PHYSIOLOGICAL OBSERVATIONS AND NURSING INTERVENTIONS IN THE
PRE-ARREST PATIENT: A DESCRIPTIVE STUDY

by

Tara Marie Ryton-Malden

A thesis submitted to the Victoria University of Wellington

in partial fulfilment of the
requirements for the degree of
Master of Nursing (Clinical)

Victoria University of Wellington
2011

Abstract

Aim

To identify how nurses respond to abnormal physiological observations in the 12 hours prior to a patient having a cardiac arrest.

Methods

A descriptive observational design was used to retrospectively review the observation charts and nursing notes of 28 patients who had an in-hospital cardiac arrest, during a 20 month period. This study was performed in a large, tertiary teaching hospital in New Zealand.

Key Findings

Only one patient met the hospitals minimum standard of four hourly observations and a full set of vital signs were performed on only three patients. The nursing responses were limited to increasing the frequency of observations or informing the doctor. There were few other interventions to treat the abnormality. Eight (32%) patients who had either no response or a partial response to their abnormal physiology did not survive. The nursing documentation demonstrated that abnormal neurological observations were tolerated for significant periods of time and were not acted upon in 62% of these patients. The nursing documentation revealed that the delivery of oxygen was often insufficient to meet the patient's requirements and the medical staff were aware of less than half the patients with abnormal physiology.

Discussion removed statement re pt survival

This research identified major deficiencies with recording patient vital signs. If these are not recorded regularly, patient deterioration will be missed and treatment cannot be initiated. Nurses need to respond to abnormal physiology beyond repeating vital signs and informing the medical staff. They are accountable for initiating interventions to prevent further deterioration.

Conclusion

The early recognition of patient deterioration and treatment are essential to prevent cardiac arrest. Education strategies are required to improve compliance with recording patient vital signs, communication between nursing and medical staff and how to respond to patient deterioration. The barriers to these must be addressed and solutions sought if patient mortality is to be improved.

Key words: Deteriorating patient; cardiac arrest; vital signs; nursing observations

Acknowledgements

There are many people who without their encouragement and support this thesis would never have reached completion. Becoming unwell was not part of the plan when I started this journey and my health has significantly impacted upon my ability to study. Sheer will, determination, stubbornness and the fabulous people in my life have helped me get where I am today.

I would like to express my gratitude to my husband Brent, who without his love, understanding and patience, I would never have reached this point. He has supported us financially so that I have been able to work full time on this thesis and has also taken on all of the additional responsibilities. Not only this but having moved to a new country he has had to spend a large amount of time alone, whilst I have been locked away in the study. Thankfully he has had kite surfing to keep him amused. On a serious note, you are my strength and my rock and I truly appreciate everything you have done, thank you from the bottom of my heart.

I would like to thank my supervisors Dr Kathy Nelson and Dr Sara Quirke for sharing their knowledge and providing feedback, even if at times it was hard to hear. You kept me on the right path when I had a tendency to go off course, which has hopefully resulted in a worthwhile piece of research. I am truly grateful for your kindness and understanding during the times when it was difficult to see the wood for the trees.

To Professor Jo Walton, Head of School and the University for not giving up on me and providing me with the additional time I needed to complete this study. Jo, without your backing I would not be writing this acknowledgement today, so my sincere thanks.

A big thank you to the ward clerk from the intensive care unit for obtaining the patient notes required to carry out this study.

I would also like to acknowledge my family, friends and colleagues who gave me words of advice and encouragement when it seemed like too big a mountain to climb. You know who you are. Finally, thank you to my employer for allowing me to carry out this research and to my managers for their ongoing support.

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List of abbreviations

ACSQH: Australian Commission on Safety and Quality in Healthcare

ADDS: Adult Deterioration Detection System

ALERT: Acute life threatening events recognition and treatment

AVPU: Alert, responds to voice, responds to pain, unresponsive

BP: Blood pressure

EWS: Early warning score

GCS: Glasgow coma score

HR: Heart rate

ICU: Intensive care unit

LOC: Level of consciousness

MET: Medical emergency team

NICE: National Institute for Health and Clinical Excellence

NPSA: National Patient Safety Agency

NZ: New Zealand

PAR: Patient at risk

PEA: Pulseless electrical activity

RR: Respiratory rate

SBP: Systolic blood pressure

SPSS: Statistical Package for Social Science

SpO₂: oxygen saturation

UK: United Kingdom

VT: Ventricular tachycardia

VF: Ventricular fibrillation

Chapter One: Introduction

Introduction

There is evidence to show that as many as 84% of patients demonstrate abnormal physiological observations for many hours prior to an adverse event, such as cardiac arrest, in-hospital death or unexpected admission to the intensive care unit (ICU) (Franklin & Matthew, 1994; Schein, Hazday, Pena, Ruben, & Sprung, 1990). These events are not uncommon and the mortality rate for these patients is high (Considine & Botti, 2004). Given that most of the abnormalities are reversible with early and appropriate intervention, adverse events are preventable (Horswill et al., 2010). However, it has been highlighted that clinical staff do not recognise and/or respond to physiological dysfunction, which leads to suboptimal care (McQuillan et al., 1998; Subbe, Kruger, Rutherford, & Gemmell, 2001). It has been hypothesised that this is due to a lack of documenting patient vital signs, a failure to appreciate the significance of the abnormality and/or a failure to initiate an appropriate response (Considine & Botti, 2004). As a result a key strategy within healthcare is to reduce the number of adverse events by improving the early recognition and management of the deteriorating patient (Australian Commission on Safety and Quality in Healthcare (ACSQH), 2008).

This chapter presents the aims of the study, my professional interest and why this research was necessary. The research methods and key definitions are described. The New Zealand (NZ) context includes the findings and recommendations of an audit that was performed at a district general hospital in NZ (Coombs, Quirke & Imray, 2004) and from an investigation by the Health and Disability Commissioner (2007) following a sentinel event at a NZ district general hospital. This chapter concludes with an overview of the thesis.

The aims and objectives of the study

The aim of this study was to identify how nurses respond to abnormal physiological observations in the pre-arrest patient, in a NZ hospital. The objectives were to:

- establish the frequency and comprehensiveness of recording patient vital signs
- ascertain the incidence of abnormal vital signs or signs and symptoms prior to a cardiac arrest
- determine which vital sign or system was most likely to become deranged pre-arrest

- determine the timeframes the abnormalities occur within
- identify interventions or actions employed by nurses when abnormal vital signs or signs and symptoms are identified.

My professional interest

For most of my nursing career I have worked in the ICU, both in the United Kingdom (UK) and in NZ. In both of these units it was not uncommon for patients to be admitted from the general wards who either had not had their vital signs recorded for prolonged periods of time or had exhibited abnormal vital signs or signs and symptoms for many hours that had been inadequately treated. I became aware of initiatives that had been implemented in the UK to address these issues and improve the early recognition and management of the deteriorating patient. These included an early warning score (EWS) system and a critical care outreach team. The purpose of the EWS is to identify physiological deterioration early and one of many roles of the critical care outreach team is to intervene and stabilise the patient. At the same time I was conscious of an audit that was performed in a district general hospital in NZ by Coombs et al. (2004) to inform business managers of these initiatives and the level of service the organisation would require. The audit identified that many patients were missing vital signs in the hours prior to ICU admission and 74% (n = 14) of the patients would have triggered the critical care outreach team. Another event that occurred was the death of a patient in a NZ district general hospital, who had received suboptimal care on a general ward. This reached the national media and an inquiry was held by the Health and Disability Commissioner (2007). Both of these are discussed in more detail later in this chapter.

My own first hand experiences, knowledge of these events and a new role as the resuscitation clinical nurse specialist led to an interest in the management of the pre-arrest patient, on the general wards. I attended many cardiac arrests and began to question what was happening to these patients prior to them having a cardiac arrest, did they exhibit abnormal physiology and if so what were the nurses doing to correct this? I decided to investigate this further and perform a literature search. I discovered that no research had been conducted in NZ on this subject, which prompted me to perform this study to establish the NZ context.

Background

A significant amount of resources have been invested into healthcare initiatives on a global level in an effort to improve the quality of care and patient safety. This has led to the development of EWS systems, rapid response teams to treat the acutely unwell patient and education strategies aimed at improving the early recognition and treatment of the deteriorating patient (Perkins & Soar, 2005). This has seen the management of cardiac arrests move away from a curative approach to one of prevention (Weil & Fries, 2005). Given the high mortality rate for these patients, preventing further deterioration avoids the inevitable progression to a cardiac arrest. In order to do this it is essential that the vital signs are documented in the first instance and that the clinical deterioration is recognised and managed appropriately. However, it has been reported that nurses ignore, do not respond to or inadequately treat abnormal physiological observations (National Patient Safety Agency (NPSA), 2007). In 2005, there were 1,804 serious incidents reported in the UK via the National Learning Reporting System (Thomson, Luettal, Healey & Scobie, 2007). Of these, 576 deaths were considered to be potentially avoidable and 64 (11%) were due to a lack of recognition and treatment. Further analysis demonstrated that 14 patients had no observations recorded for extended periods of time and changes in physiological observations went unrecognised. In 30 patients the abnormalities were recorded but there was no recognition or response and in 17 patients assistance was sought but there was a delay in the patient being reviewed by a doctor.

Whilst there is evidence to show that patients demonstrate abnormal physiology pre-arrest there is limited research to show how nurses respond to this. There are two studies where nurses were given questionnaires and were asked how they would 'hypothetically' respond to a patient with abnormal vital signs (Daffurn, Lee, Hillman, Bishop, & Bauman, 1994; Tippins, 2005). There are three further studies that also examined nursing responses, however these were limited to whether a doctor was notified, whether the medical emergency team (MET) was activated or whether oxygen was applied (Crispin & Daffurn, 1998; Goldhill, White, & Sumner, 1999; Rich, 1999). Thus, there is minimal evidence to show how nurses actually respond to abnormal physiology and the interventions they employ to correct these in the pre-arrest patient.

Significance and relevance of this research

The prevention or early recognition of a cardiac arrest has the potential to significantly improve patient outcomes. This study may reveal that nurses do recognise and respond to

abnormal observations and despite intervention and treatment patients still go on to have a cardiac arrest. Conversely, it may highlight that nurses do not document observations regularly or that they are recorded, but abnormalities are not acted upon. As a result existing practices may need to be reviewed and policies and procedures revised. Other considerations may include changes to the nursing documentation, communication or education strategies to improve the recognition of the deteriorating patient.

Research methods

A descriptive observational design was utilised to perform this study using both quantitative and qualitative data. The rationale for using this design was multifaceted. It enabled a longer data collection period to be used, thereby increasing the sample size and thus generalisability. This was performed over a 20 month period rather than two or three, as would have occurred with the use of other designs given the limited time to complete the study. Furthermore, as it reviewed events that had already occurred the Hawthorne effect would not be an issue (Schneider, Whitehead, Elliott, Lobiondo-Wood and Haber, 2007). Whilst the data was collected in 2008, the analysis was not performed until 2011. This was due to health reasons that impacted upon my ability to complete the study at that time.

Key definitions

There are several definitions that were identified prior to commencement of this study. These definitions were adapted from the work of Smith (2003).

Cardiac Arrest: The sudden cessation of the heartbeat requiring cardiopulmonary resuscitation.

Patient's notes: A file that contains confidential patient information such as investigation results, documented assessments and/or treatment implemented by health professionals.

Nursing observations: The measurement of a patient's physiological vital signs including blood pressure, heart rate, respiratory rate, oxygen saturations and level of consciousness.

Nursing assessment: The information obtained from observing and questioning the patient, which is used to make an informed judgement about their clinical condition.

Assessment of abnormal clinical signs and symptoms: Including but not limited to: Respiratory distress, noisy breathing, dyspnoea, shallow breathing, laboured breathing, difficulty breathing, cyanosis, increased work of breathing, accessory muscle usage, wheeze, altered mental status, agitation, drowsy, sleepy, irritability, restlessness, lethargy,

anxiety, combative, confusion, pallor, cool/clammy skin, diaphoresis, skin turgor, sluggish capillary refill, haemorrhage, pain, nausea, fatigue or feeling unwell.

Local context

Setting

This study was performed in a large tertiary teaching hospital in NZ. The nursing workforce consists of Registered and Enrolled nurses and the model of care used was team nursing. The hospital is a classic design consisting of an emergency department, intensive care unit and medical and surgical wards.

New Zealand context

The findings and recommendations of the audit by Coombs et al. (2004) and the investigation by the Health and Disability Commissioner (2007) following a sentinel event are both used in the following section to demonstrate that poor documentation of patient vital signs and suboptimal care exists in NZ. The Health and Disability Commission (2007) report was sent to all district health boards in NZ for educational purposes and to review their own systems and practices. Based upon the recommendations of the report nursing practice in NZ should have improved since this time.

