (2003) *Systematic Reviews*. London: Continuum Books

UKRIO (2009) *Code of Practice for Research*. London: Universities UK

van Galen, L.S., Struik, P.W., Driesen, B.G.J.M., Merten, H., Ludikhuize, J., van der Spoel, J.I., Kramer, M.H.H., Nanayakkara, P.W.B. (2016) Delayed Recognition of Patients in General Wards Is Mostly Caused by Human Related Monitoring Failures: A Root Cause Analysis of Unplanned ICU Admissions. *PLoS ONE* 11 (8) 1371-1385

Varipo, L., Hall, P., Lingard, L., Schryer, C.F. (2008) Inter-professional Communication and Medical Error: A Reframing of Research Questions and Approaches. *Academic Medicine* 83 (10) 576-581

Vincent, C., Neale, G., Woloshynowch, M. (2001) Adverse events in British hospitals: preliminary retrospective record review. *BMJ* 332 517-519

Vincent, C., Taylor-Adams, S., Stanhope, N. (1998). Framework for analysing risk and safety in clinical medicine. *BMJ* 316, 1154-1157

Waterson, P (2014). *Patient safety culture : theory, methods and application*. Surrey : Ashgate

Weick K E. (2004) Normal Accident Theory as Frame, Link, and Provocation. *Organization and Environment*. 17(1), pp. 27–31.

Wheatley, I. (2006) The Nursing Practice of taking level 1 patient observations. *Intensive and Critical Care Nursing* 22 (2) 115-121

Appendices

Appendix 1 – Copy of an Early Warning Score Chart

Appendix 2 – Copy of Escalation Chart

Appendix 3 – Data Collection tools

3.1 - Data collection tool Version 1

3.2 - Data collection tool Version 2

3.3 - Data collection tool Version 3

3.4 - Data collection tool Version 4

Appendix 4 – Hierarchy of Reviewer

Appendix 5 – NHS R&D correspondence

Appendix 6 – NHS East of Scotland Ethics Correspondence

Appendix 7 – University Ethics Correspondence

Appendix 8 – Caldicott Approval

Appendix 9 – Strategic Support

9.1 – Nursing Strategic Support

9.2 – Medical Strategic Support

Appendix 10 – Process Map: Recognition of deteriorating patients

Appendix 11 – Abnormal Distribution

Appendix 12 – Search Strategy

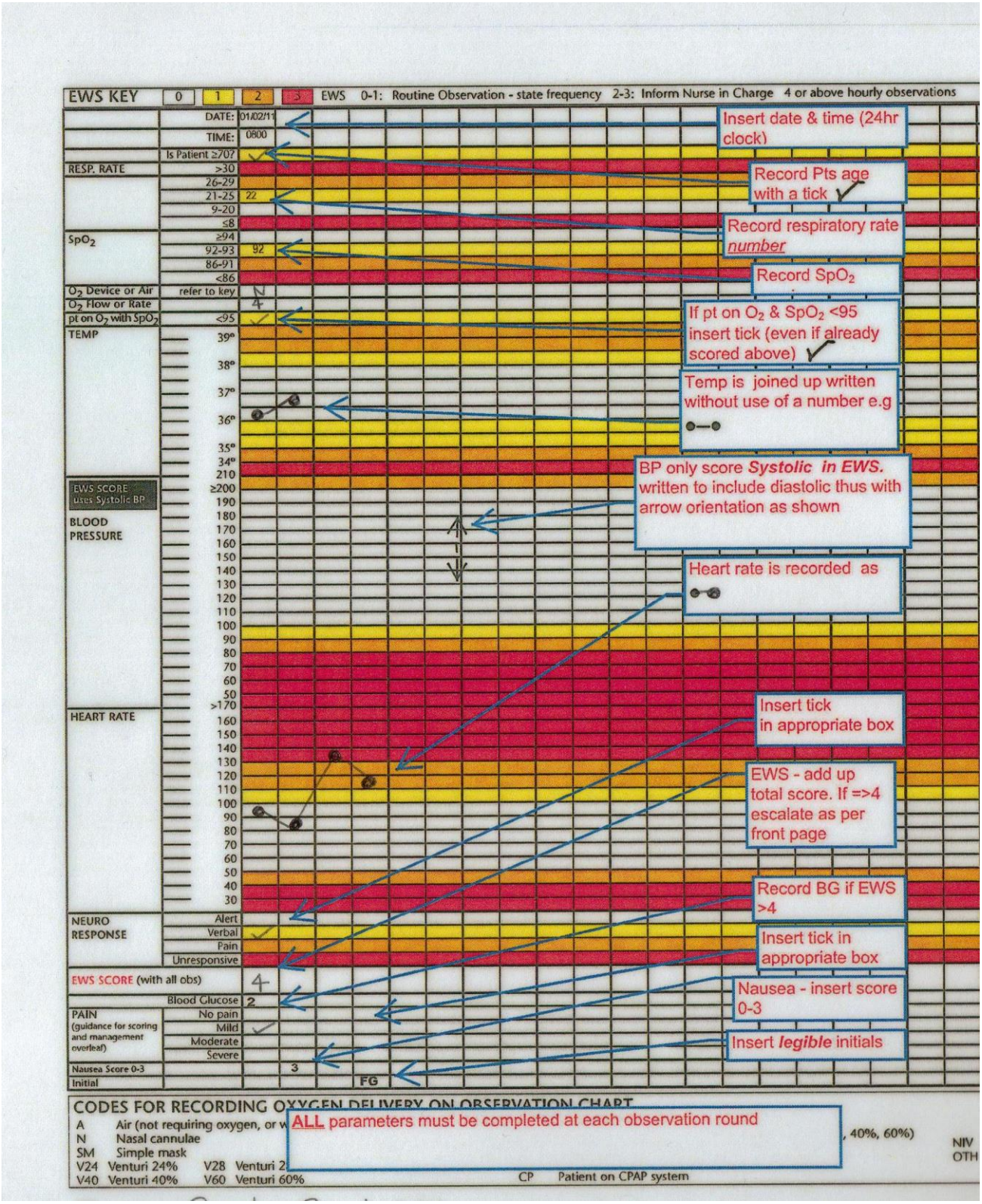
Appendix 13 – Summary of Research

Appendix 14 – STROBE checklist

Appendix 15 – Article for Publication

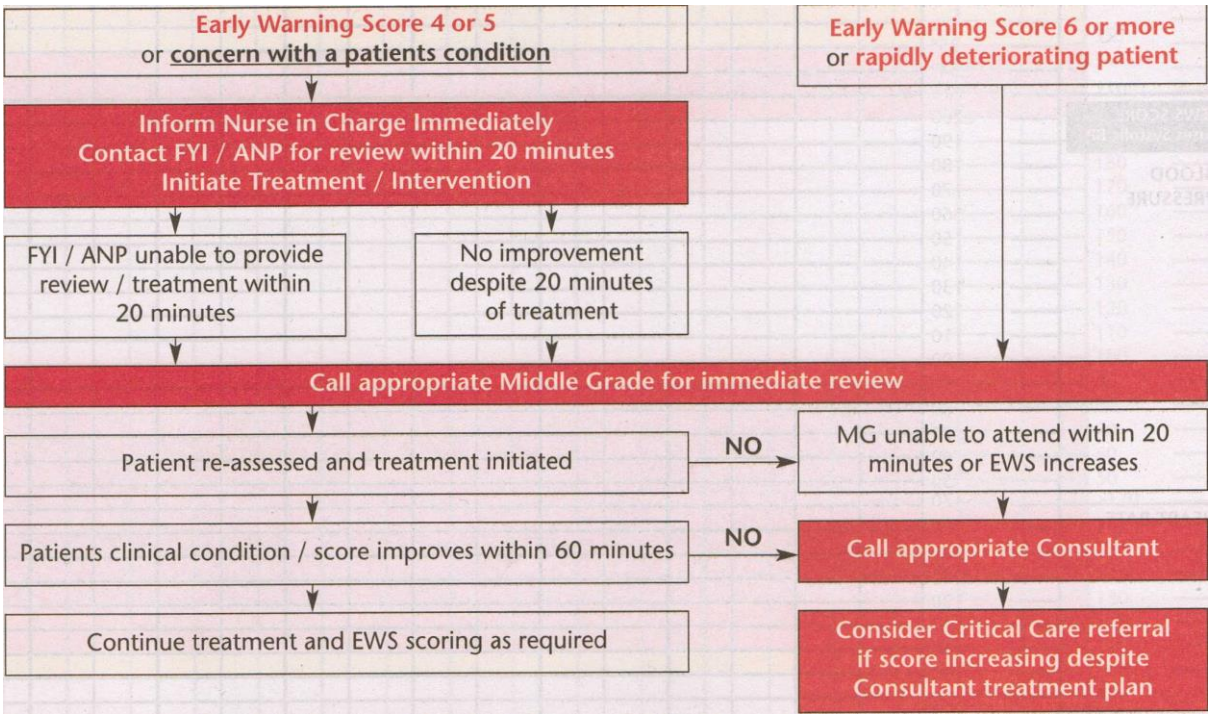
Appendix 1

Copy of an Early Warning Score Chart



Appendix 2

Escalation Policy



Appendix 3.1

Data Collection Tool V1

Unique Identification number ☐☐☐☐☐☐☐☐☐☐ Study Number ☐☐☐☐

Date of admission to hospital

☐☐☐☐☐☐

DD/MM/YY

Date of critical care admission

☐☐☐☐☐☐

DD/MM/YY

Day of critical care admission

M Tu W Th F Sa Su

Time of critical care admission

☐☐☐☐ 24hr clock

-48 hours date ☐☐☐☐☐☐ time ☐☐☐☐ 24hr clock

DD/MM/YY

Ward patient transferred from

☐

Named Consultant speciality

☐

Speciality patient transferred from applicable)

☐

On-call Consultant (s) speciality contacted (if

1 ☐ 2 ☐ 3 ☐

Reason for critical care admission

Single organ failure ☐

Multi-organ failure ☐

Other ☐

Was a ceiling of care / DNACPR decision documented prior to critical care referral?

YES ☐ NO ☐

Appendix 3.1

Differential / working diagnosis (tick all applicable)

primary surgical sepsis ☐ non-surgical sepsis ☐

Primary cardiac	☐	Primary GI	☐
Primary trauma / ortho	☐	Primary respiratory	☐
Primary haematological	☐	Primary endocrinology	☐
Primary general surgery	☐	Primary vascular surgery	☐
Primary speciality surgery	☐	Primary renal	☐
Primary neurological	☐	Other	☐

Is critical care admission cause speciality same as admission speciality?

Yes ☐ No ☐ unclear ☐

Appendix 3.1

Critical care involvement (section 2)

Date of critical care first call

DD/MM/YY

Time of critical care first call

24hr clock

Date of critical care review

DD/MM/YY

Time of critical care review

24hr clock

Grade of reviewer

Grade of referrer

Date of critical care consultant review

DD/MM/YY

Time of critical care consultant review

24hr clock

Date of decision to transfer to CC

DD/MM/YY

Time of decision

24hr clock

Grade of decision maker

Appendix 3.1

Ward Consultant Involvement (section 3)

Did a consultant within the patient's own speciality review patient prior to critical care referral or was there documented involvement of discussion with consultant concerning critical care referral?

YES ☐ Continue this section

NO ☐ Go to section 4

Date of consultant referral ☐☐☐☐☐☐ DD/MM/YY

Time of consultant referral ☐☐☐☐ 24hr clock

Grade of referrer ☐☐

Date of consultant review ☐☐☐☐☐☐ DD/MM/YY

Time consultant review ☐☐☐☐ 24hr clock

EWS at time of consultant referral <4 ☐ 4 or 5 ☐ 6 or more ☐

Was a consultant assessment and management plan documented prior to critical care referral?

YES ☐ NO ☐

Was time to consultant review / response within accepted policy guidelines?

YES ☐ NO ☐

Appendix 3.1

Initial Monitoring of EWS & escalation / Nursing (section 4)

(limited to 48hrs prior to CC admission)

Were all parameters completed in EWS entries? YES ☐ NO ☐

Was EWS calculated in each completed entry? YES ☐ NO ☐

Was EWS calculation correct in each completed entry? YES ☐ NO ☐

EWS <4 throughout 48 hours prior to CC admission YES ☐ EXIT STUDY

NO ☐ CONTINUE

Date of first EWS 4 or more (max 48hrs) Time of first EWS 4 or more (max 48hrs)

☐☐☐☐☐☐ ☐☐☐☐

24hr clock

DD/MM/YY

Was there written evidence in case records at this time of recognition of abnormal values?

YES ☐ NO ☐

Was there an appropriate increase in frequency of EWS measurements?

YES ☐ NO ☐

Was there written evidence in case records of an escalation call?