An audit of vital sign documentation

A retrospective audit was performed by Coombs, et al. (2004) in a NZ hospital. The authors identified 19 patients who had been acutely admitted to the ICU from the medical and surgical wards. The notes were reviewed to identify the clinical course of the patient's deterioration in the 13 hours prior to ICU admission. In all, 247 patient hours of ward charts and notes (made by both the medical and nursing staff) were reviewed.

There were 126 (51%) occasions where the patients had some of their vital signs recorded. Of these, a full set of observations including respiratory rate (RR), blood pressure (BP), heart rate (HR), oxygen saturations (SpO₂), urine output, temperature and level of consciousness (LOC) was only recorded 18 times (14%). This included observations documented in the patient's notes by medical staff, as this was not always documented on the observation chart by the nurses. The observations most frequently recorded were HR 88%, BP 87%, SpO₂ 75%, temperature 55%, RR 50%, LOC 39% and urine output 37%. The vital signs were recorded more frequently in specialised areas such as the neurology unit and cardiothoracic high dependency unit. Of the 19 patients, 14 (73%) achieved a

score of four or more on the EWS system, which would have triggered the critical care outreach team if one was in use. There were 34 occasions where this would have occurred, however the medical staff were called in only 17 of these. It was noted that when a full set of observations were completed and patient deterioration was recognised, the nurses were quick to alert the medical staff. Once the doctor was involved the nurses did not appear to further assess the patient or increase the frequency of observations.

It was reported that a lack of vital sign documentation made it difficult to ascertain the actual number of patients who may have triggered the critical care outreach team. The recommendations from the findings of this audit included improving the recording of patient observations, (in particular the RR and LOC as these were the least recorded), a greater emphasis on obtaining a full set of observations and the clinical importance of these, the implementation of a user friendly neurological assessment tool and an observation chart that enabled clearer documentation and allocated space for the observations to be recorded.

The following is a sentinel event in a NZ hospital that was investigated by the Health and Disability Commissioner (2007). The patient's family made a complaint regarding the level of care the patient had received as an in-patient. The purpose of the Health and Disability Commission in New Zealand is to protect the rights of consumers in relation to health and disability services and to ensure that any complaints are managed effectively (Health and Disability Commission, 2011).

The Health and Disability Commissioner's findings following a sentinel event

Patient X was admitted to hospital with a primary respiratory diagnosis and died following a cardiac arrest, 42 hours later. The patient exhibited abnormal vital signs and clinical signs and symptoms from the time of admission. The patient's RR was recorded once by the nursing staff throughout the admission and no vital signs were recorded in the 12 hours pre-arrest. A doctor recorded the patient's RR as 60 breaths per minute in the patient's notes, however there were no further documented vital signs or interventions to correct it. According to Seddon (2007) a failure to manage this deterioration was because the abnormality was not recognised. Other abnormal clinical signs and symptoms that the patient exhibited included the use of accessory muscles to assist breathing, the inability to speak in sentences and the inability to perform a peak flow measurement due to dyspnoea. The patient also had an altered LOC, which the family had expressed concern about to the nursing staff.

The Health and Disability Commissioner (2007) found that there was a distinct lack of vital sign recordings and that had the patient been observed more closely, the deterioration may have been recognised. It was reported that there was a lack of understanding the patient's abnormal observations and that the nursing staff did not appear to respond to these. It is thought that the severity of the patient's condition was greatly underestimated. This is supported by the NCEPOD Report (2005) who state both nursing and medical staff may fail to understand the urgency of the situation. Had an EWS system and a critical care outreach team been in use, these observations would have triggered a response, which may have identified the patient earlier, leading to earlier treatment.

Summary

Both the findings from the audit (Coombs et al, 2004) and the Health and Disability Commission (2007) investigation demonstrate poor documentation of patient vital signs in NZ. If these are not recorded regularly and comprehensively patient deterioration will be missed, treatment cannot be initiated and patients will continue to die. The Health and Disability Commission (2007) report also highlighted that nurses do not recognise or respond to abnormal physiology. If these are left untreated the patient will eventually have a cardiac arrest, of which the outcome is catastrophic. Given these findings and the lack of research, it is considered essential to perform this study in a NZ context.

Thesis structure

Chapter 2 presents the process of enquiry into the topic and the literature search. What is currently known about the importance of the early recognition and management of the critically ill patient is discussed and the significance physiological observations have in assisting early recognition. The potential causes of abnormal vital signs and possible interventions that nurses may implement are described, as are abnormal clinical signs and symptoms that may be obtained from the nursing assessment. The initiatives that have been developed to improve patient safety are also discussed.

Chapter 3 outlines the research design and methodology employed to perform the study. These include the advantages and disadvantages associated with the design. The sample are described, the processes employed for managing the data and statistical analyses are also detailed. Finally ethical and cultural considerations are highlighted.

Chapter 4 reports the findings of the study and the process of analysing the data. The results are presented as a discussion which includes tables and graphs. Chapter 5 discusses

the implications of the findings. The limitations of the study are also acknowledged. Finally, Chapter 6 summarises the research project. The recommendations for organisations, nursing practice and further research are presented.

Chapter Two: Literature review and practice considerations

Introduction

The safety of patients in hospital is a key priority within healthcare (Thomson et al, 2007). However, it has been reported that patients who become acutely unwell in hospital do not receive adequate care, as their deterioration is often not recognised, not appreciated and/or not responded to appropriately (NPSA, 2007). Failure or delays to adequately treat physiological derangement may lead to multiple-organ failure from inadequate tissue perfusion, which increases the probability of an adverse event and death (Mitchell, et al., 2010). It was identified by Hodgetts et al. (2002b) that in the UK alone there are a potential 23,000 avoidable adverse events per annum. As a result various initiatives have been developed to improve the early recognition and management of the acutely ill patient in an attempt to improve quality of care and safety (ACSQH, 2008). This chapter will demonstrate that the evidence available indicates the management of the deteriorating patient outside of the critical care area is a challenging and complex issue that requires a multifaceted approach (Clinical Excellence Commission, 2008).

The content of this chapter includes the link between abnormal physiology and adverse events and presents the only study that includes any NZ data. It is this lack of research that has prompted investigation to ascertain the NZ position. The best practice recommendations on the type, frequency and times vital signs should be recorded are presented and why these are important in preventing patient deterioration. The barriers to measuring vital signs and factors influencing the nurse's ability to recognise patient deterioration are also described. The possible actions or interventions that can be employed by the nurse in response to abnormal findings are outlined. Finally the service initiatives that have been implemented to address these issues are included.

The literature search

The initial literature search for this study was performed in 2008 when the study began and again in 2011 when the study recommenced. Both Cumulative Index to Nursing and Allied Health Literature (CINAHL) plus with full text and Ovid Medline were searched in order to source the literature for this review. The title, abstract and the key words used were cardiac arrest, heart arrest, pre-arrest, in-hospital, resuscitation, nursing assessment,

nursing observations, patient assessment and vital signs. 'Cardiac arrest/heart arrest' alone had 2550 hits. 'In-hospital' alone had 1810 hits. To narrow the search these were combined which provided 35 hits. 'Pre-arrest' alone retrieved 106 hits but when combined with 'resuscitation' this resulted in 73 hits. The university librarian was also accessed to ensure all available literature had been sourced. The second search was of the same databases, plus the Cochrane Library database which was searched using the title, abstract and the keywords 'deteriorating patient' and 'medical emergency team.' Through this search 17 Cochrane reviews were retrieved, one of which one was a systematic review and 88 clinical trials. The systematic review and two randomised control trials were included. Other relevant literature was found by reviewing the reference list of the articles already acquired and performing a manual search of the Resuscitation journal. In addition the grey literature referred to in this study included the Nursing Council of New Zealand and the Health and Disability Commission. There were multiple international reports and guidelines pivotal to this study that were sourced from the NPSA and the National Institute for Health and Clinical Excellence (NICE) in the UK and the Clinical Excellence Commission and ACSQH in Australia.

The following section presents the literature as it was arranged in themes. These include the connection between abnormal physiology and adverse events, documentation of vital signs, nursing assessment and evaluation of treatment, recognition of abnormal physiology and nursing responses and interventions, as these are fundamental to this study.

Abnormal physiology and adverse events

There are multiple studies that have demonstrated an association between abnormal physiology and cardiac arrest. The most pivotal of these was performed by Schein et al. (1990) whose study refuted the notion that cardiac arrests were unexpected events. They reviewed 64 patient's notes for abnormal vital signs or changes in the patient's condition, in the eight hours prior to a cardiac arrest. It was identified that 84% of the patients had abnormal vital signs or changes in behaviour that were either reported by the patient or based upon a nursing assessment. Of these, 70% were related to either the respiratory function or mental status. Only five (8%) patients survived to hospital discharge.

Patients with abnormal observations are at risk of an adverse event and are less likely to survive. This was identified by Lighthall, Markar and Hsiung (2009) who reported that 170 (15%) patients had abnormal vital signs. Of these, 59 (35%) had an adverse event, which doubled when patients had more than two abnormal observations. Overall, patients

with abnormal vital signs had a higher mortality rate. This has been reported to be as much as a three fold increase (Fuhrmann et al., 2008). Similarly, Smith and Wood (1998) reported that 24 (51%) patients had at least one abnormal vital sign and at least one abnormal laboratory result in the 24 hours prior to a cardiac arrest. None of the patients with abnormal observations survived to hospital discharge.

The number of clinically abnormal vital signs is associated with an increased risk of death. Buist et al. (2004) reported that 564 (8%) patients had at least one abnormal clinical event during their hospital admission. The most frequent events were decreased SpO₂ and hypotension. They identified that a decreased respiratory rate was associated with a 13.7 fold increase in mortality, making it the strongest indicator of mortality. Alteration in LOC was the second highest predictor of mortality which was associated with a 5.5 fold increase. In patients who had one abnormal event the probability of death was 16% and in patients who had four or more abnormal events, the likelihood of death increased significantly to 88%. The limitation to this study is that it included patients who were not for resuscitation who may have more deranged observations.

The ACADEMIA study by Kause et al. (2004) was a large multi centre prospective observational study that included centres from the UK, Australia and NZ. This is the only study to include NZ data. They identified 638 adverse events, of which there were 308 in-hospital deaths, 141 cardiac arrests and 189 unplanned admissions to ICU. Of the cardiac arrests, 79% (112) of the patients had clinical antecedents prior to the event. Unexpected admission to ICU was the most common event in Australia and NZ compared with in-hospital death and cardiac arrest in the UK. The rationale for these differences include a higher number of ICU beds available in Australia and NZ and the use of a MET team that responds to patient deterioration prior to cardiac arrest. On the contrary the UK has less capacity and use a cardiac arrest team only.

Whilst these studies have demonstrated that most cardiac arrests are preceded by premonitory signs and symptoms they have not explored how nurses responded when these were identified. Furthermore, the Australia and NZ data were combined in the ACADEMIA (Kause et al., 2004) study making it impossible to determine the NZ position.

Types and reasons for measuring vital signs

A recent NICE (2007) guideline recommends patients should have a set of full set of vital signs completed on initial assessment, when they are admitted to hospital or when being transferred from a critical care area to a general ward. This information is used to establish

their health status at that moment in time and to provide a baseline with which future recordings can be compared (Smith et al., 2006). Not only are vital signs used to determine treatment but they are also used to support decisions with respect to admission to hospital. The rationale for this is that abnormal vital signs are often due to an underlying illness that may require further intervention (Gresham Bayne, 1997). The normal vital signs for an adult (17 years and older) are listed in Table 1.

Table 1. Normal physiological ranges for an adult

Systolic Blood Pressure	100-179
Heart Rate	50-99
Respiratory Rate	12-20
SpO ₂	96-100%
Level of Consciousness	Alert or GCS 15

(Adapted from Smith, 2003)

Documenting vital signs has underpinned nursing practice since the time of Florence Nightingale (Mitchell et al., 2010). The recommended vital signs that should be recorded include BP, HR, RR, temperature, LOC and SpO₂ (NICE, 2007). The documentation policy for recording patient vital signs at the hospital where this study was performed includes these vital signs as a minimum standard. A fluctuation in any of these vital signs indicates a change in the patient's condition and should determine a timely response and initiation of treatment. Such physiological derangements may facilitate a diagnosis, determine the effectiveness of medical interventions or medications or influence a decision to transfer a patient for more specialist care (Trim, 2004). Based upon this information measuring vital signs should be considered a fundamental aspect of nursing practice. However, there is growing evidence to suggest that nurses do not regularly record patient vital signs or recognise abnormalities (Chen et al., 2009; DeVita et al., 2010; Nurmi et al., 2005; Tippins, 2005). As a consequence patient deterioration is missed along with the opportunity to correct the abnormality (Hodgetts et al., 2002a). There is no research available from NZ to support or refute this.

Design of observation charts and recognition of deterioration

Patient observation charts are used to record the patient's vital signs and alert healthcare professionals to the deteriorating patient (Chaterjee, Moon, Murphy, & McCrea, 2005).

However, it is thought that a lack of standardisation of observation charts may impact upon the nurse's ability to recognise patient deterioration (Smith, 2010). Consequently, the design of the observation chart has received attention as some charts make trends and physiological deterioration difficult to detect (ACSQH, 2008). A study in the UK by Chatterjee et al. (2005) presented medical staff, student nurses and healthcare assistants with observation charts that had normal and abnormal values documented. The most common abnormal observations that the participants did not recognise were tachypnoea (58%) and hypoxia (53.5%). When the same observations were recorded on a newly designed observation chart, the participants were significantly more likely to recognise the abnormal observations. This was reported as a 41% increase in the detection of tachypnoea and 51% increase in the detection of hypoxia ($p < 0.05$). This study confirmed that the design of the chart significantly affected the user's ability to recognise abnormal observations.

Following from this Horswill et al. (2010) developed the Adult Deterioration Detection System (ADDS) for the ACSQH and Queensland Health. They reviewed the observation charts used in NZ, surveyed healthcare professionals to determine their opinions of observation charts, developed the ADDS chart in response to these findings and performed experimental comparisons between the ADDS chart and other existing charts to determine the users ability to detect abnormal observations and record patient data. The goal of this initiative was to have one standardised observation and response chart in the general wards across Australia to assist with the early recognition of deterioration.

A lack of recording patient vital signs and monitoring plans

It has been suggested that the policies for the frequency of recording patient vital signs are based upon expert opinion and tradition rather than research based evidence and are consequently viewed as a ritualistic exercise (Considine & Botti, 2004; Zeitz & McCutcheon, 2006). As a result vital signs are not performed as often as they should be (Smith, 2010). However, if patient deterioration is to be detected in a timely manner, these vital signs must be measured regularly (Peberdy, Herlitz, & Cretikos, 2007b). The recommended minimum standard for measuring and recording patient's vital signs is 12 hours (NICE, 2007). However, the frequency of the vital signs should reflect the acuity of the patient and should be changed according to the clinical situation (Smith et al., 2006). The hospital in which this study was performed has a policy stating vital signs should be

recorded at least four hourly. These can be increased by nursing or medical staff at any time, based upon their assessment of the patient's condition. Consequently the measuring and recording of observations becomes tailored.

It is recommended that each patient should have an individualised plan regarding which vital signs should be measured, how frequently they should be performed, unacceptable values and the action required when they become abnormal (DeVita et al., 2010; Fuhrmann, Lippert, Perner, & Ostergaard, 2008; NICE, 2007; Rich, 1999; Smith et al., 2006). However, whilst this is ideal practice, in reality it rarely occurs. One UK report determined that the patient's notes were frequently missing a documented plan regarding the type and frequency of observations to be recorded (NCEPOD, 2005). Similar findings were also identified by Endacott, Kidd, Chaboyer and Edington (2007) who found that none (n = 17) of the patients with a documented deterioration had such a plan in their notes.

Reasons for not measuring and recording patient vital signs

The role of the nurse has changed significantly in recent years and has become increasingly complex (Kause et al., 2004). Nurses have to meet ever increasing demands and targets and consequently performing patient observations has lost its priority (Heaps, Thorley, & Langley, 2005). This is supported by the NPSA (2007) who reported that recording vital signs was seen as a task that needed to be completed and given that most patients have normal findings, a degree of complacency exists. The reasons for not measuring patient observations are multifaceted but are primarily due to staffing and workload issues, a lack of understanding why vital signs are important and a lack of resources (DeVita et al., 2010; Mitchell et al., 2010; NPSA, 2007). As a consequence healthcare assistants are taking on more nursing duties, one of which includes taking patient observations (Castle, Kenward, & Hodgetts, 2003). However, the concern with this is that healthcare assistants may not recognise abnormal observations or appreciate their significance (Sharpley & Holden, 2004). As stated by NICE (2007) patient observations must be taken by staff who are adequately trained to do so and have an understanding of their clinical meaning.

Factors affecting the accuracy of vital sign measurements

The practice of measuring and interpreting vital signs is a complex process that requires skill and knowledge (Mason, 2005). There are multiple factors that can influence the accuracy of assessment findings and it is essential that the person taking the measurements

is aware of these. Accuracy is essential if the deteriorating patient is to be recognised early (Smith et al, 2006; Tippins, 2005). To reduce the risk of user error automated machines have become increasingly popular. At the touch of a button these machines measure BP, HR and SpO₂, making the process quick and efficient. As a result the nurse can perform other tasks whilst the machine measures the observations. In NZ nurses are responsible for measuring patient observations and automated machines are widely used.

The concern with electronic monitoring is that nurses have become increasingly reliant upon them (Hogan, 2006). The issue with this is that documenting observations has become more about getting the job done, rather than an opportunity to establish the status of the patient (Lockwood, Conroy-Hiller, & Page, 2004). Clinicians can acquire far more information simply by touching, talking and observing the behaviour of the patient (DeVita et al., 2010). The use of these machines may lead to less hands-on time and vital clues that can be obtained by simply visualising or touching the patient may be missed (Wheatley, 2006). Furthermore, the accuracy of the machines has been questioned (Lawes, 2000).

Nursing assessments and clinical decision making

Registered nurses in NZ are governed by the Nursing Council of New Zealand competency framework (2007) and are expected to perform patient assessments to inform care planning. This enables the acquisition of valuable information which is also used by other healthcare professionals and forms the basis for many clinical decisions (Considine & Botti, 2004). It is believed that trends and patterns facilitate the decision making process (Ashcraft, 2004). Other factors that influence decision making include previous knowledge and experience which determines the information that is obtained when assessing the patient and the nurse's ability to interpret and act upon the information collected. This information informs clinical judgement and consequently clinical decisions. Nurses also use instinct and pattern recognition when assessing a patient. This is supported by Santiano et al. (2009) who found that nurses use past experiences, intuition and clinical judgement to recognise the deteriorating patient. The authors identified that nurses mainly used subjective data to inform them of the patient's condition, such as the colour of the patient, agitation and only minor deviations in the vital signs. Similarly, a study by Lighthall et al. (2009) in the United States of America found that patients with normal vital signs were admitted to ICU based upon subjective observations, such as changes in mental state or poor appearance.

There are occasions when nurses are concerned about the patient and instinctively know that something is wrong, despite numerical data showing otherwise (Castle et al.,

2003). This concern is also described by Hodgetts et al. (2002a) as the suspicion that a nurse gets about the condition of the patient when they may demonstrate subtle signs that are difficult to quantify. It is this intuition or concern that has seen the 'worried' or 'concerned' criterion added to many medical emergency criteria and the new ADDS chart in Australia (Horswill et al., 2010).

Some changes in patient behaviour are not always obvious to the staff, but are recognised by the family. As such it is now recommended that the patient's family and visitors are included in the recognition of the deteriorating patient, as they are able to identify subtle changes in the patient's behaviour (Department of Health, 2008; DeVita et al., 2010). Given that one nurse may have six patients to care for and that patients are often behind closed doors, they may go unobserved by nurses for extended periods of time (Kaye & Mancini, 1996). Hence, having family members or visitors that can alert the nurses of their concern will improve patient safety (DeVita et al., 2010).

Factors influencing nursing response to abnormal clinical findings

There is a general misconception amongst healthcare professionals that in-hospital cardiac arrests occur unexpectedly. Indeed the opposite is true as most cardiac arrests are predictable events (Perkins & Soar, 2005). However, the signs and symptoms these patients exhibit is never clear-cut and vary from patient to patient. What is a normal measurement for one patient may be abnormal for another. Not only is there no consensus within the literature on the definitions of abnormal vital signs, but also the timeframes that these changes occur within. Some patients have been found to exhibit abnormal signs and symptoms for as many as 72 hours pre-arrest, however this is typically between six and eight hours beforehand (Peberdy et al., 2007b). In addition whilst most patients may demonstrate abnormalities prior to a cardiac arrest, some do not exhibit any at all. It is these inconsistencies and lack of definitions that may affect a nurse's ability to recognise clinical deterioration.

Nurses are ideally positioned to recognise and intervene before a cardiac arrest occurs, as they have the most direct patient contact (Considine & Botti, 2004). To achieve this they must collect patient observations, analyse the information to make it meaningful, communicate their findings and implement appropriate interventions (Ashcraft, 2004). In NZ nurses are expected to provide interventions within their scope of practice, in response to clinical findings (Nursing Council of New Zealand, 2007). Thus, nurses are responsible for initiating interventions to correct physiological abnormalities, which may include

adding supplemental oxygen, administering prescribed medications or intravenous fluids (Considine & Botti, 2004). However, Smith et al. (2006) argue that although abnormal observations may be present there is often minimal evidence of any interventions.

Inappropriate nursing response to abnormal physiology

The management of the deteriorating patient requires knowledge and expertise if appropriate interventions are to be implemented (Considine & Botti, 2004). The cause of the abnormality may not always be apparent and may be attributable to various factors. Therefore the experience of the nurse will determine their ability to recognise the abnormal observations and ultimately how they respond (Tippins, 2005). An altered mental state, tachypnoea or oliguria may not be concerning for a junior nurse, however a more experienced nurse would know that these are worrying signs (Smith & Wood, 1998). Table 2 presents the possible causes of abnormal observations and the interventions that nurses may employ to treat the abnormality.

When nurses do recognise abnormal vital signs their response is not always appropriate. A study by Daffurn et al. (1994) required nurses to complete a two part questionnaire that included hypothetical patient scenarios and they were asked to indicate the most appropriate response. It was identified that the nurses would have called the emergency response team in only 24% (n = 70) of occasions where the patient met the medical emergency criteria. It was highlighted that nurses were often reluctant to call the emergency response team if there was no immediate danger to the patient or if there was a single abnormal vital sign, instead they opted to call the junior doctor. Reasons for this include fear of reprisal from medical staff if it is a false call and a lack of confidence in ones own assessment findings and clinical decision making. Obvious patient distress or multiple abnormal signs and symptoms appeared to be the trigger for nurses to call the emergency response team.

Similar findings were reported by Clark (2001) who found that nurses recognised abnormal observations but they did not intervene, instead they waited until the patient had a cardiac arrest before calling the emergency team. From this it was highlighted that nurses needed to be educated on simple interventions such as checking the SpO₂, elevating the head of the bed, alerting others and/or preparing emergency drugs for administration, to prevent the patient from further deterioration. This is supported by the NICE (2007) guidelines and Smith (2010) who suggest that nurses should be taught how to: assess a patient, correctly measure vital signs, interpret the findings, recognise the signs of

Table 2: Potential causes of abnormal observations and possible interventions

Abnormal observation	Potential Causes	Possible Nursing Interventions/Actions
Any	Anything	Recheck observation, compare with other observations, administer prescribed medications request a medical review
Heart Rate	Exercise, fever, pain, anxiety, medications postural change, hypovolaemia, metabolism	Troubleshoot equipment, provide reassurance/calm, sit/lay patient down, remove stressors, administer prescribed fluids
Blood Pressure	Age, stress, medications, time of day, ↓/↑ cardiac output, ↓/↑ peripheral vascular resistance, ↓/↑ blood volume, ↓/↑ blood viscosity	Troubleshoot equipment, provide reassurance/calm, remove stressors, lay patient supine/head down & elevate legs, administer prescribed fluids
Respiratory Rate & SpO₂	Exercise, anxiety, pain, smoking, body position, neurological disorders, fatigue, medications	Troubleshoot equipment, provide reassurance/calm, remove stressors, sit in straight erect position, tracheal suctioning, refer to a physiotherapist, administer prescribed oxygen
Level of Consciousness	Neurological disorders, cerebral lesion, hypo/hyperthermia, drug toxicity, hypoglycaemia, hyponatremia, hypoxia, hypothyroidism, hypercapnia, hepatic encephalopathy, hypotension	Check pupils, place in recovery position, maintain an airway, measure blood glucose, administer prescribed oxygen, administer prescribed fluids

(Adapted from Smith, 2003)

deterioration and when and how to implement simple interventions such as airway opening or administering intravenous fluids. It is these actions that can change the management of cardiac arrest from being reactive to proactive (Peberdy et al., 2007b). However, to achieve this nurses need to identify the at risk patient and become more aggressive with their management, even when this means stepping outside of their normal practice (Considine & Botti, 2004).

Evaluation of treatment and responding to patient deterioration

In NZ nurses are responsible for and must be competent to evaluate the patient's response to interventions (Nursing Council of New Zealand, 2007). If a patient is not improving despite treatment this needs to be addressed. The NICE (2007) guidelines recommend a graded response strategy. When a patient is identified as being at risk of deterioration the frequency of observations should be increased and the nurse in charge informed. If an EWS system is used and the patient has a medium score, then interventions should be initiated to treat immediate derangements, assess the efficacy of the intervention and formulate a plan. The ward doctor should be urgently contacted and the critical care outreach team, if this service is available. Finally, if the patient has a high score an urgent call should be made to a team with critical care skills. The EWS and critical care outreach teams are discussed in more detail later in this chapter.