YES ☐ continue to section 4a

NO ☐ continue to section 4b

Appendix 3.1

Section 4a

Date of referral | Time of referral | Grade referred to

☐☐☐☐☐☐ DD/MM/YY | ☐☐☐☐ 24hr clock | ☐☐

First triggering EWS 4 or 5 ☐

6 or more ☐

Section 4b

Date of first medical review after trigger | Time | Grade of reviewer

☐☐☐☐☐☐ DD/MM/YY | ☐☐☐☐ 24hr clock | ☐☐

Was referral made but no supporting nursing documentation? ☐

or

Was review routine? ☐

or

Unknown ☐

(If consultant review without junior medical / ANP involvement data collection is complete)

Appendix 3.1

Junior Medical / ANP Involvement (section 5a)

First Response (limited to 48hrs prior to CC admission)

If maximum EWS is 4 or 5 complete this section; if EWS 6 or more proceed to section 5b

Date of review | Time of review | Grade of reviewer

☐☐☐☐☐☐ DD/MM/YY ☐☐☐☐ 24hr clock ☐☐

Was time to review / response within accepted policy guidelines?

YES ☐ NO ☐

Was reviewer of the acceptable grade or above as per guidelines for EWS?

YES ☐ NO ☐

Was there documentation of assessment and management plan?

YES ☐ NO ☐

Was there documentation of review of interventions?

YES ☐ NO ☐

Was there documentation of escalation if EWS did not improve?

YES ☐ NO ☐

Appendix 3.1

Junior Medical / ANP Involvement (section 5b)

First Response (limited to 48hrs prior to CC admission)

EWS 6 or more

Date of review ☐☐☐☐☐☐ DD/MM/YY

Time of review ☐☐☐☐ 24hr clock

Grade of reviewer ☐☐

Was time to review / response within accepted policy guidelines?

YES ☐ NO ☐

Was reviewer of the acceptable grade or above as per guidelines for EWS?

YES ☐ NO ☐

Was there documentation of assessment and management plan?

YES ☐ NO ☐

Was there documentation of review of interventions?

YES ☐ NO ☐

Was there documentation of escalation if EWS did not improve?

YES ☐ NO ☐

Appendix 3.1

Secondary Escalation (section 6)

Repeat according to patient journey until consultant and/or critical review

(within 48hr period prior to critical care admission)

Date of referral ☐☐☐☐☐☐ DD/MM/YY

Time of referral ☐☐☐☐ 24hr clock

Grade referred to ☐☐

Date of review ☐☐☐☐☐☐ DD/MM/YY

Time of review ☐☐☐☐ 24hr clock

Grade of reviewer ☐☐

Was time to review / response within accepted policy guidelines?

YES ☐ NO ☐

Was reviewer of the acceptable grade or above as per guidelines for EWS?

YES ☐ NO ☐

Was there documentation of assessment and management plan?

YES ☐ NO ☐

Was there documentation of review of interventions?

YES ☐ NO ☐

Was there documentation of escalation if EWS did not improve?

YES ☐ NO ☐

Appendix 3.1

Codes for specialities

EM – emergency medicine

AM – acute medicine

AH – ageing health

GMm – general medicine miscellaneous

GMe – general medicine endocrinology

GMr – general medicine respiratory

GMc – general medicine cardiology

GMg – general medicine gastroenterology

ON – oncology & haematology

OR - orthopaedics

GS – general surgery

VS – vascular surgery

ENT – ear, nose & throat surgery

Uro – urology surgery

NE = neurology

GY – gynaecology

OP – opthomology

Ob - obstetrics

Codes for Grade

1 – Advanced Nurse Practitioner including Hospital at Night

2 – Doctor Foundation Year 1

3 – Doctor Foundation Year 2

4 – Doctor Core Trainee Year 1

5 – Doctor Core Trainee Year 2

6 – Doctor ACCS year 1

7 – Doctor ACCS year 2

8 – Doctor ST year 3

9 – Doctor ST year 4

10 – Doctor ST year 5

11 – Doctor ST year 6

12 – Doctor ST year 7

13 - Doctor ST year 8

14 – Doctor staff grade

15 – Doctor Consultant Grade

Appendix 3.2

Data Collection Tool V2

Unique Identification number ☐☐☐☐☐☐☐☐☐☐ Study Number ☐☐☐☐

Date of admission to hospital ☐☐☐☐☐☐ DD/MM/YY

Date of critical care admission ☐☐☐☐☐☐ DD/MM/YY

Day of critical care admission

M Tu W Th F Sa Su

-48 hours Date ☐☐☐☐☐☐ DD/MM/YY

Time of critical care admission

time ☐☐☐☐ 24hr clock

time ☐☐☐☐ 24hr clock

EWS Monitoring & Escalation (limited to 48hrs prior to CC admission)

Were all parameters completed in EWS entries? YES ☐ NO ☐

Was EWS calculated in each completed entry? YES ☐ NO ☐

Was EWS calculation correct in each completed entry? YES ☐ NO ☐

EWS <4 throughout 48 hours prior to CC admission YES ☐ EXIT STUDY

NO ☐ CONTINUE

Date of first EWS 4 or more (max 48hrs) ☐☐☐☐☐☐ DD/MM/YY

Time of first EWS 4 or more (max 48hrs) ☐☐☐☐ 24hr clock

Was there written evidence in case records at this time of recognition of abnormal values?

YES ☐ NO ☐

Was there an appropriate increase in frequency of EWS measurements?

YES ☐ NO ☐

Was there written evidence in case records of an escalation call?

YES ☐ NO ☐

Appendix 3.2

Date of referral ☐☐☐☐☐☐ DD/MM/YY

Time of referral ☐☐☐☐ 24hr clock

Grade referred to ☐☐

First triggering EWS 4 or 5 ☐

6 or more ☐

Date of first medical review after trigger ☐☐☐☐☐☐ DD/MM/YY

Time ☐☐☐☐ 24hr clock

Grade of reviewer ☐☐

Was referral made but no supporting nursing documentation? ☐

or

Was review routine? ☐

or

Unknown ☐

Appendix 3.2

First Response (limited to 48hrs prior to CC admission)

Date of review ☐☐☐☐☐☐ DD/MM/YY

Time of review ☐☐☐☐ 24hr clock

Grade of reviewer ☐☐

Was time to review / response within accepted policy guidelines?

YES ☐ NO ☐

Was reviewer of the acceptable grade or above as per guidelines for EWS?

YES ☐ NO ☐

Was there documentation of assessment and management plan?

YES ☐ NO ☐

Was there documentation of review of interventions?

YES ☐ NO ☐

Was there documentation of escalation if EWS did not improve?

YES ☐ NO ☐

Appendix 3.2

Secondary Escalation

Repeat according to patient journey until consultant and/or critical review

(within 48hr period prior to critical care admission)

Date of referral ☐☐☐☐☐☐ DD/MM/YY

Time of referral ☐☐☐☐ 24hr clock

Grade referred to ☐☐

Date of review ☐☐☐☐☐☐ DD/MM/YY

Time of review ☐☐☐☐ 24hr clock

Grade of reviewer ☐☐

Was time to review / response within accepted policy guidelines?

YES ☐ NO ☐

Was reviewer of the acceptable grade or above as per guidelines for EWS?

YES ☐ NO ☐

Was there documentation of assessment and management plan?

YES ☐ NO ☐

Was there documentation of review of interventions?

YES ☐ NO ☐

Was there documentation of escalation if EWS did not improve?

YES ☐ NO ☐

Appendix 3.2

Ward Consultant Involvement at Time of Deterioration

Was there documented involvement of discussion with consultant responsible or on-call?

YES ☐ NO ☐

Date of consultant referral ☐☐☐☐☐☐ DD/MM/YY

Time of consultant referral ☐☐☐☐ 24hr clock

Grade of referrer ☐☐

Did Consultant attend?

YES ☐ NO ☐

If no, was there a documented reason for non-attendance?

YES ☐ NO ☐

Date of consultant review ☐☐☐☐☐☐ DD/MM/YY

Time consultant review ☐☐☐☐ 24hr clock

DNA ☐

EWS at time of consultant referral <4 ☐ 4 or 5 ☐ 6 or more ☐

Was a consultant assessment and management plan documented prior to critical care referral?

YES ☐ NO ☐

Was time to consultant review / response within accepted policy guidelines?

YES ☐ NO ☐

Appendix 3.2

Critical care involvement

Date of critical care first call

DD/MM/YY

Time of critical care first call

24hr clock

Date of critical care review

DD/MM/YY

Time of critical care review

24hr clock

Grade of reviewer

Grade of referrer

Date of critical care consultant review

DD/MM/YY

Time of critical care consultant review

24hr clock

Date of decision to transfer to CC

DD/MM/YY

Time of decision

24hr clock

Grade of decision maker

Ward patient transferred from

Named Consultant speciality

Speciality of ward patient transferred from

On-call Consultant (s) speciality contacted (if applicable)

1 2 3

Reason for critical care admission

Single organ failure

Multi-organ failure

Other

Details if other

Appendix 3.2

Was a ceiling of care / DNACPR decision documented prior to critical care referral?

YES ☐ NO ☐

If yes what grade of clinician made decision ☐

ICU differential / working diagnosis (tick all applicable)

primary surgical sepsis	☐	non-surgical sepsis	☐
Primary cardiac	☐	Primary GI	☐
Primary trauma / ortho	☐	Primary respiratory	☐
Primary haematological	☐	Primary endocrinology	☐
Primary general surgery	☐	Primary vascular surgery	☐
Primary speciality surgery	☐	Primary renal	☐
Primary neurological	☐	Other	☐

Admission Diagnosis / working diagnosis (tick all applicable)

sepsis	☐		
Primary cardiac	☐	Primary GI	☐
Primary trauma / ortho	☐	Primary respiratory	☐
Primary haematological	☐	Primary endocrinology	☐
Primary general surgery	☐	Primary vascular surgery	☐
Primary speciality surgery	☐	Primary renal	☐
Primary neurological	☐	Other	☐

Is critical care admission cause speciality same as admission speciality?

Yes ☐ No ☐ unclear ☐

Appendix 3.3

Data Collection Tool V3

Unique Identification number ☐☐☐☐☐☐☐☐☐☐ Study Number ☐☐☐☐

Date of admission to hospital ☐☐☐☐☐☐ time ☐☐☐☐

DD/MM/YY

Date of critical care admission ☐☐☐☐☐☐

DD/MM/YY

Day of critical care admission

M Tu W Th F Sa Su

-48 hours Date ☐☐☐☐☐☐

DD/MM/YY

Time of critical care admission

time ☐☐☐☐ 24hr clock

time ☐☐☐☐ 24hr clock

EWS Monitoring & Escalation (limited to 48hrs prior to CC admission)

Were all parameters completed in EWS entries? YES ☐ NO ☐

Was EWS calculated in each completed entry? YES ☐ NO ☐

Was EWS calculation correct in each completed entry? YES ☐ NO ☐

EWS <4 throughout 48 hours prior to CC admission YES ☐ EXIT STUDY

NO ☐ CONTINUE

Date of first EWS 4 or more (max 48hrs) ☐☐☐☐☐☐

DD/MM/YY

Time of first EWS 4 or more (max 48hrs) ☐☐☐☐

24hr clock

Appendix 3.3

Was there written evidence in case records at this time of recognition of abnormal values?

YES ☐ NO ☐

Was there an appropriate increase in frequency of EWS measurements?

YES ☐ NO ☐

Was there written evidence in case records of an escalation call?

YES ☐

NO ☐

Date of referral ☐☐☐☐☐☐ DD/MM/YY

Time of referral ☐☐☐☐ 24hr clock

Grade referred to ☐☐

First triggering EWS 4 or 5 ☐

6 or more ☐

Date of first medical review after trigger ☐☐☐☐☐☐ DD/MM/YY

Time ☐☐☐☐ 24hr clock

Grade of reviewer ☐☐

Was referral made but no supporting nursing documentation? ☐

or

Was review routine? ☐

or

Unknown ☐

Appendix 3.3

First Response (limited to 48hrs prior to CC admission)

Date of review ☐☐☐☐☐☐ DD/MM/YY

Time of review ☐☐☐☐ 24hr clock

Grade of reviewer ☐☐

Was time to review / response within accepted policy guidelines?

YES ☐ NO ☐

Was reviewer of the acceptable grade or above as per guidelines for EWS?

YES ☐ NO ☐

Was there documentation of assessment and management plan?

YES ☐ NO ☐

Was there documentation of review of interventions?

YES ☐ NO ☐

Was there documentation of escalation if EWS did not improve?

YES ☐ NO ☐

Appendix 3.3

Secondary Escalation

Repeat according to patient journey until consultant and/or critical review

(within 48hr period prior to critical care admission)

Not Applicable ☐

Date of referral ☐☐☐☐☐☐ DD/MM/YY

Time of referral ☐☐☐☐ 24hr clock

Grade referred to ☐☐

Date of review ☐☐☐☐☐☐ DD/MM/YY

Time of review ☐☐☐☐ 24hr clock

Grade of reviewer ☐☐

Was time to review / response within accepted policy guidelines?

YES ☐ NO ☐

Was reviewer of the acceptable grade or above as per guidelines for EWS?

YES ☐ NO ☐

Was there documentation of assessment and management plan?

YES ☐ NO ☐

Was there documentation of review of interventions?

YES ☐ NO ☐

Was there documentation of escalation if EWS did not improve?

YES ☐ NO ☐

Appendix 3.3

Ward Consultant Involvement at Time of Deterioration

Was there documented involvement of discussion with consultant responsible or on-call at time of deterioration?

YES ☐ NO ☐ Routine Ward Round Review YES ☐ NO ☐

If Yes to either

Date of consultant referral ☐☐☐☐☐☐ DD/MM/YY

Time of consultant referral ☐☐☐☐ 24hr clock

Grade of referrer ☐☐

Did Consultant attend?

YES ☐ NO ☐

If no, was there a documented reason for non-attendance?

YES ☐ NO ☐

Date of consultant review ☐☐☐☐☐☐ DD/MM/YY

Time consultant review ☐☐☐☐ 24hr clock

DNA ☐

EWS at time of consultant referral <4 ☐ 4 or 5 ☐ 6 or more ☐

Was a consultant assessment and management plan documented prior to critical care referral?

YES ☐ NO ☐

Was time to consultant review / response within accepted policy guidelines?

YES ☐ NO ☐ N/A Routine review ☐

Appendix 3.3

Critical care involvement

Date of critical care first call

DD/MM/YY

Time of critical care first call

24hr clock

Date of critical care review

DD/MM/YY

Time of critical care review

24hr clock

Grade of reviewer

Grade of referrer

Date of critical care consultant review

DD/MM/YY

Time of critical care consultant review

24hr clock

Date of decision to transfer to CC

DD/MM/YY

Time of decision

24hr clock

Grade of decision maker

Ward patient transferred from

Named Consultant speciality

Speciality of ward patient transferred from

On-call Consultant (s) speciality contacted (if applicable)

1 2 3

Reason for critical care admission

Single organ failure

Multi-organ failure

Other

Details if other

Appendix 3.3

Was a ceiling of care / DNACPR decision documented prior to critical care referral?

YES ☐ NO ☐

If yes what grade of clinician made decision ☐

ICU differential / working diagnosis (tick all applicable)

primary surgical sepsis	☐	non-surgical sepsis	☐
Primary cardiac	☐	Primary GI	☐
Primary trauma / ortho	☐	Primary respiratory	☐
Primary haematological	☐	Primary endocrinology	☐
Primary general surgery	☐	Primary vascular surgery	☐
Primary speciality surgery	☐	Primary renal	☐
Primary neurological	☐	Other	☐

Admission Diagnosis / working diagnosis (tick all applicable)

sepsis	☐		
Primary cardiac	☐	Primary GI	☐
Primary trauma / ortho	☐	Primary respiratory	☐
Primary haematological	☐	Primary endocrinology	☐
Primary general surgery	☐	Primary vascular surgery	☐
Primary speciality surgery	☐	Primary renal	☐
Primary neurological	☐	Other	☐

Is critical care admission cause speciality same as admission speciality?

Yes ☐ No ☐ unclear ☐

Appendix 3.4

Data Collection Tool V4

Unique Identification number ☐☐☐☐☐☐☐☐☐☐ Study Number ☐☐☐☐

Date of admission to hospital ☐☐☐☐☐☐ DD/MM/YY time ☐☐☐☐

Date of critical care admission ☐☐☐☐☐☐ DD/MM/YY

Day of critical care admission

M Tu W Th F Sa Su

-48 hours Date ☐☐☐☐☐☐ DD/MM/YY

Time of critical care admission

time ☐☐☐☐ 24hr clock

time ☐☐☐☐ 24hr clock

< 48hrs from admission ☐

EWS Monitoring & Escalation (limited to 48hrs prior to CC admission)

Were all parameters completed in EWS entries? YES ☐ NO ☐

Was EWS calculated in each completed entry? YES ☐ NO ☐

Was EWS calculation correct in each completed entry? YES ☐ NO ☐

EWS <4 throughout 48 hours prior to CC admission YES ☐ EXIT STUDY

NO ☐ CONTINUE

Date of first EWS 4 or more (max 48hrs) ☐☐☐☐☐☐ DD/MM/YY

Time of first EWS 4 or more (max 48hrs) ☐☐☐☐ 24hr clock

Appendix 3.4

Was there written evidence in case records at this time of recognition of abnormal values?

YES ☐ NO ☐

Was there an appropriate increase in frequency of EWS measurements?

YES ☐ NO ☐

Was there written evidence in case records of an escalation call?

YES ☐

NO ☐

If YES to above

Date of referral ☐☐☐☐☐☐ DD/MM/YY

Time of referral ☐☐☐☐ 24hr clock

Grade referred to ☐☐

First triggering EWS 4 or 5 ☐

6 or more ☐

Date of first medical review after trigger ☐☐☐☐☐☐ DD/MM/YY

Time ☐☐☐☐ 24hr clock

Grade of reviewer ☐☐

Was referral made but no supporting nursing documentation? ☐

or

Was review routine? ☐

or

Unknown ☐

Appendix 3.4

First Response (limited to 48hrs prior to CC admission)

Date of review ☐☐☐☐☐☐ DD/MM/YY

Time of review ☐☐☐☐ 24hr clock

Grade of reviewer ☐☐

Was time to review / response within accepted policy guidelines?

YES ☐ NO ☐

Was reviewer of the acceptable grade or above as per guidelines for EWS?

YES ☐ NO ☐

Was there documentation of assessment and management plan?

YES ☐ NO ☐

Was there documentation of review of interventions?

YES ☐ NO ☐

Was there documentation of escalation if EWS did not improve?

YES ☐ NO ☐

Was referral made but no supporting documentation? ☐

or

Was review routine? ☐

or

Unknown ☐

Appendix 3.4

Secondary Escalation

Repeat according to patient journey until consultant and/or critical review

(within 48hr period prior to critical care admission)

Not Applicable ☐

Date of referral ☐☐☐☐☐☐ DD/MM/YY

Time of referral ☐☐☐☐ 24hr clock

Grade referred to ☐☐

Date of review ☐☐☐☐☐☐ DD/MM/YY

Time of review ☐☐☐☐ 24hr clock

Grade of reviewer ☐☐

Was time to review / response within accepted policy guidelines?

YES ☐ NO ☐

Was reviewer of the acceptable grade or above as per guidelines for EWS?

YES ☐ NO ☐

Was there documentation of assessment and management plan?

YES ☐ NO ☐

Was there documentation of review of interventions?

YES ☐ NO ☐

Was there documentation of escalation if EWS did not improve?

YES ☐ NO ☐

Appendix 3.4

Ward Consultant Involvement at Time of Deterioration

Was there documented involvement of discussion with consultant responsible or on-call at time of deterioration? YES ☐ NO ☐

If Yes to above

Date of consultant referral ☐☐☐☐☐☐ DD/MM/YY

Time of consultant referral ☐☐☐☐ 24hr clock

Grade of referrer ☐☐

Did Consultant attend during deterioration whether escalated or not?

YES ☐ NO ☐

If YES

Was referral made but no supporting documentation? ☐

or

Was review routine? ☐

or

Unknown ☐

If NO was there a documented reason for non-attendance?

YES ☐ NO ☐

Date of consultant review ☐☐☐☐☐☐ DD/MM/YY

Time consultant review ☐☐☐☐ 24hr clock

DNA ☐

EWS at time of consultant referral <4 ☐ 4 or 5 ☐ 6 or more ☐

Was a consultant assessment and management plan documented prior to critical care referral?

YES ☐ NO ☐

Was time to consultant review / response within accepted policy guidelines?

YES ☐ NO ☐ N/A Routine review ☐

Appendix 3.4

Critical care involvement

Date of critical care first call ☐☐☐☐☐☐ DD/MM/YY

Time of critical care first call ☐☐☐☐ 24hr clock

Date of critical care review ☐☐☐☐☐☐ DD/MM/YY

Time of critical care review ☐☐☐☐ 24hr clock

Grade of reviewer ☐☐

Grade of referrer ☐☐

Ward patient transferred from ☐

Named Consultant speciality ☐

Speciality of ward patient transferred from ☐

On-call Consultant (s) speciality contacted (if applicable)

1 ☐ 2 ☐ 3 ☐

Reason for critical care admission

Single organ failure ☐

Multi-organ failure ☐

Other ☐

Details if other ☐

Was a ceiling of care / DNACPR decision documented prior to critical care referral?

YES ☐ NO ☐

If yes what grade of clinician made decision ☐

Appendix 3.4

ICU differential / working diagnosis (tick all applicable)

primary surgical sepsis	☐	non-surgical sepsis	☐
Primary cardiac	☐	Primary GI	☐
Primary trauma / ortho	☐	Primary respiratory	☐
Primary haematological	☐	Primary endocrinology	☐
Primary general surgery	☐	Primary vascular surgery	☐
Primary speciality surgery	☐	Primary renal	☐
Primary neurological	☐	Other	☐

Admission Diagnosis / working diagnosis (tick all applicable)

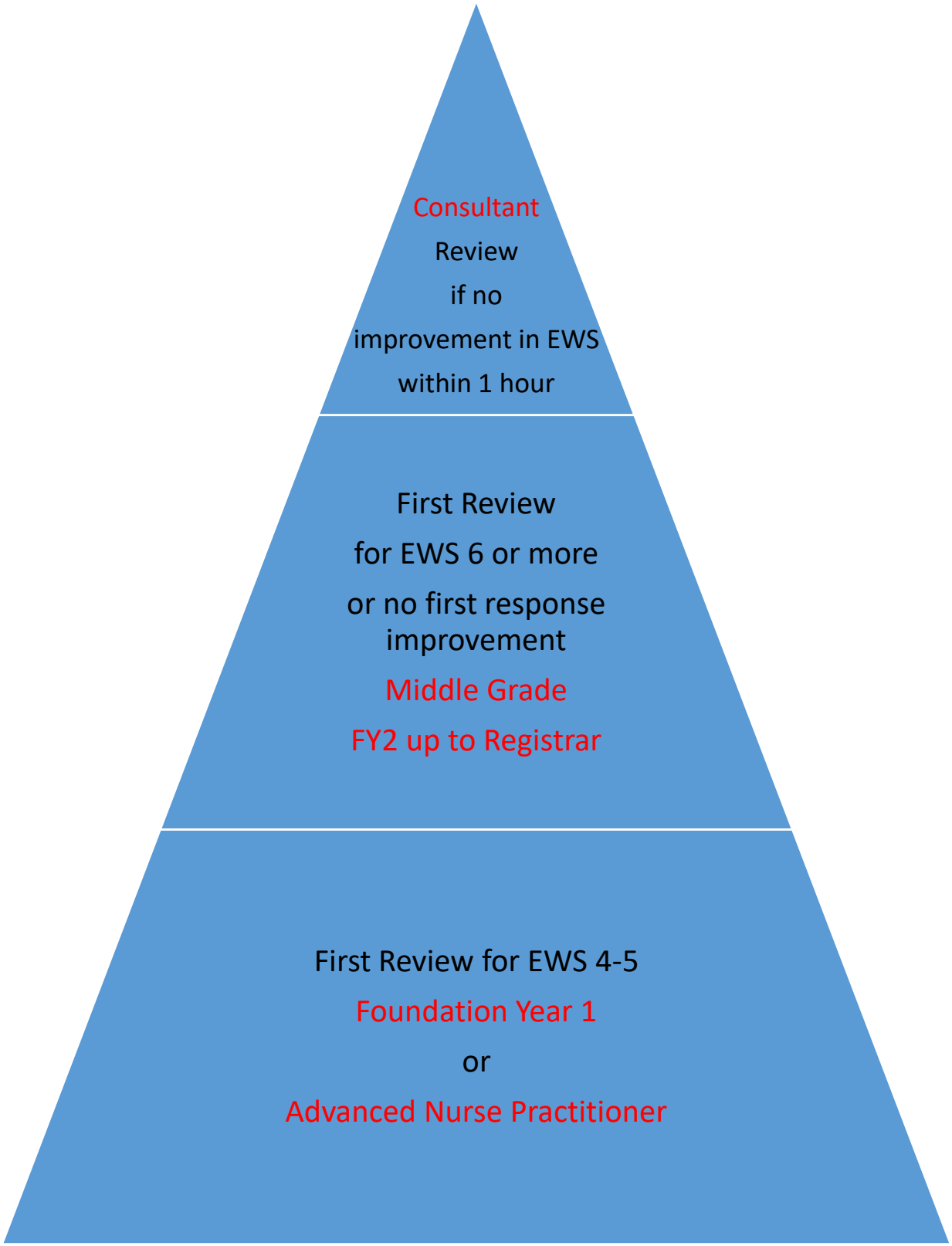
sepsis	☐		
Primary cardiac	☐	Primary GI	☐
Primary trauma / ortho	☐	Primary respiratory	☐
Primary haematological	☐	Primary endocrinology	☐
Primary general surgery	☐	Primary vascular surgery	☐
Primary speciality surgery	☐	Primary renal	☐
Primary neurological	☐	Other	☐

Is critical care admission cause speciality same as admission speciality?