So far this chapter has highlighted the significance of recording patient vital signs in relation to detecting deterioration, the barriers to nurses not recording the patient's vital signs and factors that affect the nurse's ability to recognise and respond to deterioration. It was important to include this information so as to understand the role vital signs have in alerting nurses to a change in the patient's condition. However, if the vital signs are intermittent, incomplete, inaccurate or are not interpreted the patient's deterioration will not be recognised. There are no robust studies from NZ to show the nursing practice of recording patient vital signs or how nurses respond to abnormal findings. Thus there is little understanding of what is happening to patients pre-arrest.

Management of the deteriorating patient

It has been reported that although patient deterioration may be documented, nurses do not act upon the abnormalities (NCEPOD, 2005). The early detection and interventions in the pre-arrest period are described as the difference between pre-arrest and failure to rescue (Ashcraft, 2004). Failure to rescue is classified as recognition but no intervention; failure

to recognise and therefore no action; and recognition but the intervention is started either too late or not at all. Factors that may influence these include diluted skill mix, shortage of staff, nurse patient ratios, difficulty recruiting or retaining experienced nurses, use of agency nurses and reduced educational opportunities (Weil & Fries, 2005). This leads to less experienced nurses caring for acutely unwell patients, who have not had adequate training and support. It is thought that patient mortality is increased by 7% for every additional patient the nurse has to care for (Ashcraft, 2004).

This lack of recognition by nurses is supported by Tippins (2005) who investigated whether nurses recognised abnormal physiology, using a questionnaire and interviews. The 23 participants were given scenarios and were asked questions in relation to the presentation of the patient and the actions they would take. Only a small number of the nurses recognised abnormal signs and symptoms in the patient scenarios and most failed to recognise the severity of the patient's condition or seek more expert help. However, this was not a simulated scenario or based upon an actual event therefore the response of the participants may not be an accurate reflection of how they would normally respond. Similarly, Fuhrmann et al. (2008) reported that although 1:5 patients had abnormal vital signs the nurses were mostly unaware of the abnormalities. However, the vital signs were not recorded by the nurses; they were recorded by the study personnel. Furthermore, the nurses were asked if they were aware of any abnormal observations before they were told of any abnormal findings. Thus, they most likely would not be aware of the abnormalities.

It has been identified that some patients on the general wards receive inadequate care which leads to an increase in morbidity, mortality and ICU admissions. McQuillan et al. (1998) reviewed the notes of 100 patients who had been admitted to ICU from the general wards. The panel identified that 54% of the patients had received suboptimal care and 39% should have been admitted to ICU earlier. The suboptimal care consisted of poor management of oxygen therapy, airway, breathing, circulation and inadequate monitoring. The causes of suboptimal care in order of significance included: failure of the organisation, a lack of knowledge, a failure to appreciate the urgency of the patient's condition, a lack of experience, a reluctance to seek advice, a lack of supervision, non-availability of equipment, fatigue, equipment failure and medical staff not being available. It was reported that the life threatening abnormalities of the airway, breathing and circulation were missed, misinterpreted or mismanaged. This directly contributed to the mortality of 33% of the patients. Limitations to this study are that the panel disagreed on the quality of care in 26%

of patients. As such the rates of suboptimal care could be either over or under estimated. The authors also had knowledge of the patients which could introduce a biased opinion.

A later study by Hodgetts et al. (2002b) reported that 78 (68%) of 118 cardiac arrests could have been prevented. Examples of inadequate treatment were defined as poor monitoring of vital signs, failure to provide oxygen and failing to act upon abnormal vital signs. Abnormal observations were acted upon partially in 41 (53%) cases and not at all in 37 (48%). The RR was recorded in only 27% (32) of patients, in the 24 hours prior to their cardiac arrest and oxygen was only administered to 32% (9/28) of patients whose SpO₂ was less than 90%. This study demonstrated that a significant proportion of patients were mismanaged prior to cardiac arrest. That the nurses failed to administer oxygen to patients with a falling SpO₂ would suggest that they either did not recognise the abnormal observation or lacked the experience or education to respond appropriately. Also the low frequency of recording the RR results in a lost opportunity to recognise patient deterioration. The authors believe that a lack of education, experience and a reticence or an unwillingness to seek advice leads to inadequate treatment and that these issues need to be addressed in order to reduce the incidence of cardiac arrests.

These studies have highlighted that many adverse events are potentially avoidable with early recognition and intervention. Whilst it is well documented that patients may receive suboptimal care, this includes both the medical and nursing management of the patient. As such there is limited evidence to demonstrate how nurses actually respond to abnormal observations and the interventions they may initiate. The following section describes the strategies that have been developed to ameliorate the early recognition and management of acutely unwell patients.

Initiatives to improve patient safety

The Department of Health (2008) in the UK established a chain of response for recognising and responding to acutely unwell patients. This identified the role of staff across all disciplines, as well as patients and visitors, in recognising the deteriorating patient. This chain is applicable to NZ and commences with non-clinical staff, the patient or visitors who may alert clinical staff of a situation, the recorder as the person who measures and documents the observations and the recogniser as the person who interprets the information and may adjust the frequency of observations. This is followed by the primary responder as the person who initiates treatment and the secondary responder who may be called when the first intervention has failed. This person is also responsible for making a diagnosis,

reviewing the management plan and initiating a second intervention. Finally, the tertiary responder has critical care skills such as advanced airway, resuscitation and clinical examination skills. It is recognised that there may be some overlap between the roles as the nurse may be the recorder, the recogniser and the primary responder.

Rapid response systems

Rapid response systems were developed to facilitate the early recognition and management of the acutely unwell patient (Mailey et al., 2006). It also provides an opportunity to optimise the use of limited resources by identifying these patients early, potentially avoiding admission to ICU and consequently reducing length of stay in hospital (Peberdy et al., 2007b). The Clinical Excellence Commission (2008) recommend a co-ordinated approach for a rapid response system that includes a) a system for recognising the patient's deterioration including chart design, a minimum standard for recording patient observations and an EWS system, b) an escalation process including who to call and when, and c) provision of education for all clinical staff that includes basic life support training and recognition of the deteriorating patient.

Early warning scoring systems

The EWS was introduced to provide a system for recognising the deteriorating patient when it became apparent that abnormal physiology was associated with the critically ill patient (Cuthbertson et al., 2007). There are a variety of scoring systems available and they differ in the vital signs measured and the cut-off points (ACSQH, 2008). However, they all use either a score or criteria to determine a response or action (McGaughey et al., 2009). The EWS have several functions which includes the early recognition of the deteriorating patient, which is especially beneficial for junior nursing and medical staff who may not have the skills or knowledge to detect the changes suggestive of deterioration (ACSQH, 2008; Mitchell et al., 2010). They are also useful for determining which vital signs should be measured, when they should be measured and the frequency they should be recorded, as this is not always fully understood (Clinical Excellence Commission, 2008). It is recognised that nurses sometimes have difficulty communicating their concerns to the doctor or convincing them of the urgency of the problem (NPSA, 2007). Thus, the EWS can also improve communication between disciplines, as it enables nurses to convey objective concerns about the patients condition (Hodgetts et al., 2002a). Finally, the EWS

are usually linked to a rapid response team to ensure the patient receives timely and appropriate intervention by clinicians with the right skills (Mitchell et al., 2010).

The EWS system cannot be used in isolation as it also requires an element of decision making (ACSQH, 2008). Furthermore, the EWS is only effective if the vital signs are measured and documented regularly (Smith & Wood, 1998). If the vital signs are sporadic or incomplete the system will fail and the appropriate response team will not be activated (Smith et al., 2006). It was found by DeVita et al. (2010) that the introduction of the EWS system increased the frequency of measuring and documenting vital signs, however the completeness remained poor. The clinical nurse specialist of the Patient at Risk (PAR) team at hospital where this study was conducted has reported an increase in compliance with recording observations since its implementation in 2008 (J. Hill, personal communication, June 6, 2011). Finally an increased score from one observation does not necessarily mean that the patient is at risk of acute deterioration (Nauman & Montenegro, 2005). Thus, the sensitivity and specificity of the tool need to be high so that patients are detected early, without triggering an unnecessary response.

Rapid response teams

Historically nurses did not call the cardiac arrest team until the patient actually had a cardiac arrest, despite evidence of deterioration (Endacott et al., 2007). However, there is now research to show that early recognition and treatment of the deteriorating patient may prevent adverse events. It is therefore possible that in many cases a cardiac arrest may be indicative of inadequate management (Buist, Harrison, Abaloz, & Van Dyke, 2007). This may be due to inadequate skills and knowledge, a lack of communication, a lack of escalation guidelines, a lack of clarity regarding who to call and when and professional hierarchies, all of which may lead to prolonged delays in the patient receiving treatment (ACSQH, 2008). Consequently medically led rapid response teams were established to provide immediate care for the acutely unwell patient (McGaughey et al., 2009). The first country to implement a MET service was Australia in 1990. This has since been widely implemented with 60% of hospitals with an ICU, in Australia and NZ, having a MET service (Jones, George, Hart, Bellomo, & Martin, 2008).

Nurse led services such as critical care outreach teams or patient at risk teams use a much earlier calling criteria than the MET (McGaughey et al., 2009). They assess and stabilise the patient, provide advice on how to manage the deteriorating patient, follow up ICU patients and educate ward nurses by sharing critical care knowledge (Barbetti & Lee,

2008). The most common interventions required are administration of basic medications, intravenous fluids and oxygen therapy, gaining intravenous access and nasopharyngeal suctioning. Other decisions made by the teams may include transferring the patient to ICU, transfer to another hospital, consultation with the team caring for the patient and do not attempt resuscitation orders (Peberdy et al., 2007a).

The rapid response team has been widely implemented despite a lack of robust evidence to show it is of any benefit (ACSQH, 2008). There have been two randomised control trials and systematic reviews that have shown no reduction in the incidence of adverse events (McGaughey et al., 2009). However, one of the randomised control trials demonstrated that a critical care outreach team reduced the mortality rate of patients in the general wards (Priestley et al., 2004). In a large multi-centre study by Hillman et al. (2005) it was reported that the MET team were not always activated even though patients met the criteria, thus the intervention was not always received. In a more recent study by Jones et al. (2008) the introduction of a MET service did not reduce the number of ICU readmissions or mortality, however there was a significant decrease in the incidence and rate of patients admitted to ICU following a cardiac arrest.

Taking this information into account it has been agreed that sufficient evidence exists to support the use of EWS and rapid response teams to detect the acutely unwell patient and initiate an appropriate response (NICE, 2007). Other factors such as leadership, data collection, organisational support and funding are necessary for the system to be successful (Clinical Excellence Commission, 2008). Factors affecting the efficacy of the service are staff acceptance, a lack of compliance with using the scoring system, incorrect EWS calculations, organisational culture and a failure to activate the team (Buist et al., 2007; Crispin & Daffurn, 1998; Cuthbertson et al., 2008; Daffurn et al., 1994; NPSA, 2007). It has been suggested that activation of the team is not a simple matter and is affected by staff confidence, anxiety for fear of being wrong, ward staff trying to manage the patient on their own and workload (ACSQH, 2008; NPSA, 2007). However, it is hoped that using objective criteria will empower nurses to use their initiative and become proactive rather than reactive and call for appropriate help (Santiano et al., 2009).

Education and training

It has been suggested that simply having a MET or EWS system alone is insufficient to prevent patient deterioration and that clinical staff require appropriate ongoing education (Buist et al., 2007). This is supported by Smith (2010) who states that education is

fundamental in preventing deterioration and cardiac arrests. As a result of the findings in the McQuillan et al. (1998) study it was highlighted that healthcare professionals should receive training on how to recognise and manage the critically ill patient (McGaughey et al., 2009). This led to the development of the Acute Life Threatening Events Recognition and Treatment (ALERT) course which is a multi-professional course that aims to improve the knowledge, skills and attitudes of the staff (Kause et al., 2004). This course was created in the UK as a result of increased awareness that better patient care may prevent adverse events (Smith, 2003). The objective of the course is to provide healthcare staff with the skills to recognise and prevent critical illness in the early stages. They are taught a structured approach to patient assessment and management which aims to reduce avoidable deaths and improve documentation, communication and teamwork (Smith, 2003). The course has already proven that attendance increases not only the knowledge and confidence of the staff in managing critically ill patients but also empowers ward staff to call for senior help (Smith & Featherstone, 2007). As a result they are more likely to be able to anticipate and prevent cardiac arrests.