Yes ☐ No ☐ unclear ☐

Appendix 4

Hierarchical Chart – Reviewers Grade / Response to EWS score



Appendix 5

NHS Forth Valley R&D Correspondence

Hi Sharon

Further to our discussion on Friday, I am emailing to confirm that your project "A retrospective case note analysis of the recognition and management of deteriorating patients prior to critical care admission', as you described it to me, does not require NHS R&D Management approval.

Good luck with your project. let me know if you have any other questions.

Allyson

Allyson Bailey
Research and Development Officer
NHS Forth Valley
Falkirk Community Hospital
Administration Offices
Westburn Avenue
Falkirk FK1 5SU
tel. 01324 677564
within NHS Forth Valley: x6854
fax 01324 678523
allyson.bailey@nhs.net

Appendix 6

East of Scotland Research Ethics Service Correspondence

EoSRES

NHS SCOTLAND

East of Scotland Research Ethics Service (EoSRES)
Tayside Medical Sciences Centre (TASC)
Residency Block C, Level 3
Ninewells Hospital & Medical School
George Pirie Way
Dundee DD19SY

Sharon Oswald
Consultant Nurse
Acute Care
NHS Forth Valley
Livilands Gate
Stirlingshire
FK8 2AU

Date: 13th April 2012
Your Ref:
Our Ref: CYA/AG/12/GA/058
Enquiries to: Mrs Caroline Ackland
Extension: Ninewells extension: 32589
Direct Line: 01382 632589
Email: Caroline.ackland@nhs.net

Dear Sharon

Re: To identify measures for improvement in the quality of Patient Care in acute wards

You have sought advice from the Research Ethics Office on the above project. I have considered this and can advise that this does not require ethical review under the terms of the Governance Arrangement for Research Ethics Committees (GAfREC) in the UK. The advice is based on the following documentation provided:

Document	Version	Date
Emails	N/A	Various
Protocol	Not Specified	Not Specified

- You are undertaking a retrospective data analysis
- You will require Caldicott Guardian Approval
- You may still require Research and Development approval

Please note that this advice is issued on behalf of the Research Ethics Service Office and does not constitute an opinion of a Research Ethics Committee (REC). It is intended to satisfy Journal editors and conference organisers, who may require evidence of consideration of the need for ethical review prior to publication or presentation of your results.

You should keep a copy of this letter within your project file.

Yours sincerely,

Caroline

Caroline Ackland
Scientific Officer, East of Scotland Research Ethics Service

Cc: Dr Allyson Bailey R+D Manager NHS Forth Valley

Appendix 7

University of Stirling Ethics Approval

JP/SG

12 April 2013

UNIVERSITY OF STIRLING

SCHOOL OF NURSING, MIDWIFERY AND HEALTH

Sharon Oswald
21 Willow Brae
Plean
Stirlingshire
FK7 8FB

Email: nursingmidwifery@stir.ac.uk
Web: www.nm.stir.ac.uk

John Paley
Chair
School Research Ethics Committee

School of Nursing, Midwifery and Health
University of Stirling
Stirling FK9 4LA

Tel: +44 (0) 1786 466399
Fax: +44 (0) 1786 466333
Email: john.paley@stir.ac.uk

Dear Sharon

Preventable or delayed critical care admissions from general wards: A retrospective case record analysis

Thank you for submitting this application, which was discussed at the meeting on 10 April 2013.

I am happy to report that the report was approved. We noted that Caldicott approval will be sought and that East of Scotland Research ethics service has confirmed that ethical review is not required.

However one might argue that there is potential about staff anxiety; anyone who knows that the study is being conducted might be concerned that their own professional practice is being evaluated, especially if they have been involved in one of the cases being examined. But it's not clear what could, or should, be done about this.

Our main concern is the analytical strategy – the committee felt that it's not clear what the dependent variable will be; and how multiple regression can answer the research questions. Whilst these are not ethical issues, we felt that you may wish to discuss these observation with your supervisors

Thank you for attending and answering the questions posed by committee members – it was a pleasure to meet you.

May I take this opportunity to remind you that a site-file of *all* documents related to the research should be maintained throughout the life of the project, and kept up to date at all times. The site file template can be found on the SREC page of the School's website. Please bear in mind that your study could be audited for adherence to research governance and research ethics protocols.

Yours sincerely

John Paley
(Chair)
School of Nursing, Midwifery and Health Research Ethics Committee

Appendix 8

Caldicott Approval

NHS FORTH VALLEY
CALDICOTT / DATA PROTECTION CONSENT FORM

NHS Forth Valley

APPROVAL FOR THE RELEASE OF NON-ANONYMISED INFORMATION WITHOUT CONSENT

Data Source [enter details of system]:	CASE RECORDS
Reason for Request:	DATA COLLECTION FOR CLINICAL DOCTORATE
Time period for request:	**Start Date:** JUNE 2013 **End Date:** MARCH 2014

Intended Recipients Details	
Name:	SHARON OSWALD
Position:	CONSULTANT NURSE ACUTE CARE
Organisation:	NHS FORTH VALLEY
Address:	STIRLING ROAD LARBERT FK5 4WR
Tel. No:	01324 566000 pg 1953
Email Address:	sharon.oswald@nhs.net
Data Protection Registration No.	
Name(s) of any co-user(s):	LISA FABISIAK ANP LINDA MITCHELL ANP
Data Remaining within UK:	Yes ☑ No ☐
Will the Data be transferred out with the European Economic Area (EEA) at any time: Yes ☐ No ☑	
Give Reason for transfer out with EEA:	

Nature of Information
Information Requested (specific details required): CASE RECORDS OF 48 HOURS PRIOR TO CRITICAL CARE ADMISSION
Intended use of data (include publications): ANONYMISED DATA FOR CLINICAL DOCTORATE THESIS + SUBMISSION FOR PUPLICATION
Name of Person & Department responsible for the data gathering: SHARON OSWALD - ACUTE CARE
Detail how the shared data will be transferred, during storage and destruction SCANNED TO NHS FV NETWORK, INDIVIDUALISED PASSWORD PROTECTED

- 1 -

Caldicott Guardian Details (*see over for appropriate Guardian*)	
Name:	Dr Iain Wallace
Position:	Medical Director/Caldicott Guardian
Organisation:	NHS Forth Valley
Address:	Carseview House, Castle Business Park, Stirling FK9 4SW
Tel. No.	01786 463031
Data Protection Registration No:	Z6175671

Please return this form to:-

Information Governance Department
Central Supplies
Colquhoun Street
STIRLING, FK7 7PX

Telephone No: (01786) 433285

Fax No: **(01786) 451156**
(non secure)

Office Use Only

Date Received – Information Governance	20/6/2013	**Date Sent to Guardian:**	20/6/2013
Form Checked By:	DC	**Date received from Guardian:**	20/6/2013
Date Checked:	20/6/2013	**Copy sent to applicant:**	—
Information Governance Approved:	(YES) NO*	**Date sent:**	21/6/2013
If No: state reason:			

Confidentiality Statement

For users of NHS patient data

Recipient's Declaration:

I declare that I understand and undertake to abide by the rule for confidentiality, security and release of data received from NHS FORTH VALLEY. , as specified in points 1 - 7 on page 4 of this document.

Signature: S Oswald **Date:** 20/06/13

Name:
(Print) SHARON OSWALD

Caldicott Guardian's Declaration:

I declare that SHARON OSWALD (named above as the recipient of the data requested), is engaged in a reputable research/audit project and that the data requested can be entrusted to him/her in the knowledge that (s)he will conscientiously discharge his/her obligations in regard to confidentiality of the data, as stated in paragraph 1 - 7 on page 3 of this document. I am happy for him/her to receive this data.

Signature: **Date:** 20/6/13
(on behalf of NHS Forth Valley)

Name:
(Print) IAIN WALLACE

RULES OF CONFIDENTIALITY, SECURITY AND RELEASE OF INFORMATION

FOR USERS OF NHS PATIENT DATA

1. Data held by NHS Forth Valley on NHS patients have been registered under the Data Protection Act 1998 for the purpose of:
   - The provision and administration of patient care
   - Research and audit
   - Prevention and control of disease within the community

   It cannot be used for any other purpose.

2. If the data received from NHS Forth Valley is to be held on computer or in manual records, the intended recipient of this request, or the organisation (s)he represents, should have an appropriate registration with the Office of the Information Commissioner. Details of the registration number should be entered on page 1 of this document. This will be verified prior to release of any information.

3. Data received from NHS Forth Valley should not be divulged to any person whose name is not specified as a 'co-user of data' nor used for any purpose other than that declared on page 1 of this document.

4. Proper security safeguards (e.g. encryption, password protected, Secure Mail Delivery, Double wrapped) will be applied during the transfer, use, storage and destruction upon completion of the work/project declared on page 1 to prevent any breach of confidentiality. Any misuse or loss of these data should be notified immediately to NHS Forth Valley's Data Protection Officer (email: linda.allen2@nhs.net, telephone 01786 433285.

5. Recipients should not attempt to access hospital case records using information supplied by *[enter details of supplying location]*, without the prior consent of the consultant in clinical charge of those patients. This applies regardless of whether the patient is currently in hospital or not.

6. No patient should be approached by a research worker as a result of information supplied by *[enter details of supply location]*: , without prior consent of the consultant who was responsible for the care in the episode selected for research.

7. Any statistics or results produced for research or audit based on data received from: should not be made available in a form which:
   a) directly identifies individual data subjects
   b) is not covered by the "intended use of data" clause specified on page 1

* For release to other NHS organisations of data relating to their own treated patients the authoriser will be NHS Forth Valley's Medical Director/Caldicott Guardian. For release to Health Boards of data relating to their resident population the authoriser will be NHS Forth Valley's Medical Director/Caldicott Guardian.

Appendix 9.1

Strategic Reporting Structure – Nursing

Department of Nursing

NHS Forth Valley
Department of Nursing
Administration Offices
Seminar Room 6 Corridor
Forth Valley Royal Hospital
Stirling Road
LARBERT
FK54WR

NHS Forth Valley

Date 5th September 2012
Your Ref AW/lf
Our Ref

Enquiries to Miss Leigh Fagan
Extension 67661
Direct Line (01324) 567661

To Whom It May Concern

Clinical Doctorate Research Ethics Application

I am writing to confirm that I will be the designated contact for any nursing and midwifery issues that should arise during Mrs Sharon Oswald's research work.

- ***Any consistent or repeated individual nurse's acts or omissions causing patient harm are relayed directly to the Executive Nurse Director***

Please do not hesitate to contact me if you require any further information.