The Clinical Excellence Commission (2008) recommends a tiered approach to education. Tier one includes basic life support training, recognition of the deteriorating patient, escalation, communication, e-learning and resource manuals for all clinical staff. Tier two includes the use of simulation, scenarios and drills with ongoing assessment for ward based doctors and tier three advanced clinical diagnostic assessment, advanced resuscitation and procedure training with the use of simulation and assessment for the rapid response team.

It is important to highlight that despite the implementation of these initiatives patient deterioration continues to go unrecognised and patients are still dying. As such we need to take a closer look at what is happening to these patients in the pre-arrest phase. Are nurses documenting vital signs and if not what can be done to improve compliance? If the vital signs are being recorded are nurses responding appropriately. What are nurses seeing and doing? This study will contribute to this gap in the literature.

Conclusion

This chapter has identified the complexities associated with documenting vital signs. The person who takes the patients vital signs must have the skills and knowledge to understand and interpret the clinical data. A standardised approach to documentation should be used to minimise discrepancies and facilitate the recognition of deterioration. The optimal frequency

of taking patient observations has not been established however, this should be based on the individual patient, rather than traditional regimes. In order to prevent further deterioration it is paramount that nurses are able to act upon the information they have collected and implement appropriate treatment plans. Whilst it is recognised that some interventions can only be authorised by a doctor there are numerous actions that nurses can perform beforehand.

There is considerable research to show that patients demonstrate abnormal physiology for prolonged periods prior to an adverse event and that early recognition and treatment of these are essential if the patient is to survive. There is no solid evidence to determine which physiological variables are most likely to determine a cardiac arrest or the cut off points. It is this variability that may cause confusion for the nurse and make them hesitant to seek help sooner for fear of getting it wrong. The barriers to seeking assistance appear to be individual, cultural or organisational. Therefore an organisational wide, co-ordinated approach is required to ensure these patients are managed appropriately. There has been a substantial amount of work to improve compliance with documentation, recognition of deterioration and getting the right people with the right skills to the bedside in a timely manner.

There is evidence that these patients may receive suboptimal care and rapid response systems have been established to address this. Despite the implementation of these initiatives, patient deterioration is still going unrecognised and patients continue to die. Furthermore, there is no research in NZ to provide an insight into what is happening to these patients prior to an adverse event or how nurses respond to prevent them deteriorating further.

Chapter Three: Methodology & Research Process

Introduction

The purpose of this study was to determine what vital signs and/or clinical signs and symptoms were documented in the pre-arrest patient, identify whether any of these were abnormal and what if any actions or interventions were performed by the nursing staff in response to the abnormal clinical findings. The notes of patients who were identified as having had an in-hospital cardiac arrest were retrospectively reviewed. The data extracted consisted of the vitals signs recorded on the patient's observation chart and any documented descriptions of abnormal clinical signs or symptoms in the patient's notes, obtained from either a nursing assessment or as reported by the patient. When 'abnormal' criteria were identified the patient's notes were explored for any documented actions or interventions by the nurse in response to the clinical findings. The nursing and medical staff documentation was reviewed to develop a greater understanding of events that occurred, up to 12 hours before cardiac arrest.

This chapter describes the methodology used to execute the study and the advantages and disadvantages associated with the research design. The methods employed for managing the data and the research process are described. This includes the sampling process, data collection and how the data were managed. The process of analysis and attempts to improve the rigour of the study are also discussed. The considerations regarding cultural safety and ethics are also detailed.

Methodology

Before embarking upon a research project, consideration must be given to the type of design that is going to be used to perform the study. This should be one that is most likely to answer the research question. There is a continuum for the various levels of research which range from randomised control trials to case studies. For interventions, randomised control trials are the highest forms of singular evidence, which by their very nature are quantitative, experimental designs. This is regarded as true experimental research (Polit & Hungler, 1999). Conversely, case series are qualitative, non-experimental designs and are considered as the lowest form of evidence (Courtney, 2005). A descriptive, observational design was considered the most appropriate to conduct this study. It has been suggested that most hypotheses in nursing are best answered using either qualitative or observational designs (Courtney, 2005). Whilst this is not considered to be the strongest form of

evidence, it does not make the findings any less important. This view is supported by Schneider et al. (2007) who state that many exceptional non-experimental studies have been the catalyst for changing nursing practice.

A descriptive design provides information when there is minimal or no research available (Schneider et al., 2007). As stated by Polit and Hungler (1999) descriptive studies establish what exists and how often it occurs. The advantages of using this design are that it is non-experimental and as such there is no requirement to randomise participants into groups or apply artificial intervention (Courtney, 2005). They are often easier to perform than experimental studies, are usually inexpensive and can be conducted within shorter time frames (Hyde, 2004). Furthermore, a large number of variables can be investigated, whereas experimental designs usually focus on only one or two (Polit & Hungler, 1999). The disadvantages associated with this design are that there is no cause and effect between variables and the lack of a control group means that comparisons cannot be made (Schneider et al., 2007). It is the latter that increases the risk of confounding or bias. It is therefore essential to identify any potential risks early and employ strategies to reduce them. To strengthen the reporting of this study and add generalisability, the STROBE check list was utilised (von Elm et al., 2007). This check list has 22 items concerning what needs to be addressed in an article when reporting on an observational study. This is discussed in more detail later in this chapter.

This study retrospectively reviewed a large volume of data, which involves looking back on events that have already occurred. The challenges associated with retrospective reviews are the reliance upon others having documented relevant data and using information that is documented for one reason, namely patient care, for research purposes. A lack of data can significantly impact upon the findings and therefore the rigour of the study. It is thought that confounding or bias are common sources of error with retrospective observational studies. These may occur as a result of missing data, illegible hand writing, events that occurred but were not documented and inaccurate interpretation (Polit & Hungler, 1999). It is these issues that make this design less favourable than experimental research. When it comes to nursing assessment and actions, if it is not documented, it is considered as not being done.

Research Design

Sampling

Selecting a sample for an observational research study can be a complex process. The first step is identifying the population, collecting information and making decisions based upon the sampling procedure (Schneider et al., 2007). It is therefore essential that the sample is representative of the population, as decisions about clinical practice are often based upon the findings. Each step of the sampling process increases the risk of bias, which threatens the validity of the study (Gillis & Jackson, 2002). Consequently efforts must be made to minimise or control these risks. Inclusion criteria identifies the characteristics of the sample who are eligible for inclusion in the study. These are designed to control bias and increase the generalisability of the study (Schneider et al., 2007). The criteria and rationale for these are listed next.

Inclusion Criteria:

- ***Cardiac arrests that occur in adult in-patients***

Participants had to be patients who had been admitted to hospital. Areas such as outpatients and people such as visitors or staff were excluded, as there would be no pre-arrest data to review.

Exclusion Criteria:

- ***Cardiac arrests that occur in the Operating Theatre, Emergency Department or Intensive Care Unit***

These areas manage their own cardiac arrests and do not activate the cardiac arrest team. As a consequence the cardiac arrest or 777 forms are not completed (a description of these forms are provided on the following page), and the patients are not identifiable.

- ***Patients who have a do not attempt resuscitation order***

These patients were excluded as there should have been no attempt to resuscitate them. Consequently there would be no cardiac arrest or 777 forms completed.

- ***Patients who do not meet the cardiac arrest definition***

Patients who had a cardiac arrest and 777 forms completed for medical emergencies (such as hypotension or seizures) were excluded as they did not meet the cardiac arrest definition.

- ***Patients less than 18 years of age***

Cardiac arrests occur less frequently in children and are often a primary respiratory arrest. Also the physiological parameters vary in children according to their age. Hence the adult 'abnormal' ranges would not be applicable, as this could be normal for their age group.

- ***Patients in wards that are covered by the PAR service***

An EWS system is used in these patients which may trigger the PAR team if the vital signs become deranged. As a result the nursing actions may be guided by the team, rather than acting upon the nurses own initiative or judgement. Consequently, this would provide an inaccurate reflection of how nurses respond to abnormal observations. In June 2008 the PAR service covered medical and surgical wards. None of the patients in the sample were in an area where the service was provided at the time of cardiac arrest.

The sample consisted of 36 patients who had sustained an in-hospital cardiac arrest between 1st January 2007 and 31st August 2008. This time frame was chosen as the documents used to identify the sample were undergoing changes to improve nursing compliance with their completion. The sample were identified from the cardiac arrest records and 777 forms that were completed during this time. The cardiac arrest forms are completed by the nursing staff at the time of the resuscitation, which includes the cardiac arrest variables and interventions performed. The 777 forms are completed by the after hours duty nurse managers and identifies date, time, location, performance or equipment issues and patient outcome. This enables the events to be reviewed for quality assurance purposes and to provide the organisation with incidence, location and survival rates from cardiac arrests. Given that this was an observational study that was designed to identify all cardiac arrests over the 20 month period; no power analysis was used to determine the minimum sample size needed.

Setting

This study was performed in a level three, tertiary teaching hospital with 498 in-patient beds, across 2 sites. The hospital serves a population of 270,000 and provides specialist services for 900,000 people across the region. The hospital admits approximately 25,000 patients per annum.

Methods

Once the sample had been identified the patient's notes were obtained. The observation charts and the nursing documentation were examined from the time of the cardiac arrest, to

the preceding 12 hours. The variables were selected to align with previous research studies, with careful consideration of any recommendations and limitations. This also included routinely collected data, for example in NZ, this includes ethnicity. The following data were extracted:

- Basic demographic details including age and gender (retrieved from the patient identification label), ethnicity and length of stay in hospital prior to the cardiac arrest (from the patient admission form) and number of admissions to hospital in the previous 3 months (from the examination and progress notes).
- Clinical details including primary diagnoses which were classified as: renal, respiratory, cardiac, gastrointestinal, sepsis, neurological, vascular and other (from the medical staff documentation).
- Co-morbidities which were classified as: coronary artery disease, left ventricular failure, diabetes, previous stroke, obesity, pulmonary disease, impaired renal function, arrhythmias, hypertension, angina, peripheral vascular disease and other (from the medical staff documentation).
- Cardiac arrest variables: Time, location, initial cardiac arrest rhythm, return of spontaneous circulation and survival (from the cardiac arrest and 777 forms).
- The documentation of the following vital signs Systolic blood pressure (SBP), HR, RR, SpO₂, Glasgow Coma Score (GCS) *or* Alert, responsive to voice, responsive to pain unresponsive (AVPU) from the time of cardiac arrest to the preceding 12 hours (from the patient observation charts).
- Documentation of abnormal clinical signs or symptoms from the nursing documentation within 12 hours of the cardiac arrest. These were:
 - **Respiratory:** Respiratory distress, noisy breathing, dyspnoea, shallow breathing, laboured breathing, difficulty breathing, cyanosis, increased work of breathing, accessory muscle usage, wheeze or unequal chest movement
 - **Neurological:** Altered mental status, agitation, drowsy, sleepy, irritable, restlessness, lethargy, anxiety, combative, confusion, vague or unequal pupils
 - **Cardiovascular:** Pallor, cool/clammy skin, diaphoresis, dizziness, skin turgor, dehydration or sluggish capillary refill
 - **Other:** Pain, bleeding (could be either cardiovascular or respiratory) fatigue, nausea or feeling unwell

- Any documented nursing actions and interventions following an abnormal vital sign, clinical sign and symptom or patient complaint.
- Nursing and medical staff documentation up to 12 hours prior to cardiac arrest.

A standardised approach to data collection

The vital signs were recorded at various times and were often singular observations. Given that these were reported within specific timeframes the following principles were applied to ensure consistency:

- The vital sign was considered to have been documented within one hour of the cardiac arrest if it was recorded between 30 and 60 minutes. If it was less than 30 minutes it was coded as such.
- The vital sign was coded to have been documented within two hours of the cardiac arrest if it was recorded between 61 and 120 minutes, three hours between 121 and 180 minutes and so forth. This was applied to the remaining time frames.
- A complete set of observations were considered as a documented SBP, HR, RR, SpO₂ and LOC. The temperature was not included in the data collection to maintain consistency with the data collected by previous researchers.

The nursing documentation was reviewed using the information from Table 2, in Chapter 2, to determine interventions and actions that the nurses may have implemented to address abnormal vital signs and/or abnormal clinical signs and symptoms. This information was obtained from personal experience, knowledge and the ALERT course manual (Smith, 2003). The list is not exhaustive and the interventions are not sequential. It is these nursing interventions/actions that this research endeavoured to identify when abnormal observations were found.

The nursing and medical staff documentation was reviewed to understand the clinical context, beyond the vital sign documentation. This information was used to create vignettes for each patient, of which four examples can be seen in Appendix 3.

Data management

The demographic data, clinical details, co-morbidities and cardiac arrest variables were extracted from the patient's notes and entered directly into the Statistical Package for Social Science (SPSS), version 16.0 database. The vital signs and the nursing and medical staff documentation were entered into a password protected electronic document. The vital

signs, abnormal clinical signs and symptoms and nursing responses to abnormal findings were later transferred into SPSS.