Best regards

PROFESSOR ANGELA WALLACE
Executive Nurse Director

Appendix 9.2

Strategic Reporting Structure – Medicine

Medical Directorate

Carseview House
Castle Business Park
Stirling
FK9 4SW

Telephone:
Fax:

NHS Forth Valley

To Whom it May Concern

Date 13 September 2012
Your Ref
Our Ref IW/ig

Enquiries to Irene Graham@nhs.net

Direct Line (01786) 457293

Clinical Doctorate Research Ethics Application

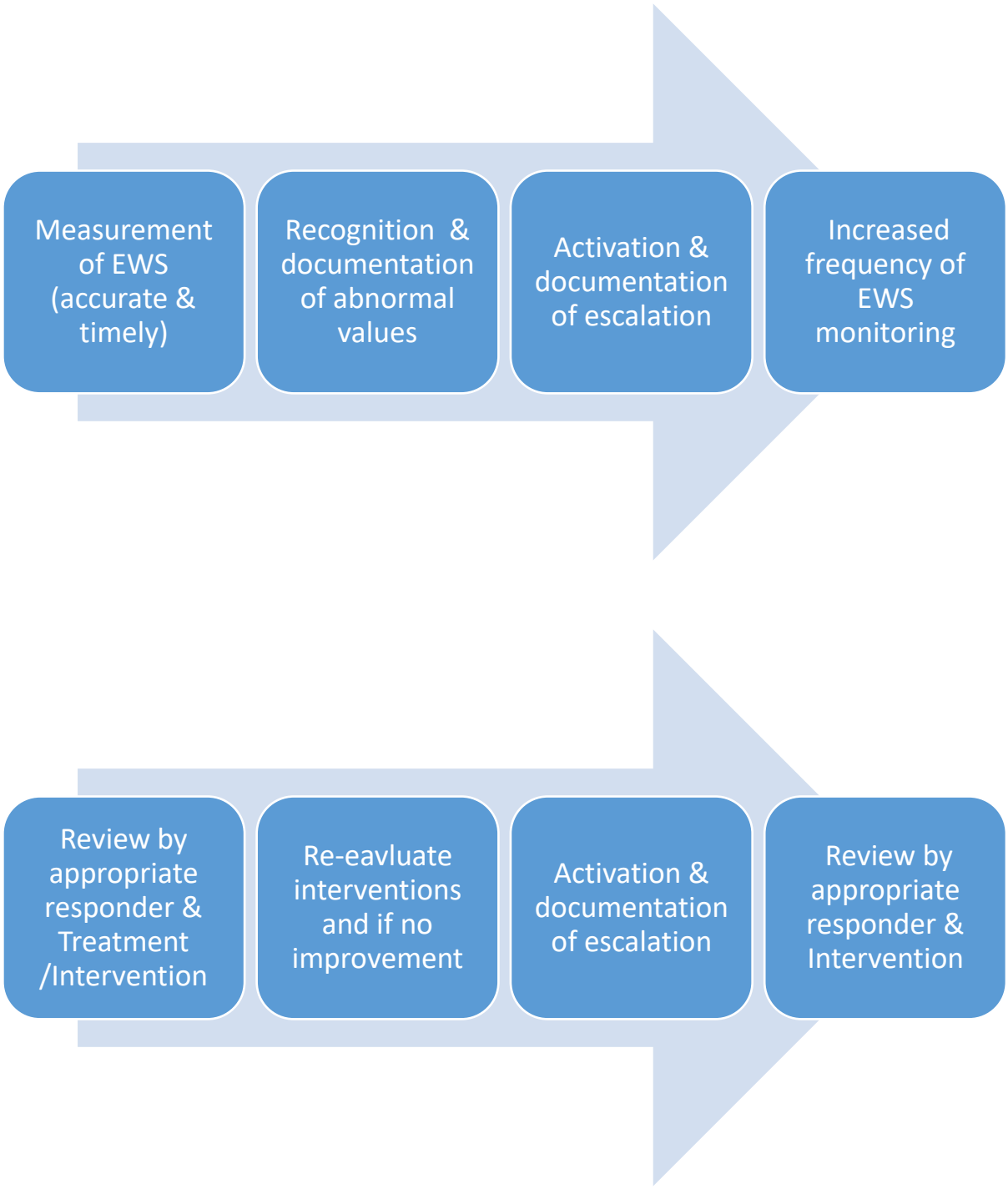
I am writing to confirm that I am the designated contact for any medical staff performance issues arising from Mrs Sharon Oswald's research work in line with her proposal that 'any consistent or repeated individual medical staff's acts or omissions causing patient harm are relayed directly to the medical director'.

I wish Sharon well with her application as this is an important area to research.

Iain Wallace
Medical Director

Appendix 10

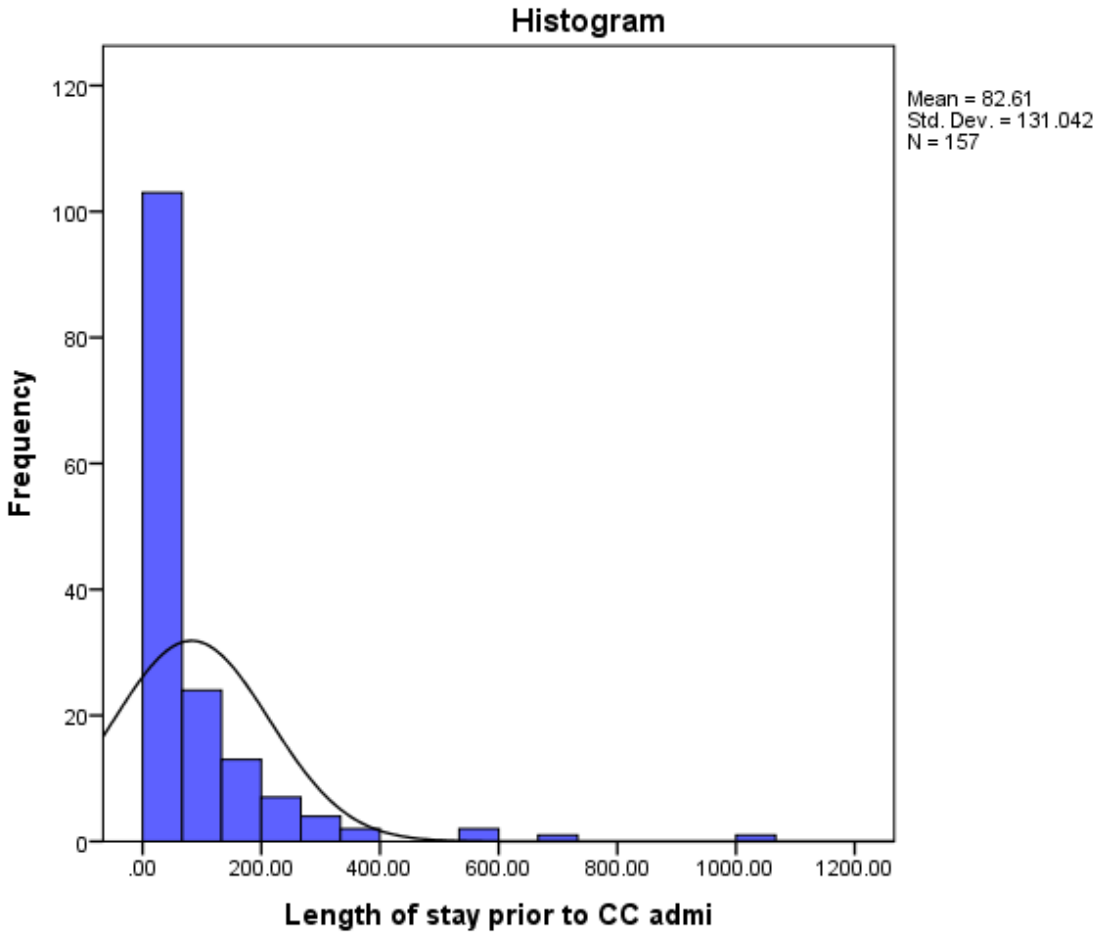
Process Map – Recognition of the Deteriorating Patient



Appendix 11

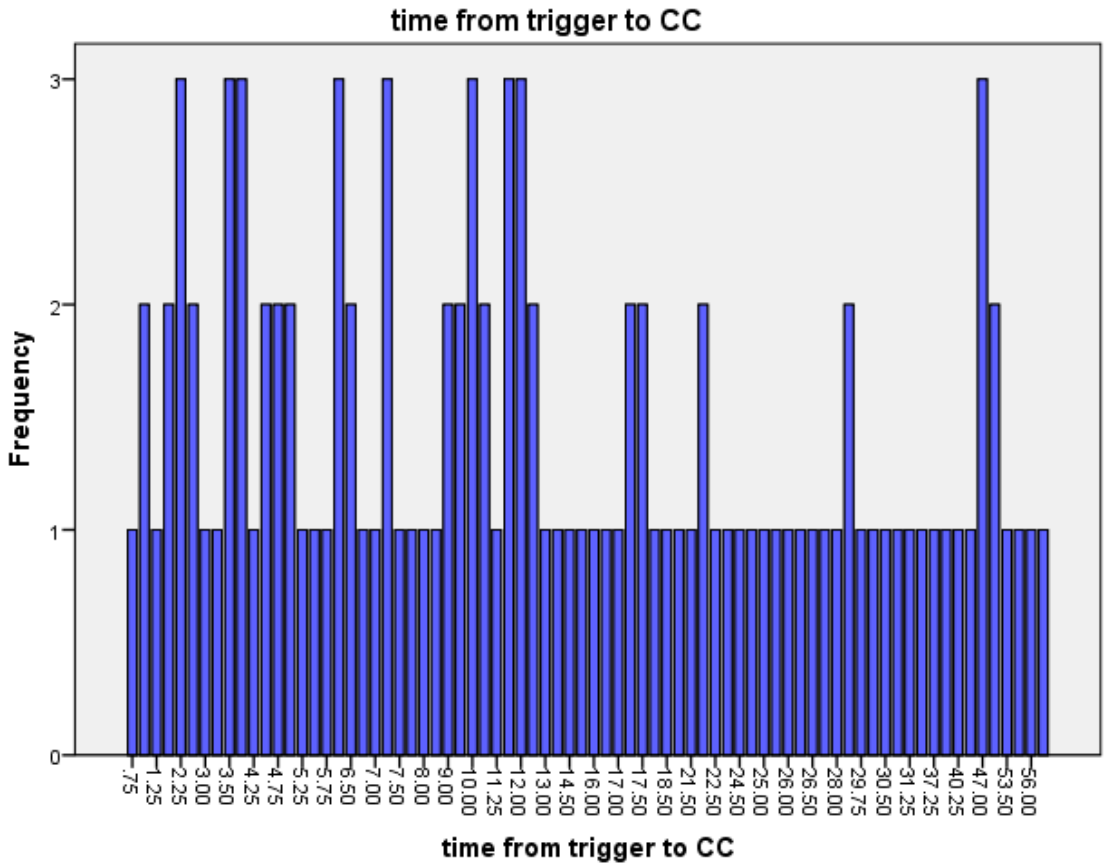
Abnormal distribution of numerical variables:

Length of stay before critical care admission

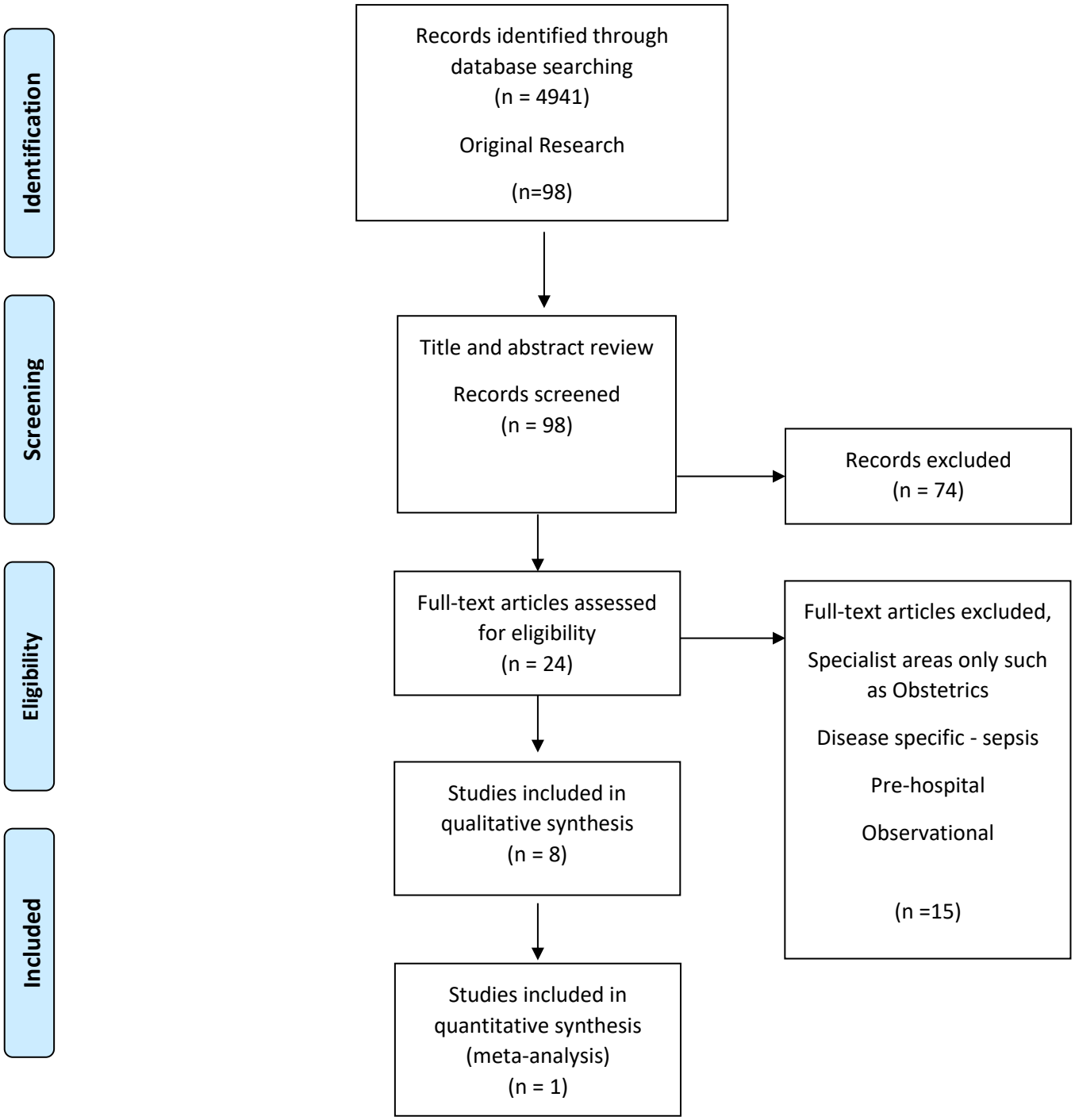


Abnormal distribution of numerical variables:

Time from trigger to Critical Care admission



Appendix 12 – Literature Search Results



Appendix 13 – Literature Summary: MET

Author Year & Location	Aim of Study	Sample, study population	Methods	Findings
Salamonson et al (2001) Australia	Effect of MET system on ICU admission and hospital mortality rate	299 MET calls	Quantitative prospective single centre cohort study	MET education extensive and increased use of MET
Hillman et al (2005) MERIT study Australia	MET effect on cardiac arrest rate & unplanned ICU admissions	23 hospitals 11 control 12 intervention	Quantitative Multi-centre RCT	MET education extensive and increased use of MET
Cretikos (2006) Australia	Factors associated with MET use	Nurses over 24 hr period Number unknown	Quantitative Before and after analysis of use of MET	MET education extensive and increased use of MET
Cioffi (2000) Australia	RN experiences of calling MET	32 nurses with 5 or more years experience Purposive sampling	Qualitative, Exploratory descriptive study. Unstructured in-depth interviews. Thematic analysis of 7 wards	Uncertainty of calling MET Hierarchical barriers Intuitive decisions
Jones et al (2006) Australia	Nurses value of MET and barriers to calling	351 ward nurses over 24 hours 100% response	Quantitative Questionnaire pre and post education and MET	Uncertainty of calling MET Hierarchical barriers MET education extensive and increased use of MET
Bellemo et al (2003) Australia	Cardiac arrest rate before and after MET implementation	Before and 4 months after MET	Quantitative Cardiac arrest rate pre and post education and MET	Reduction in cardiac arrest rate Extensive education and increased use of MET

DeVita et al (2004) USA	Use of MET Cardiac arrest rate before and after MET implementation	Cardiac arrest rate 5 ears prior to MET and then 1.8 years after	Quantitative Retrospective analysis	Extensive education and increased use in MET Decrease cardiac arrest rate
Buist et al (2002) Australia	Cardiac arrest rate before and after MET implementation	Before MET and 3 years after education and MET implementation	Quantitative Cardiac arrest rate pre and post education and MET	Quantitative Cardiac arrest rate pre and post education and MET
Story et al (2004) Australia	Effect on adverse events after MET in post-operative patients	Data on 11 serious adverse events and 30-day mortality before and after MET	Audit Pre and post MET implementation	Reduction of adverse events. No significant decrease in mortality

Appendix 14 – Literature Critique

Critical Appraisal STROBE

Title & Abstract	1	McQillan et al (1998) Confidential inquiry into quality of care before admission to intensive care
Background & Rationale	2	Unplanned admissions to intensive care have high morbidity & mortality. Critically ill patients show signs of clinical deterioration, but these are often missed
Objectives	3	To examine the prevalence, nature, causes and consequences of sub optimal care before admission to intensive care
Methods		
Study Design	4	Prospective confidential enquiry on the basis of structured interviews and questionnaires
Setting	5	Two sites, one District General Hospital and one Teaching Hospital
Participants	6	100 consecutive admissions to intensive care 50 on each site
Variables	7	Opinions of two external assessors on quality of care focus on recognition, investigation, monitoring and management of abnormalities of airway, breathing, circulation, oxygen therapy and monitoring
Measurement	8	No assessment tool detailed Assessors opinion only Subjective measurement No consensus of opinion No definition of sub-optimal care
Bias	9	Not blinded to outcome Reviewers of only one speciality & one discipline
Study size	10	No detail on how the study size was arrived at
Quantitative Variables	11	Lack of consensus in 26% of cases and were entered in the sub-optimal group despite the mortality of those being similar to the well managed group
Statistical Methods	12	Kruskai-wallis test but no detail of statistical methods
Results	13	From the100 patients reviewed 20 were deemed to have been well managed (group 1). 54 patients were identified as having sub-optimal care (group 2). No agreement in 26 cases (group 3)
Descriptive Data	14	Consecutive intensive care admissions reviewed but no descriptive data identified

Outcome Data	15	Mortality data identified Group 1 (25%) Group 2 (48%) Group 3 (23%)
Main Results	16	Intensive care admission deemed late in 69% of patients 41% of intensive care admission deemed avoidable
Other Analysis	17	APACHEII scores found the severity of illness similar across the groups
Discussion		
Key Results	18	Sub-optimal care identified but nature, causes and consequences not discussed Very vague around how groups were identified
Limitations	19	Recognise outcome bias, assessor disagreement, small sample and wide confidence intervals
Interpretation	20	Very subjective study, results should be viewed with caution
Generalisability	21	Not generalisable due to the lack of objective measures and lack of agreement between reviewers
Funding	22	Funding was supported by internal audit departments / no conflicts

Appendix 15 – Paper for Publication

Journal - Resuscitation

Title: A retrospective case-note review of the accuracy and frequency Early Warning Scores (EWS) measurements prior to critical care admission.

ABSTRACT

Background

Urgent unanticipated admission to critical care from acute care wards is a serious adverse event. The recognition and management of deteriorating patients in acute care wards is essential to promote patient safety and reduce unnecessary morbidity and mortality. EWS are commonly used in hospitals to identify patients at risk of deterioration.

Methods

I conducted a retrospective case-note review of all patients admitted to critical care from acute care wards over a six-month period. The accuracy and frequency of EWS measurement was examined in 157 patients with 110 patients triggering on EWS prior to critical care admission.

Results

I found that 59.2% of EWS scores were miscalculated. Normal EWS (less than 4) were less frequently miscalculated (15%). Scores of four or five were the most frequently miscalculated (52%) followed by scores of six or more (32%).

In the 110 patients who triggered on EWS the frequency of EWS measurements was not increased appropriately in 31%. The EWS values that most frequently did not result in an appropriate increase in frequency of measurements were those of 4 or 5 (80%). Patients with scores of six or more did not have an appropriate increase in frequency of measurements in 20% of cases. When entered in to a binary logistic regression analysis, the lack of increase in the frequency of EWS measurement was statistically significant in the delay to critical care admission (p = 0.013).

Conclusion

Poor compliance with the frequency of EWS measurements can predict delay to critical care admission in patients showing physiological evidence of deterioration.

1. INTRODUCTION

Failure to recognise deteriorating patients and delaying critical care admissions is a healthcare safety issue which can increase unnecessary morbidity and mortality (NCEPOD 2012, Kause et al 2004, NCEPOD 2005). Concerns about safety originate from the growing realisation that health care is an industry that frequently, and often avoidably, harms vulnerable people (Reason 2016, Hurwitz & Sheikh 2009). Effective recognition and management of the deteriorating patient is an integral aim of the Scottish Patient Safety Programme and the Healthcare Quality Strategy for NHS Scotland (2010). Similar work is ongoing nationally and internationally (ACSQHC 2012, NPSA 2007b, NHS Wales 2010).

The term 'sub-optimal care' emerged in the late nineties with studies suggesting many aspects of the care of deteriorating patients were below accepted standards. In the frequently referenced work of McQuillan (1998) and McGloin (1999), both claimed that nurses failed to monitor, recognise or report physiological abnormalities. Their comments were however generalised, not quantified and lacked objectivity. Since then several studies (Wheatley 2006, Hogan 2006, Andrews and Waterman 2005, Minnick and Harvey 2003, Kenward and Hodgetts 2002, Cioffi 2000) have focussed on the nursing role in the recognition and management of the deteriorating patient. In the qualitative studies, some key themes emerged such as nurses related to 'knowing their patients' and detecting changes in behaviour or appearance by gut instinct rather than physiological abnormalities (Cox et al 2006, Cioffi 2000, Kenward and Hodgetts 2002, Minnick and Harvey 2003). This concept of 'nurse intuition' is much debated in the literature (Paley 2002, Paley et al 2007, Lynecham et al 2008) but is out with the study emphasis on EWS compliance.

From a large body of evidence, it is well recognised that abnormal physiology is associated with adverse clinical outcomes (Cei et al 2009, Burch et al 2008, Duckitt et al 2007, Goldhill et al 2005, Buist et al 2004, Goldhill and McNarry

2004, Subbe et al 2001). In that body of research, it was shown that physiological abnormalities determined the severity of illness. Much of this work has led to the development of Early Warning Scores (EWS). EWS enable ward staff to combine their routine observations and produce an aggregate physiological score, the higher the score the sicker the patient (Sharpley and Holden 2004). EWS therefore, provide set criteria to simplify and inform the decision of when to call for help. They are a means of identifying and highlighting patients at risk by providing a framework for nurses to establish when a patient's physiological parameters are outside the accepted range (Odell 2002). Studies have continued to provide evidence of the validity of EWS to predict patient outcomes (Smith et al 2012, Day et al 2010, Groarke et al 2008). Along with an early warning score, either a protocol or guideline to direct further care is recommended by the National Institute for Health and Clinical Excellence (NICE 2007) and the National Patient Safety Alliance (NCEPOD 2007). This should include instructions on the frequency of EWS measurements when physiology is abnormal and who and when to escalate concerns.

My aim was to investigate the accuracy of EWS calculations and the frequency of EWS measurement as part of the process in the recognition and management of deteriorating patients. I also wanted to determine whether this had any statistical significance in any delay to critical care admission.

2. METHOD

2.1 Study Design

This was a retrospective observational case note review of all patients admitted to critical care from acute care wards over a six-month period in a District General Hospital serving a population of approximately 300,000. The data was collected on patients admitted to critical care between mid-January and mid-July 2013. Excluded were any patients admitted to critical care from the Emergency Department or any planned admissions.

2.2 Ethical Statement

The East of Scotland Research Ethics Service were informed of the study and verified that it did not require ethical review under the terms of the Governance Arrangements for Research Ethics Committees. Ethics application was then sent to University of Stirling Faculty of Health Sciences and Sport's research ethics committee and was subsequently approved. Caldicott approval was granted by the NHS board where the research was undertaken. Confidentiality was given great consideration throughout the research process and Caldicott principles were always maintained.

2.3 Data Collection

A data collection tool was specifically designed to collect information from the case records of the population. The tool reflects local policy in the optimal process to recognise and respond to deteriorating patients and is comparable to those used in similar sites across the UK. No qualitative data was included within the tool. Objective information included both accuracy of calculation of early warning scores and appropriateness of the timing of measurements. A group of one doctor and three nurses used the tool to test inter-relater reliability. The data

collection entries demonstrated consistency as only objective information was sought and no questions required subjective opinions of the group.

2.3 Statistical analysis

2.3.1 Descriptive statistics

SPSS version 21 was used to measure descriptive statistics of EWS accuracy and frequency of EWS measurement. The results on accuracy were displayed in percentages of those calculated correctly or incorrectly and then cross-tabulated to determine what scores were most frequently miscalculated. The appropriate increase in frequency of measurements for those who triggered on EWS were displayed in percentages of those who had appropriate increase in EWS measurements and those who did not. These were cross-tabulated to determine which scores had appropriate increase in frequency and those who did not.

2.3.2 Inferential statistics

Categorical variables were compared using Chi square test and SPSS version 21 was used to undertake statistical analysis. Multivariate logistic regression analysis assessed for association between the independent variables and the dependent variable which was whether the time from triggering EWS to critical care admission was less or more than six hours.

3. RESULTS

Descriptive data was collected from the medical notes of all 157 patients. It was found that 30% of patients did not trigger on early warning scores prior to critical care admission (see Fig.1). Those who did not trigger on EWS later exited the study prior to inferential statistical analysis. The dependent variable was based on time from triggering on the EWS to admission to critical care; those who did not trigger were subsequently not included in the final analysis.

When measuring the accuracy of EWS scores all 157 patient records were included demonstrating that 59.2% of patients did not have an accurate calculation of the early warning score. The calculation was analysed irrespective of the aggregate score. score (Fig.2).

Cross-tabulation demonstrated that scores of 4 or 5 were the most frequently miscalculated followed by scores of more than or equal to 6 (Fig.3)

Fig. 1: Early Warning Score (EWS) proportion

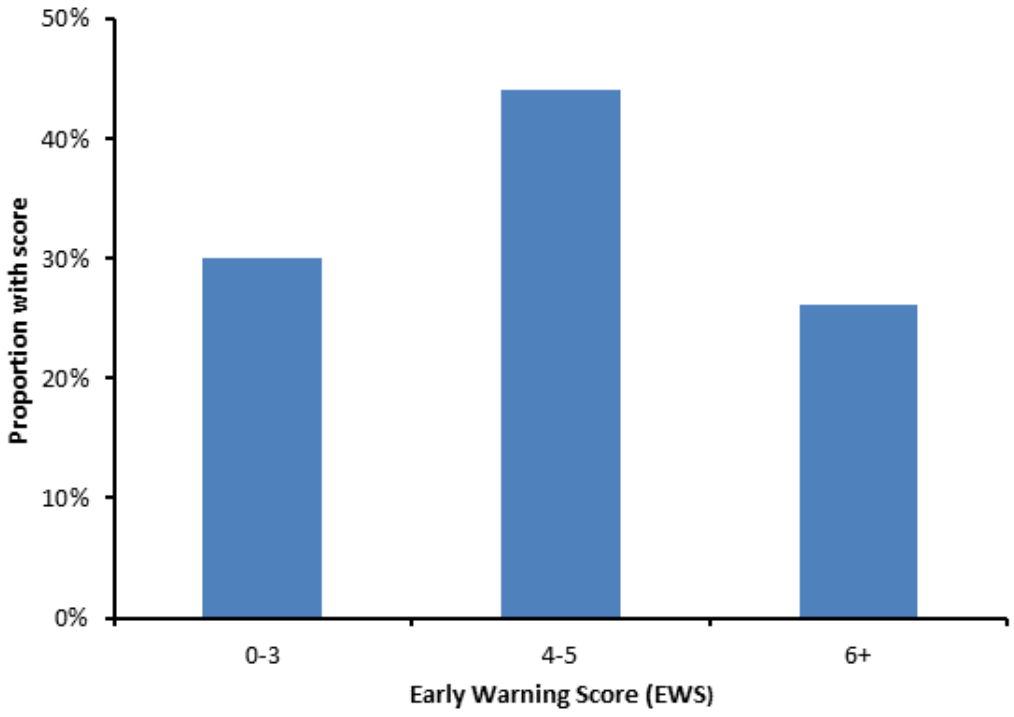


Fig. 2: Proportion of correct and incorrect EWS calculations

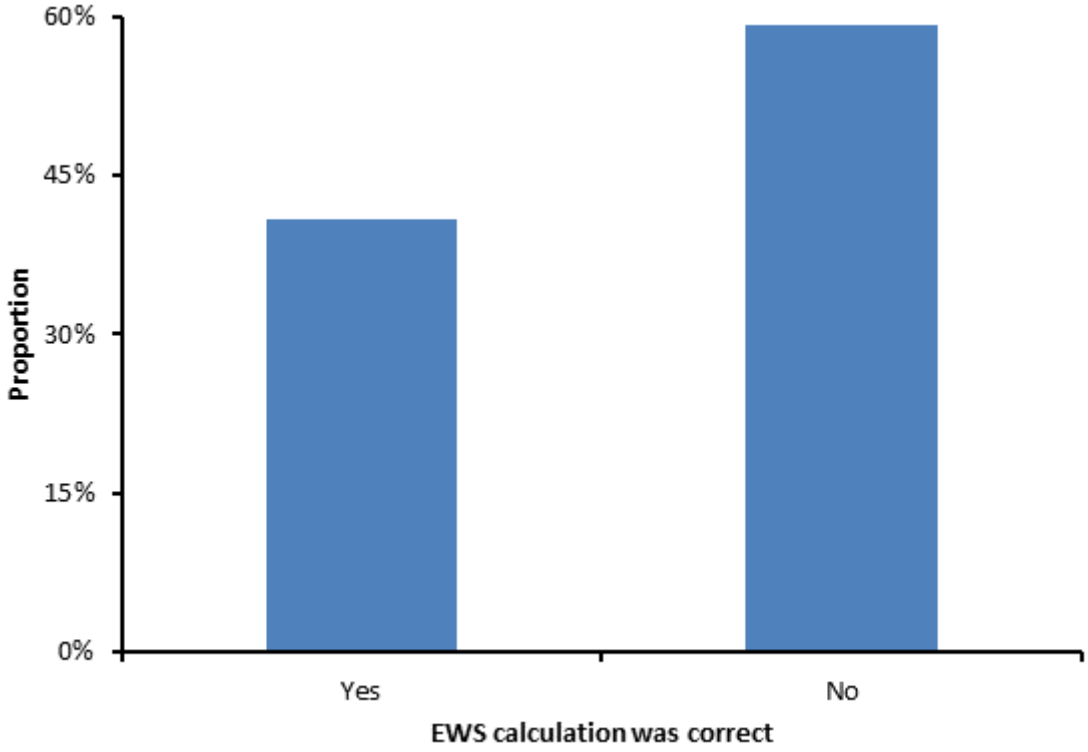
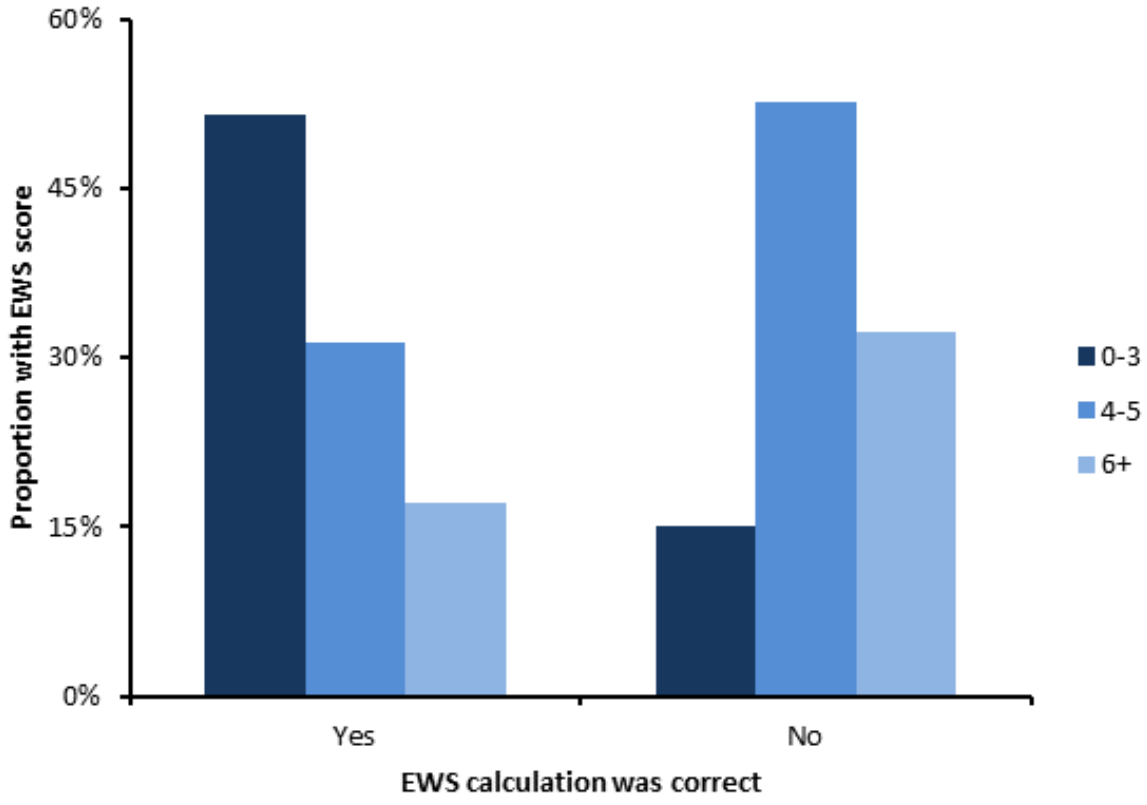


Fig. 3: EWS score by whether or not EWS calculation was correct



If the EWS score is found to be out with normal limits (4 or more) then the frequency of EWS recordings should be increased in line with local guidelines. From the total 157 patients, 110 had EWS out with normal limits (4 and above). The results of whether or not EWS measurement was appropriately increased in those patients is displayed below (Fig.4.) These results were then cross-tabulated with the EWS values to determine which EWS values were most frequently not increased appropriately (Fig.5).

Fig. 4: Proportion of whether or not EWS frequency was appropriate

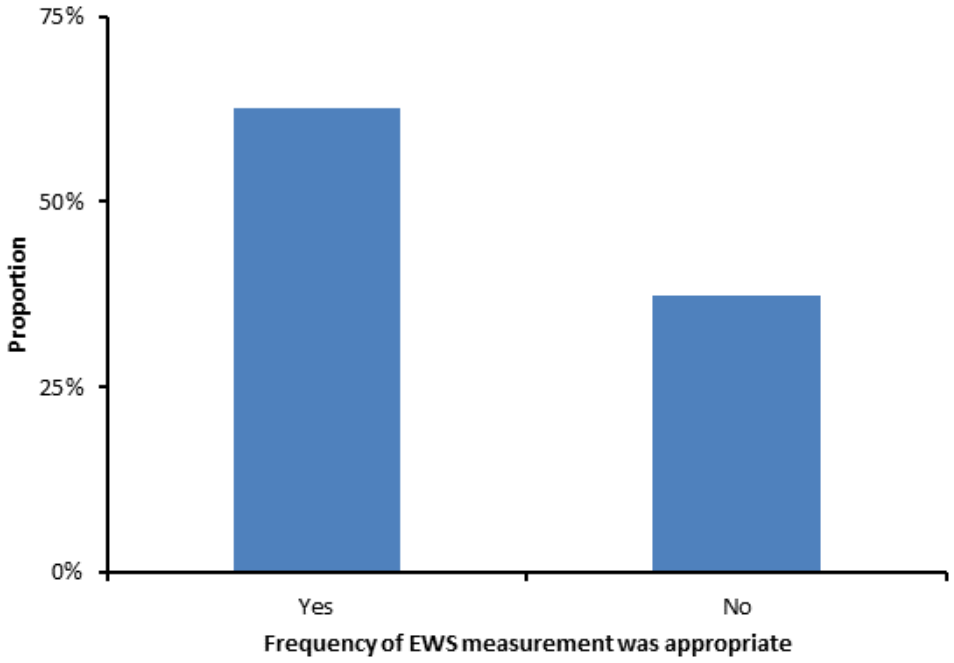
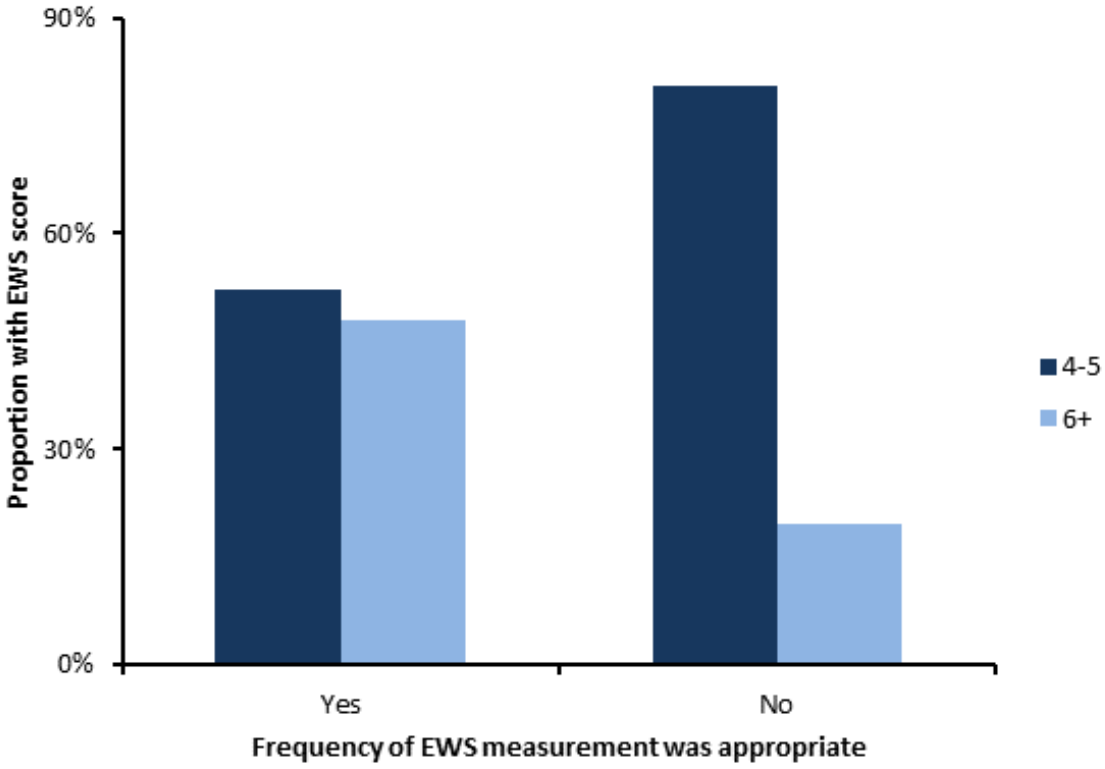