Analysis

Analysis involved both quantitative and qualitative techniques. Statistics are used to give meaning to the data collected during a study, via a process of organising, describing and summarising (Schneider et al., 2007). As this was an observational study, descriptive statistics were used. These are used to describe information on 'what is' or what the data shows (Trochim, 2011). They provide a powerful summary about the sample, the measures used in the study and are used to present quantitative data in a manageable and meaningful way. A statistician was initially consulted for advice on how to present the data.

The analysis involved a sequence of steps. The first step was to clean the data to check it was accurately entered. Secondly, the patient demographics, clinical and cardiac arrest variables were analysed using frequency distribution for nominal data and for continuous variables, central tendency and measures of dispersion.

There are three main characteristics of an individual variable that can be analysed. These include the distribution, the central tendency and the variability. It is common practice for these to be described for each variable. Distribution refers to the frequency of individual values, which is the most common way of organising the data (Schneider et al., 2007). This involves grouping the values and presenting them in relation to the number of times they were observed (Gillis & Jackson, 2002). The central tendency is a single score that summarises continuous data, which are mean, median and mode (Schneider et al., 2007). However, these do not give an adequate portrayal of distribution. Hence, variability refers to the spread of the values around the central tendency, the most common being standard deviation (Trochim, 2011). Standard deviation is the most accurate measure of variability for continuous data and one that clinicians are interested in when determining the extent of dispersion. The analysis found there were two groups; one group included patients who had been in hospital for less than 12 hours and the other group 12 hours or more. Future analyses were done within the groups, as well as with the total data set.

The third step was to analyse the number of vital signs that had been recorded for each patient group, establish how many of these were complete sets and identify the most frequently measured vital sign. From here further coding was performed to determine the number of abnormal vital signs. These were identified using the following criteria:

- SBP <90mmHg
- HR <50 or >130 beats per minutes
- RR <6 or >30 breaths per minute
- SpO₂ <90% (with or without supplemental oxygen)
- GCS <12 or a decrease by 2 points or more
- Responsive only to Pain or Unresponsive as per AVPU

(Adapted from: Buist, Bernard, Nguyen, Moore, & Anderson, 2004).

The frequency and type of abnormal vital signs present, the number of abnormal vital signs present per patient and the time frames these abnormalities occurred within were also determined. This analysis involved calculating and presenting percentages.

Step four involved analysis of the abnormal clinical signs and symptoms. This included identifying the type and number of abnormal clinical signs and symptoms, the number of abnormalities present per patient group and the time frames these occurred within. The abnormal clinical signs and symptoms were then categorised to ascertain the proportion of respiratory, cardiovascular or neurological abnormalities. These were then compared with the abnormal vital signs (SBP and HR being part of the cardiovascular system, RR and SpO₂ being part of the respiratory system and GCS or AVPU being part of the neurological system) to establish whether they corresponded with one another. This data was combined to determine the overall system most likely to deteriorate. Again this data was calculated and presented as percentages.

Following on, step 5 involved identifying and listing the nursing responses to abnormal vital signs or abnormal clinical signs and symptoms. The number of times the medical staff were informed of the patient's abnormal vital signs or abnormal clinical signs and symptoms and the number of abnormalities per patient before the nurse called the doctor were calculated. A response to abnormal observations was considered not applicable in situations where the abnormality was being treated with a therapy. This principle was also applied when the doctor was present, as the actions or interventions of the nurse may be at the request of the doctor, rather than an independent nursing decision.

Step 6 involved calculating the total number of patients with abnormal vital signs and/or abnormal clinical signs and symptoms to determine the total number of patients with abnormal physiology. The final analysis was performed to establish the outcome of the cardiac arrest in relation to demographic and clinical data and whether there was a nursing response.

Validity and reliability

Very few research studies are performed perfectly and most have some degree of weakness (Courtney, 2005). It is the acknowledgement and management of these that reduce the risk of bias and add credibility to the study. There are several ways in which to strengthen the rigour of a research study. These include a thorough review of the literature, the knowledge of the researcher, selecting an appropriate methodology, adequate sampling, the design, time frames and returning to the literature (Courtney, 2005). A comprehensive review of the literature was performed and I had a good understanding of the subject. Careful planning before the study took into account the research process which aimed to employ appropriate strategies. Once ethical approval had been obtained the notes of two patients who had sustained an in-hospital cardiac arrest (outside of the data collection period) were used as a trial to ensure that the variables included in the study were appropriate. It was following this that 'vascular' was added as a primary reason for diagnosis and angina and hypertension were added as co-morbidities (Appendix 4). The AVPU scale was also included at this time.

Once the demographic and clinical data had been entered into the SPSS database this was manually checked against the patient's notes to ensure accuracy. The vital signs and nursing and medical staff documentation that had been transcribed into the electronic document was also checked against the patient's notes, prior to entry into SPSS. This was checked again, once all the data had been entered. This was sent to the supervisors for a final check. The definitions of the abnormal vital signs were strictly adhered to during data collection, to ensure consistency. All of the data were collected by the researcher and as such there were no concerns regarding variability in how the data were collected. The descriptive terms used for abnormal clinical signs and symptoms are subjective and open to interpretation. Furthermore, as this study reviewed retrospective data, the nurses were unable to verify what they observed. Therefore, the nursing documentation was searched for key words to describe abnormal signs and symptoms, as defined earlier in this chapter.

There were no instances where assumptions were made and only the facts have been presented. There were no occasions where the documentation was illegible or inaccurately interpreted. Pre-planned analysis accommodated for anticipated missing data. The sample size included all cardiac arrest patients who could be identified during the data collection period who met the inclusion criteria and the exclusion criteria were systematically applied. Given that the period of data collection was across a 20 month period this was felt to be a representative population. This study did not seek to make

comparisons or identify cause and effect, thus the design used was considered to be the most appropriate.

Finally in reporting on this study, the STROBE check list was used (von Elm et al., 2007). This meant for example in the methods chapter the design used for the study has been described, how the sample were identified, the inclusion/exclusion criteria with rationale for choices and the dates of data collection. All variables have been clearly defined, efforts to address potential bias have been described and the sources of data and methods of assessment have been explained. The process of managing the data, the management of missing data and statistical methods have been described. Other items include exploring the literature and providing rationale for the study, in the findings I have reported the numbers eligible for the study and provided reasons for those that were excluded, presented demographic and clinical data for each participant and reported the outcome data and main results. The discussion summarises the key findings with results from similar studies and limitations to the study

Ethical considerations

Before embarking upon a research project it is essential to consider the ethical implications involved. As this was a descriptive study using retrospective data an Expedited Review of Observational Studies application was submitted to a regional Health and Disability Ethics Committee. However, having reviewed the application and the research proposal it was decided that ethical approval was not required as the study came under the category of 'audit and observational' studies (Appendix 1). Following this an application was submitted to the Victoria University Human Ethics Committee for approval (Appendix 2). Approval was also sought from the hospital in which the research was to be performed. A copy of the research proposal and the ethics application were given to the Acting Director of the Nursing and Midwifery Professional Development Unit. Permission was granted to proceed with the study.

Patient confidentiality was maintained throughout the study. Once the data had been extracted from the patient's notes, the patients were assigned a number and identifiable details removed. The data were directly entered into the SPSS database and an electronic document, which was password protected. Storage was not an issue as no paper copies were maintained. The supervisors and the researcher were the only people who had access to this data. Every effort was made to conceal the identity of the hospital in which the study

was conducted. No staff or names of patients or relatives were recording when accessing the patient's notes.

Cultural safety

The ethnicity of the participants was included in this study, as NZ has a diverse ethnic population. According to the last NZ Census (Statistics New Zealand, 2006) the ethnic groups included NZ European, Maori, Pacific peoples, Asian, Middle Eastern, Latin American and African. The indigenous population in NZ are the Maori people who have specific cultural beliefs. The Treaty of Waitangi is an agreement that protects the rights of the Maori people and there are guidelines available for researchers to use, to ensure cultural sensitivity is maintained (Schneider et al., 2007). A consultation process with the Maori Health Unit at the hospital was conducted prior to commencement of the study. It was agreed that any findings that may have implications for the health and well being of Maori patients would be passed on to the unit.

Conclusion

This chapter has identified the processes employed to perform this study and the complexities associated with conducting a piece of research. There are multiple considerations ranging from choosing an appropriate research design, selecting a sample to collecting the data. It is the selection of these that may inadvertently impact upon the validity and reliability of the study. Efforts were made to reduce the risk of bias so that the findings of the study were as rigorous as possible. Ethical and cultural considerations also aim to improve the credibility of the study. The findings of this study are presented in the next chapter.

Chapter Four: Results

Introduction

This chapter presents the findings of the study. These consist of the demographic characteristics, diagnosis, co-morbidities and cardiac arrest variables of the sample. The patients are presented as two groups; those who were in hospital for less than 12 hours prior to having a cardiac arrest (Group 1) and those who were in hospital for 12 hours or more prior to having an arrest (Group 2). The frequency and comprehensiveness of the vital sign recordings are reported up to 12 hours before arrest. From these recordings the abnormal vital signs were identified. The abnormal clinical signs and symptoms that were documented in the patient's notes are also presented, per patient group. The nursing responses to any of the documented abnormal vital signs and/or abnormal clinical signs and symptoms are reported.

Sample

A total of 36 patients were identified from the cardiac arrest records and 777 forms. Of these, eight patients were excluded for the following reasons: Five were not for resuscitation, one was an out-patient, one was under 18 years old and the eighth person was admitted but had gone directly for intervention and died during the procedure. Demographic and clinical details were available on the remaining 28 patients.

Demographic and clinical profile of the sample

Table 3 presents the patient's gender, age, ethnicity, length of stay in hospital, number of hospital admissions in the previous three months, primary diagnosis and co-morbidities. Standard deviations were used where appropriate as the measure of dispersion. Table 3 demonstrates that the sample were predominantly male, over the age of 61 and of New Zealand European ethnicity. Of the four Pacific Island patients, three were Samoan and one a Cook Island Maori. Of the four Asians, two were Indian. The three in the 'other' group were listed as British, but their actual ethnicity was not reported. There were no NZ Maori (NZ indigenous peoples) in the sample.

The most prominent reason for admission was due to a cardiac cause accounting for 17 (61%) patients. All of the patients had a minimum of two co-morbidities and 22 (79%) patients had at least four.

Table 3. Demographic and clinical characteristics by patient group

		Group 1 <12hrs n = 4	Group 2 >12 hrs n = 24	Total N = 28
Gender	Male	4 (100%)	13 (54%)	17 (61%)
	Female	0 (0%)	11 (46%)	11 (39%)
Age	< 40	0 (0%)	1 (4%)	1 (4%)
	41 – 60	1 (25%)	4 (17%)	5 (18%)
	61 +	3 (75%)	19 (79%)	22 (78%)
Ethnicity	NZ European	3 (75%)	14 (58%)	17 (61%)
	Pacific Island	1 (25%)	3 (13%)	4 (14%)
	Asian	0 (0%)	4 (16%)	4 (14%)
	Other	0 (0%)	3 (13%)	3 (11%)
Primary diagnosis				
	Cardiac	2 (50%)	15 (64%)	17 (61%)
	Respiratory	1 (25%)	2 (8%)	3 (11%)
	Gastrointestinal	0 (0%)	2 (8%)	2 (7%)
	Vascular	0 (0%)	2 (8%)	2 (7%)
	Neurological	0 (0%)	1 (4%)	1 (4%)
	Sepsis	1 (25%)	0 (0%)	1 (4%)
	Cancer	0 (0%)	1 (4%)	1 (4%)
	Other	0 (0%)	1 (4%)	1 (4%)
No. of co-morbidities				
	Mean (SD)	5 ($\pm$ 2)	5 ($\pm$ 2)	5 ($\pm$ 2)
	Range	3-7	2-8	2-8
Length of stay in days prior to cardiac arrest				
	Mean (SD)	0.75 ($\pm$ 0)	12 ($\pm$ 10)	10 ($\pm$ 10)
	Range	0-1	1-36	0-36
Hospitalised in previous 3 months		1 (25%)	10 (42%)	11 (39%)

The maximum number of co-morbidities per individual was eight, which occurred in three patients. Figure 1 demonstrates that hypertension was the most frequently occurring co-morbidity, which was present in 21 (75%) patients. Twelve (42.8%) patients had both left ventricular failure and coronary artery disease, 13 (46.4%) had hypertension and coronary artery disease and 12 (42.8%) had left ventricular failure and hypertension. Nine of the 10 patients with angina also had coronary artery disease. ‘Other’ co-morbidities included dyslipidaemia which was present in 10 (36%) patients. Of the 28 patients, eight (28%) were in hospital for less than 24 hours, 13 for more than one week and five patients for more than three weeks. A large proportion of the patients (39%) had been admitted to hospital at least once in the previous three months, with one (9%) of these patients being admitted twice, during the three month time frame.