Fig. 5: EWS score by whether or not EWS frequency was appropriate



Cross-tabulation was undertaken to determine association between variables. Using the cross-tabulations allowed the independent variables to be individually evaluated for likelihood of relationship to the dependent variable prior to entering data for statistical analysis. The significance of the independent variables of accuracy of EWS calculations and appropriate increase in frequency of EWS measurements are shown in Table 1

Table 1: Significance of association between categorical independent variables and dependent variable (patient admitted to critical care within 6 hours of triggering on EWS)

EWS calculation correct	0.462
Frequency of observations increased appropriately	**0.006**

Predictor (independent) variables were identified and the strength of the relationship tested by cross-tabulation. Only those with the strongest relationship were chosen to enter the logistic regression model. The variable of whether EWS calculation was correct or not was not a predictor variable and therefore was not entered in the binary logistic regression model. The outcome of the binary logistic regression on the frequency of EWS measurements is displayed in Table 2

Table 2: Significance of association between categorical independent variables and dependent variable (patient admitted to critical care within 6 hours of triggering on EWS)

Significant Variables	Pearson chi-square (p value)
Frequency of observations increased appropriately	**0.013**

The binary logistic regression analysis with the predictor variable showed statistical significance. This therefore rejects the null hypothesis that there is no association between the independent variables and the dependent variable (time from triggering EWS to admission to critical care to either six hours or less or more than six hours)**.**

4. DISCUSSION

This study explored the accuracy of the EWS calculation and found that most were calculated incorrectly. Previously studies have also found miscalculation rates of 21.9% (Smith & Oakey 2006) to 42% (Mohammed et al 2009). However, I found the percentage of incorrectly calculated EWS was 59%. This finding, although alarming, was not statistically significant in prediction of delay in admission to critical care. Calculation errors in EWS were less evident in the lower scores - in those with a score of 4 or less the error rate was 15%. As the least frequently miscalculated scores were those <4, this finding concurs with Smith & Oakey (2006) who demonstrated that abnormal EWS scores (higher scores) were most frequently miscalculated. I examined miscalculations in more detail and found that the most frequently miscalculated scores were the intermediate scores (EWS 4 or 5 – error rate 52%) rather than in the highest scores (6 or more – error rate 32%). Smith & Oakey (2006) only categorised to the normal versus abnormal EWS. If this divide was replicated in my study, then findings would concur, however the full picture of miscalculation would not have emerged. It is of note that I found that the highest scores were less frequently miscalculated than the intermediate. If the miscalculation was purely a numerical addition error, then it would be logical that the highest scores would have more miscalculation. I believe that perhaps within this pattern of miscalculation, there may have been misinterpretation or lack of knowledge on how to use the chart. There is existing literature to suggest education programmes improve EWS measurement and deepen knowledge of the use and understanding of the chart (Kenward et al 2001, Buist et al 2002, Bellomo et al 2003). There was no structured education within the study centre at the time of data collection. The lack of any structured training may have impacted on the high error rate results.

Recognition of abnormal values and evidence of escalation forms part of the recognition and management of deteriorating patients. If abnormal physiology is recognised, the frequency of EWS calculations should be increased. Local and national policies guide the increased frequency times however, the general

concept is that the higher the EWS score, then the more frequently the EWS should be measured.

A significant finding to emerge from my research was that if there was not an appropriate increase in the frequency of observation recording then this could predict a delay in critical care admission. Morris & Davies (2010) published the results of their audit on EWS compliance. They identified poor compliance with EWS completion including missing data or omitted or incorrect scores. They also noted a lack of increase in the frequency of observations but did not quantify the data clearly or evaluate the impact of this. In my study the frequency of observations was only appropriate in 69% of the sample. Despite the inappropriate frequencies being a smaller percentage than those who followed local policy, poor compliance in increasing the frequency of EWS monitoring was significant in predicting delay to critical care admission. This has not been documented in the literature to date. The EWS value which most frequently failed to result in an appropriate increase in frequency of measurement was the intermediate values (EWS 4 or 5). These were also the scores most frequently miscalculated (error rate 52%). The results revealed that 80% of the EWS values 4 or 5 did not have appropriate increase in frequency of measurements. The scores of 6 or more demonstrated less deviation from optimum process appropriately increasing the frequency of EWS measurements in 80% of the cases (error rate 20%). They also had a lesser calculation error rate than the intermediate scores (error rate 32%). The results suggest that patients scoring 4 or 5 therefore are very much at risk of sub-optimal care.

5. CONCLUSION

This study addressed compliance with EWS in both accuracy of calculations and frequency of measurements when EWS is abnormal. Intermediate scores were most frequently miscalculated and had less appropriate increase in the frequency of EWS measurements. As the calculation error rate was higher in the intermediate scores than the higher scores, this suggests that a knowledge deficit may accompany any possible numeracy issues. Poor compliance with the increase in frequency of EWS measurements was found to be statistically significant in predicting delay to critical care admission. Ongoing education and evaluation of EWS compliance is required to ensure optimum recognition and management of deteriorating patients in acute care wards to reduce unnecessary morbidity and mortality.

REFERENCES

ACSQHC (2012) Australian Commission on Safety and Quality in Health Care. *National safety and quality health service standards*. Sydney: ACSQHC

Andrews, T. and Waterman, H. (2005) Packaging: a grounded theory of how to report physiological deterioration effectively. *Journal of Advanced Nursing* 52 (5) 473-481

Bellomo, R., Goldsmith, D., Uchino, S., Buckmaster, J., Hart, G.K., Opdam, H., Silvester, W., Doolan, L., Gutteridge, G. (2003) A prospective before-and-after trial of a medical emergency team. *MJA* 179 (6) 283-287

Buist, M.D., Moore, G.E., Bernard, S.A., Waxman, B.P., Anderson, J.N. (2002) Effects of a medical emergency team on reduction of incidence of and mortality from unexpected cardiac arrests in hospital: preliminary study. *BMJ* 3241-6

Buist. M., Bernard, S., Nguyen, T.V., Moore, G., Anderson, J. (2004) Association between clinically abnormal observations and subsequent in-hospital mortality: a prospective study. *Resuscitation* 62 137-141

Burch, V.C., Tarr, G., Morroni, C. (2008) Modified early warning score predicts the need for hospital admission and in-hospital mortality. *Emergency Medical Journal* 25 674-678

Cei, M., Bartolomei, C., Mumoli, N. (2009) In-hospital mortality and morbidity of elderly medical patients can be predicted at admission by the Modified Early Warning Score: a prospective study*. Internal Journal of Clinical Practice* 63 (4) 591-595

Cioffi, J. (2000) Nurse' experiences of making decisions to call emergency assistance for their patients. *Journal of Advanced Nursing* 32 (1) 108-114

Cox, H., James, J., Hunt, J. (2006) The experiences of trained nurses caring for critically ill patients within a general ward setting. *Intensive and critical Care Nursing* 22, 283-293

Day, A., Oldroyd, C., McDaniel, S. (2010) The Use of Early Warning Scores in the Emergency Department. *Journal of Emergency Nursing* 36 (2) 154-155

Duckitt, R.W., Buxton-Thomas, R., Walker, J., Cheek, E., Bewick, V., Venn, R., Forni, L.G. (2007) Worthing physiological scoring system: derivation and validation of a physiological early-warning system for medical admissions. An observational, population-based single-centre study. *British journal of Anaesthesia* 98 (6) 769-774

Goldhill, D.R. and McNarry, A.F. (2004) Physiological abnormalities in early warning scores are related to mortality in adult inpatients. *British Journal of Anaesthesia* 92 (6) 882-884

Goldhill, D.R., McNarry, A.F., Mandersloot, G., McGinley, A. (2005) A physiologically-based early warning score for ward patients: the association between score and outcome. *Anaesthesia* 60 547-553

Groarke, J.D., Gallagher, J., Stack, J., Aftab, A., Dwyer, C., McGovern, R., Courtney, G. (2008) Use of an admission early warning score to predict patient morbidity and mortality and treatment success. *Emergency Medical Journal* 25 803-806

Hogan, J. (2006) Respiratory assessment: why don't nurses monitor the respiratory rates of patients? *British Journal of Nursing* 15 (9) 489-492

Hurwitz, B. and Sheikh, A. (2009) *Health Care Errors and Patient Safety*. West Sussex: Blackwell Publishing Ltd.

Kause, J., Smith, G., Prytherch, D., Parr, M., Flabouris, A., Hillman, K. (2004). A comparison of Antecedents to Cardiac Arrests, Deaths and Emergency Intensive Care Admissions in Australia and New Zealand and the United Kingdom – the ACADEMIA study*. Resuscitation* 5 (16) 275-297

Kenward, G. and Hodgetts, T. Castle N (2001) Time to put the R back in TPR. *Nursing Times* 97 (40) 32-33

Lyneham, J., Parkinson, C., Denholm, C. (2008) Explicating Benner's concept of expert practice: intuition in emergency nursing. *Journal of Advanced Nursing* 64 (4) 380-387

McGloin, H., Adam, S.K., Singer, M. (1999) Unexpected deaths and referrals to intensive care of patients on general wards. Are some cases potentially avoidable? *Journal of the Royal College of Physicians of London* 33 (3) 255-259

McQuillan, P., Pilkington, S., Alison, A., Taylor, B., Short, A., Morgan, G., Neilsen, M., Barrett, D., Smith, G. (1998) Confidential inquiry into quality of care before admission to intensive care. *British Medical Journal* 316 (7148) 1853-1858

Minnick, P. and Harvey, S. (2003) The early recognition of patient problems among medical-surgical nurses. *Medsurg Nursing* 12 (5) 291-297

Mohammed, M.A., Hayton, R., Clements, G., Smith, G., Prytherch, D. (2009) Improving accuracy and efficiency of early warning scores in acute care. *British Journal or Nursing* 18 (1) 18-24

Morris, A. and Davies, K. (2010) Early warning scoring systems: observations of care in practice. *British Journal of Nursing* 19 (18) 1180-1184

National Patient Safety Agency (2007b) *Recognising & responding appropriately to early signs of deteriorating hospitalised patients.* NPSA: London

NCEPOD (2005) *An Acute Problem? A report of the National Confidential Enquiry into Patient Outcome and Death.* London: NCEPOD

NCEPOD (2007) *Emergency admissions: A journey in the right direction*. London: NCEPOD

NCEPOD (2012) *Time to intervene*. London: NCEPOD

NHS Scotland (2010) *The Healthcare Quality Strategy for NHS Scotland.* The Scottish Government: Edinburgh

NHS Wales (2010) *Rapid Response to Acute Illness*. Cardiff: NHS Wales

NICE: National Institute for Health and Clinical Excellence (2007) *Acutely ill patients in hospital, Recognition of and response to acute illness in adults in hospital. NICE guideline 50* London: NICE

Odell, M. (2002) Sepsis: early detection and care. *Professional Nurse* 18 (2) 68-69

Paley, J. (2002) Benner's remnants: culture, tradition and everyday understanding. *Journal of Advanced Nursing* 38 (6) 566-573

Paley, J., Cheyne, H., Dalgleish, L., Duncan, E.A.S., Niven, C.A. (2007) Nursing's ways of knowing and dual process theories of cognition. *Journal of Advanced Nursing* 60 (6) 692-701

Reason, J. (2016) *Organizational Accidents Revisited*. Surrey: Ashgate Publishing Limited

Sharpley, J.T. and Holden, J.C. (2004) Introducing an early warning scoring system in a district general hospital. *Nursing in Critical Care* 9 (3) 98-103

Smith, A.F., Oakey, R.J. (2006) Incidence and significance of errors in patient 'track and trigger' system during an epidemic of Legionnaires' disease: retrospective case note analysis. *Anaesthesia* 61 (3) 222-228

Smith, T., Den Hartog, D., Moermn, T., Patka, P., Van Lieshout, E.M.M., Schep, N.W.L. (2012) Accuracy of an expanded early warning score for patients in general and trauma surgery wards. *British Journal of Surgery* 99 192-197

Subbe, C.P., Kruger, M., Rutherford, P., Gemmel, L. (2001) Validation of a modified Early Warning Score in medical admissions. *Quarterly Journal of Medicine* 94 521-526

The Intensive Care Society (2009) *Levels of critical care for Adult Patients*. Available:http://members.ics.ac.uk/ICS/guidelines-and-standards.aspx. (accessed 13 Dec 2017).

Wheatley, I. (2006) The Nursing Practice of taking level 1 patient observations. *Intensive and Critical Care Nursing* 22 (2) 115-121