Figure 1. Co-morbidities of patients who had a cardiac arrest

Cardiac arrest variables

Table 4 presents the cardiac arrest variables for all 28 patients. This includes the time and location of cardiac arrest, whether the patient was admitted to a ward appropriate to their admitting diagnosis (outliers), initial cardiac arrest rhythm and survival. The cardiac arrests

Table 4. Cardiac arrest variables by patient group

	Group 1 <12hrs n = 4	Group 2 >12 hrs n = 24	Total N = 28
Shift			
Morning (0700-1529)	2 (50%)	7 (29%)	9 (32%)
Evening (1530-2259)	1 (25%)	6 (25%)	7 (25%)
Night (2300-0659)	1 (25%)	11 (46%)	12 (43%)
Location			
Medical	2 (50%)	8 (33%)	10 (36%)
CCU	0 (0%)	9 (38%)	9 (32%)
Surgical	1 (25%)	6 (25%)	7 (25%)
Interventional radiology	1 (25%)	1 (4%)	2 (7%)
Outliers	1 (25%)	2 (8%)	3 (11%)
Initial cardiac arrest rhythm			
Non VF/VT	3 (75%)	17 (71%)	20 (72%)
VF/VT	1 (25%)	5 (21%)	6 (21%)
Not known	0 (%)	2 (8%)	2 (7%)
Outcome#			
Died immediately	3 (75%)	20 (83%)	23 (82%)
Achieved ROSC*	1 (25%)	7 (29%)	8 (28%)
Died following arrest	1 (25%)	3 (11%)	4 (14%)
Discharged alive	0 (0%)	4 (17%)	4 (14%)

Percentages do not add up to 100% as people could be counted more than once.

* Return of spontaneous circulation

took place across the three nursing shifts, with most of these occurring at night. These were spread across a number of clinical areas and wards. What is not apparent in this table is that approximately two thirds of patients (n = 18) had their cardiac arrest out of office hours (1700-0800). Two of the three patients who were outliers were surgical patients admitted to a medical ward and the third was a cardiac patient with new onset angina and dyspnoea who was admitted to a medical ward. The majority (71%) of the patient's initial cardiac arrest rhythm was non-ventricular fibrillation/ventricular tachycardia (VF/VT). Of these, 12 were recorded as being in asystole, seven in pulseless electrical activity (PEA) and one patient's rhythm was reported as being non-shockable. Of the six patients with VF/VT, three had VT, two had VF and one patient's rhythm was reported as being shockable.

The overall mortality rate for the 28 patients was 86%, with almost all dying at the time of the arrest. Further examination of the mortality data revealed that none of the 10 patients who arrested in the medical wards survived and three of the nine patients who arrested in CCU survived to discharge. There were eight patients who achieved a return of spontaneous circulation (that is a perfusing cardiac rhythm) at the resuscitation event. Of these, resuscitation was considered futile in two patients, due to their pre-morbid state and their inappropriateness for admission to ICU. Resuscitation was therefore discontinued and these patients died at the event. The remaining six patients were admitted to ICU for further treatment. Two of these died in ICU and four survived to hospital discharge.

Of the four patients who were discharged alive from hospital, three had VF/VT as their initial cardiac arrest rhythm and one was not known. All four who survived were admitted with a primary cardiac diagnosis and were admitted to an area appropriate for their condition. None of the three outlier patients survived. Of the 11 patients who had been admitted to hospital in the previous three months, only one survived. Of the 18 patients who had their cardiac arrest out of office hours, 16 (89%) died. None of the four patients with more than six co-morbidities survived to hospital discharge.

The following section presents the vital signs that were recorded by the nurses on either the observation charts or in the patient's notes. It is from this data that the abnormal vital signs were identified. Any actions or interventions by the nurse in response to these abnormal vital signs are also presented.

Documented vital signs pre-arrest

A total of 478 vital signs were identified from the 28 patient's notes. All of the patients in both groups had at least one vital sign recorded in the pre-arrest period (Table 5). The vital

signs were recorded between one and seven hourly, however these were rarely complete. A full set of vital signs were only performed on eight occasions and involved only three patients, all of whom had been in hospital for more than 12 hours. None of these were performed within one hour prior to the patients having a cardiac arrest. There were two patients in Group 1 who had no vital signs recorded within 30 minutes of having a cardiac arrest and 15 patients in Group 2. None of the four patients in Group 1 met the hospital's minimum standard of complete sets of four hourly vital signs and only one patient from Group 2 met the standard.

Table 5. Vital signs by patient group

	Group 1 <12hrs n = 4	Group 2 >12 hrs n = 24
Vital signs recorded		
Yes	4 (100%)	24 (100%)
Complete set of vital signs		
Yes	0 (0%)	3 (12%)
No	4 (100%)	21 (88%)
No. of vital signs recorded		
Mean (SD)	12 ($\pm$ 2)	18 ($\pm$ 10)
Range	11-14	3-43
Vital signs recorded at least once		
BP	4 (100%)	24 (100%)
HR	4 (100%)	24 (100%)
SpO ₂	4 (100%)	24 (100%)
RR	4 (100%)	21 (87%)
LOC	0 (0%)	5 (21%)

Table 6 presents the breakdown of how many times specific vital signs were recorded by each group and the measurements. The patients in Group 1 had their SBP, HR and SpO₂ measured on at least three occasions in the pre-arrest period. The RR was measured on at least two occasions in all four patients and the LOC was not recorded in any patients. In Group 2, 19 patients had their SBP recorded on at least three occasions in the pre-arrest period, 18 had a HR recorded on at least three occasions, 13 had a RR recorded on at least three occasions and 16 patients had an SpO₂ on at least three occasions. The recording of the RR was poor with three patients having no RR recorded in the 12 hours pre-arrest and in five patients the RR was only recorded once. The LOC was only recorded in five patients, making this the least recorded vital sign. In both groups the mean measurements of the SBP and HR are within the normal values (as described in Table 1) and the RR and SpO₂ are outside of these values.

Table 6. Frequency and measurements of recorded vital signs by patient group

	Group 1 <12hrs n = 4	Group 2 >12 hrs n = 24
No. of recordings		
BP	13 (26%)	117 (28%)
HR	14 (28%)	116 (27%)
SpO ₂	13 (26%)	100 (23%)
RR	10 (20%)	83 (19%)
LOC	0 (0%)	12 (3%)
Total	50 (100%)	428 (100%)
SBP mmHg Mean (SD)	118 (±24)	112 (±26)
Range	90-167	60-194
HR per min Mean (SD)	88 (±21)	86 (±21)
Range	41-122	60-148
RR per min Mean (SD)	22 (±6)	21 (±7)
Range	16-32	10-45
SpO₂% Mean (SD)	94 (±4)	93 (±7)
Range	85-99	54-100

Abnormal vital signs pre-arrest

The 478 vital signs were examined to establish the number of abnormal findings against the criteria outlined in Chapter 1. A total of 56 (12%) abnormal vital signs were identified, in 17 (61%) patients. Table 7 presents the number of times and type of abnormal vital signs that were documented in both patient groups. A large proportion of patients (71%) with abnormal vital signs had at least two documented abnormal vital signs pre-arrest. Of the 17 patients, the mean number of abnormal vital signs was 3 (SD ±3). In Group 1, none of the patients had an abnormal SBP, yet this was the most frequently recorded abnormal vital sign in Group 2, with five patients having between two and six abnormal SBP recorded within 12 hours of cardiac arrest. There were two patients in Group 2 who had between two and four abnormal HR and two and three abnormal RR recorded. There was one patient who had three abnormal SpO₂ in Group 1 and four patients who had between two and four abnormal SpO₂ recorded pre-arrest. Overall, the SBP was the most frequently abnormal recording, followed by an abnormal SpO₂. There were 10 occasions, in six patients where the RR was not recorded when the patient had an abnormal SpO₂.

The vital signs were clustered into systems so that the system most likely to deteriorate pre arrest could be identified and compared with abnormal clinical signs and symptoms later in this chapter. The BP and HR were combined (cardiovascular system) as were the SpO₂ and RR (respiratory system) and AVPU and GCS (neurological system). The systems most likely to deteriorate pre-arrest were respiratory, present in 10 patients and

cardiovascular also present in 10 patients. An abnormal neurological system was identified in only one patient (a patient could have more than one abnormal system).

Table 7. No. of abnormal vital signs recorded by patient group

	Group 1 <12 hrs n = 4	Group 2 >12 hrs n = 24	Total N = 28
Vital signs			
Normal	1 (25%)	10 (41%)	11 (39%)
Abnormal x 1	2 (50%)	3 (13%)	5 (18%)
Abnormal 2-3	1 (25%)	6 (25%)	7 (25%)
Abnormal 4 +	0 (0%)	5 (21%)	5 (18%)
Abnormal BP at least once	0 (0%)	8 (33%)	8 (28%)
Abnormal HR at least once	1 (25%)	3 (13%)	4 (14%)
Abnormal RR at least once	1 (25%)	3 (13%)	4 (14%)
Abnormal SpO ₂ at least once	1 (25%)	8 (33%)	9 (32%)
Abnormal LOC at least once	0 (0%)	1 (4%)	1 (2%)
Frequency of times abnormal			
SBP <90mmHg	0 (0%)	21 (41%)	21 (38%)
HR >130	0 (0%)	7 (13%)	7 (12%)
HR <50	1 (20%)	0 (0%)	1 (2%)
RR > 30	1 (20%)	6 (12%)	7 (12%)
RR <6	0 (0%)	0 (0%)	0 (0%)
SpO ₂ <90%	3 (60%)	16 (31%)	19 (34%)
LOC	0 (0%)	1 (2%)	1 (2%)
Total	5 (100%)	51 (100%)	56 (100%)

The patient's notes indicate that they deteriorated at varying times before having a cardiac arrest (Table 8). The highest number of abnormal vital signs occurred within one hour of cardiac arrest (30%) yet no complete sets of vital signs were recorded in this time. The median period of instability was 3 ($\pm$ SD 4) hours.

Table 8. Documented vital signs by time and patient group

		Group 1 <12hrs n = 4	Group 2 >12 hrs n = 24	Total N = 28
30 minutes	None	2 (50%)	15 (62%)	17 (61%)
	Normal	0 (0%)	3 (13%)	3 (11%)
	Abnormal	2 (50%)	6 (25%)	8 (28%)
1-4 hrs	None	0 (0%)	4 (16%)	4 (14%)
	Normal	3 (75%)	9 (38%)	12 (43%)
	Abnormal	1 (25%)	11 (46%)	12 (43%)
5-8 hrs	Not applicable*	1 (25%)	0 (0%)	1 (4%)
	None	0 (0%)	2 (8%)	2 (7%)
	Normal	2 (50%)	16 (67%)	18 (64%)
	Abnormal	1 (25%)	6 (25%)	7 (25%)
9-12 hrs	Not applicable*	2 (50%)	0 (0%)	2 (7%)
	None	0 (0%)	4 (17%)	4 (14%)
	Normal	2 (50%)	15 (64%)	17 (61%)
	Abnormal	0 (0%)	5 (21%)	5 (18%)

*Not Applicable refers to those patients who had not yet been admitted to hospital in this time frame

Nursing actions or interventions to abnormal vital signs

Table 9 presents the type of abnormal vital signs and whether these were responded to by a nurse. A nurse acted upon all of the abnormal SBP and RR in Group 2. There were two patients whose abnormal vital signs were only responded to some of the time. Patient 5, in Group 1 had three abnormal SpO₂, of which only two were acted upon. This patient was a new admission who had abnormal vital signs when they were admitted to hospital. Patient 9 in Group 2 also had three abnormal SpO₂, of which only one was responded to. The nurse caring for this patient 12 hours pre-arrest had informed the doctor of the abnormal vital sign. However, the nurse on the following shift did not act upon the abnormal vital signs he/she had documented.

Table 9. Nursing response to number and type of abnormal vital signs by patient group

Vital Sign	Group 1 <12 hrs		Group 2 >12 hrs	
	No. of abnormal vital signs (no. of patients)	No. of times nurse responded #	No. of abnormal vital signs (no. of patients)	No. of times nurse responded #
SBP <90mmHg			21 (8)	21
HR > 130			7 (3)	3*
HR < 50	1 (1)	0		
RR > 30	1 (1)	0	6 (3)	6
RR < 6				
SpO ₂ <90%	3 (1)	2	16 (8)	12*
LOC			1 (1)	0*

One nursing response could account for more than one intervention/action

* A response to 4 abnormal HR, 1 LOC and 2 SpO₂ was not applicable.

There were a further seven abnormal vital signs in three patients where a response was considered as not applicable. One patient (Pt 18) who had four abnormal HR recordings was receiving intravenous therapy to treat the condition; therefore a response was not applicable. There were two further patients (Pt 1 and Pt 13) with abnormal vital signs where a response was not applicable as the doctor was present (thus the nurse did not need to make an independent decision). This accounted for one abnormal LOC and two decreased SpO₂. The response of the medical staff is not included in the analysis.

There were 62 nursing actions or interventions in response to the 56 abnormal vital signs (Table 10). These nursing responses were only documented in 14 of the 17 patients with abnormal vital signs. There were two patients (Pt 3 and Pt 26) who had no response to their abnormal vital signs in the pre-arrest period.

Table 10. Nursing actions or interventions to patients with abnormal vital signs

	Group 1 < 12hrs n = 3	Group 2 >12 hours n = 14	Total N = 17
Nursing response			
Yes		12 (86%)	12 (70%)
No	2 (67%)		2 (12%)
Partial	1 (33%)	1 (7%)	2 (12%)
Not required*		1 (7%)	1 (6%)
Response description			
Increased observations	1 (33%)	8 (57%)	9 (53%)
Dr informed		6 (43%)	6 (35%)
Applied O ₂		6 (43%)	6 (35%)
Increased O ₂		6 (43%)	6 (35%)
Requested medical review		5 (36%)	5 (29%)
Changed mode of O ₂ delivery	1 (33%)	3 (21%)	4 (24%)
Gave oral fluid bolus		2 (14%)	2 (12%)
Gave medication		1 (7%)	1 (6%)
Repositioned patient		1 (7%)	1 (6%)
Encouraged coughing		1 (7%)	1 (6%)
Withheld medication		1 (7%)	1 (6%)
Increased medication		1 (7%)	1 (6%)
Reduced O ₂		1 (7%)	1 (6%)

* Patient had intravenous therapy so a response was not required

The remaining patient (Pt 18), in whom there was no response from the nurse, is the same patient previously mentioned who was receiving appropriate therapy; therefore a response was not applicable. A variety of interventions were implemented to treat the abnormal vital signs in the remaining patients. The maximum number of interventions performed per patient was 11 and there were 17 occasions where there was more than one response.

The most common nursing response was to increase the frequency of vital signs which occurred in nine patients. Oxygen was applied or increased in eight patients in response to an abnormal RR and/or SpO₂. In one patient this was in response to abnormal clinical signs and symptoms (Pt 19). The amount of oxygen delivered was not always in accordance with the patient's requirements. The oxygen was commenced at only six litres in a patient (Pt 1) with a SpO₂ of 75%. There was an occasion where a nurse only increased the oxygen from two to three litres in a patient (Pt 16) with a SpO₂ of 80%. The oxygen was reduced from eight litres via face mask to two litres via nasal prongs for a 15 minute trial in Patient 15, who had a SpO₂ of 88%.

Patient 11 was on five litres of oxygen in the emergency department but this was removed at some point from the time of admission to the ward, as it was recorded that the patient was room air only. There was another patient (Pt 9) who had a SpO₂ of less than 90% for 12 hours, a nurse documented that the doctor was aware at the time of the first abnormal

recording. The patient exhibited two further abnormal SpO₂ recordings of 86% and 84%, of which there was no documented evidence of a nursing response. Two further patients (Pt14 and Pt 20) were removed from oxygen altogether to establish what the SpO₂ was without oxygen. These were recorded as 88% and 86%. There were two patients who were admitted for non-invasive ventilation, however this was removed for reasons unknown in patient 5 and there was no documented evidence it was started in the patient 6. The least performed interventions revolved around the administration of medications and intravenous fluids prior to the arrival of the doctor (as per Table 2).

According to the documentation the medical staff were not made aware by the nurses of more than half of the patients with abnormal vital signs (Table 11). The doctor had been contacted or asked to review eight patients with abnormal vital signs. The nurses requested a medical review for three (17%) patients of whom the doctor had already been informed of the abnormal vital signs.

Table 11. Frequency nurse informed the doctor of abnormal vital signs

	Group 1 <12hrs n = 3	Group 2 >12hrs n = 14	Total N = 17
Documented abnormal vital sign and doctor not informed	3 (100%)	6 (43%)	9 (53%)
Doctor informed after one abnormal vital sign	0 (0%)	3 (21%)	3 (17%)
Doctor informed after two abnormal vital signs	0 (0%)	3 (21%)	3 (17%)
Doctor informed after three or more abnormal vital signs	0 (0%)	2 (14%)	2 (12%)

The documentation showed that there were significant delays in informing the doctor of the abnormal vital signs. In patient 25 the nurse only informed the doctor after five abnormal vital signs were recorded over a period of nine hours and six abnormal vital signs over three hours in patient 1. In patient 8 the nurse informed the doctor of the abnormal vital signs, hourly for two hours and requested a medical review on three occasions over the following four hours. A nurse informed the doctor of patient 20's abnormal vital signs 12 hours before the patient had a cardiac arrest. When the patient deteriorated again nine hours later the nurse escalated this to requesting a medical review.

The following section presents the findings of the abnormal clinical signs and symptoms documented by the nurses in the patient notes. Normal vital signs or signs and symptoms are not included in the analysis. The nursing response to abnormal clinical signs and symptoms are also presented.

Abnormal documented clinical signs and symptoms pre-arrest

There were 74 recorded abnormal clinical signs and symptoms in 24 (86%) patients. Of these, the mean number of abnormal signs or symptoms per patient was 3 (SD±2). Table 12 presents the number of patients who had abnormal clinical signs and symptoms and how many were recorded in each patient. There were 14 (58%) patients who exhibited two or more abnormal clinical signs or symptoms in the pre-arrest period.

Table 12. Patient groups by no. of documented abnormal clinical signs and symptoms

	Group 1 <12hrs n = 4	Group 2 >12hrs n = 24	Total N = 28
No abnormal signs & symptoms recorded	0 (0%)	4 (17 %)	4 (14 %)
Abnormal signs & symptoms x 1	2 (50%)	8 (33%)	10 (36%)
Abnormal signs & symptoms x 2-3	1 (25%)	5 (21%)	6 (21%)
Abnormal signs & symptoms x >4	1 (25%)	7 (29%)	8 (29%)

The descriptions of the abnormal clinical signs and symptoms and the number of patients these were recorded in are presented in Table 13. The abnormal clinical signs and symptoms were clustered into systems to establish which system was most likely to deteriorate pre-arrest. This was done so that abnormal clinical signs and symptoms could be examined alongside abnormal vital signs (see later section in this chapter).

An altered neurological state was identified in 13 (54%) patients, followed by respiratory and cardiovascular, which were 12 (50%) and seven (29%) respectively. It was identified that patients could have several abnormal signs and/or symptoms, per system, recorded in the pre-arrest period. Three of the 12 patients with abnormal respiratory clinical signs and symptoms had a minimum of two respiratory signs and/or symptoms. Patients who had abnormal cardiovascular clinical signs and symptoms were more likely to have more than one abnormal cardiovascular sign and/or symptom, which occurred in five patients. Similar findings were identified with abnormal neurological clinical signs and symptoms with eight patients having more than two abnormal neurological signs and/or symptoms and four patients having more than three.

Table 13. No. and type of abnormal clinical signs and symptoms present by patient group

System	Abnormal sign or symptom	Group 1 <12 hrs	Group 2 >12rs	Total
		n = 4	n = 20	N = 24
Respiratory	Dyspnoea	1 (25%)	6 (30%)	7 (29%)
	Wheeze		4 (20%)	4 (17%)
	Increased work of breathing		1 (5%)	1 (4%)
	Noisy breathing		1 (5%)	1 (4%)
	Shallow breathing		1 (5%)	1 (4%)
	Laboured breathing		1 (5%)	1 (4%)
Subtotal		1	14	15
Cardiovascular	Peripherally cold		5 (21%)	5 (21%)
	Diaphoretic	1 (25%)	2 (10%)	3 (12%)
	Pale	1 (25%)	2 (10%)	3 (12%)
	Clammy		1 (5%)	1 (4%)
	Dehydrated		1 (5%)	1 (4%)
Subtotal		2	11	13
Neurological	Drowsy/Sleepy		10 (50%)	10 (42%)
	Confused	1 (25%)	2 (10%)	3 (12%)
	Agitated		4 (20%)	4 (17%)
	Anxious/distressed	2 (50%)	3 (15%)	5 (21%)
	Restlessness		3 (15%)	3 (12%)
	Combative	1 (25%)		1 (4%)
	Altered mental status		1 (5%)	1 (4%)
	Vague	1 (25%)		1 (4%)
Subtotal		5	23	28
Other	Pain	2 (50%)	6 (30%)	8 (33%)
	Nausea	1 (25%)	5 (21%)	6 (25%)
	Feeling unwell		1 (5%)	1 (4%)
	Fatigued		1 (5%)	1 (4%)
	Bleeding		2 (10%)	2 (8%)
Subtotal		3	15	18
Total		11	63	74

The 24 patients with documented abnormal clinical signs and symptoms had these recorded at different times in the pre-arrest period (Table 14). A significant number of patients with abnormal clinical signs and symptoms demonstrated these for prolonged periods of time, with 79% of these being for more than four hours and 54% for more than eight hours pre-arrest.

Table 14. Documented abnormal clinical signs and symptoms by time and patient group

	Group 1 <12 hrs n = 4	Group 2 >12 hrs n = 20	Total N = 24
30 minutes	1 (25%)	2 (10%)	3 (12%)
1-4 hrs	1 (25%)	1 (5%)	2 (8%)
5-8 hrs	2 (50%)	4 (20%)	6 (25%)
Not applicable*	1 (25%)		1 (4%)
9-12 hrs		13 (65%)	13 (54%)
Not applicable*	2 (50%)		1 (4%)

*Not Applicable refers to those patients who had not yet been admitted in this time frame

Nursing actions or interventions to abnormal clinical signs and symptoms

There were 27 nursing actions or interventions documented in response to the 74 abnormal clinical signs and symptoms, in 18 of the 24 patients (Table 15). Patient was undergoing a procedure during the period of instability.

Table 15. Nursing response to abnormal clinical signs and symptoms

	Group 1 <12hrs n = 4	Group 2 >12 hrs n = 20	Total N = 24
Nursing action			
Yes	2 (50%)	16 (80%)	18 (75%)
No	1 (25%)	4 (20%)	5 (21%)
NA*	1 (25%)		1 (4%)
Response			
Gave medication	1 (25%)	8 (40%)	9 (36%)
Dr informed		7 (35%)	7 (29%)
Requested medical review		3 (15%)	3 (12%)
Increased observations		3 (15%)	3 (12%)
Applied O ₂		1 (5%)	1 (4%)
Increased O ₂		1 (5%)	1 (4%)
Gave oral fluid bolus		1 (5%)	1 (4%)
Performed blood sugar level	1 (25%)	0 (0%)	1 (4%)
Performed ECG		1 (5%)	1 (4%)

*Not applicable as the medical staff were present

The medical staff were present during this time thus, an independent response from the nurse was not applicable. The maximum number of recorded interventions performed at any one time was three (11%) and there were seven (26%) occasions where there was more than one response to an abnormal finding. Of the five patients in whom there was no response, one of these was reported to be anxious, nauseous and had chest pain (Pt 11). The nurse told the patient to relax and go to sleep. The patient was later found cyanotic, with a faint pulse and slow breathing. This was a CCU patient being cared for in an area that was

inappropriate for their condition. Patient 12 was reported as being drowsy, sleepy, pale, short of breath and requesting to be sat in an upright position. The patient was transferred to a chair despite these abnormalities. It was also documented that the nurse was unable to obtain an SpO₂ on the patient. It was reported that the patient's limbs were cold to touch on the night shift prior to the patient having a cardiac arrest the following afternoon. There was no documented evidence of the medical staff being informed of any of these abnormalities.

According to the documentation the medical staff were informed of or asked to review 10 of the 24 patients with abnormal clinical signs and symptoms (Table 16). In one patient (Pt 1) the nurse on the evening shift did not inform the doctor of the patient's wheeze, however the night nurse informed the doctor of the patient's noisy breathing and escalated this to requesting a medical review when the patient did not improve. A further medical review was requested when the patient became drowsy and had developed cold peripheries.

Table 16. Frequency nurse informed the doctor of abnormal clinical sign and symptom

	Group 1 <12 hrs n = 4	Group 2 >12 hrs n = 20	Total N = 24
Documented abnormal sign or symptom & doctor not informed	3 (75%)	10 (50%)	13 (54%)
Doctor informed after one abnormal sign or symptom		1 (5%)	1 (4%)
Doctor informed after two abnormal signs or symptoms		1 (5%)	1 (4%)
Doctor informed after three abnormal signs or symptoms		6 (30%)	6 (25%)
Doctor informed after four or more abnormal signs or symptoms		2 (10%)	2 (9%)
Doctor present*	1 (25%)		1 (4%)

* Not applicable

The doctor was informed of a patient (pt 8) on the evening shift who was difficult to rouse and confused. The patient was seen by the doctor two hours later. The patient was seen on three more occasions in four hours, although it is not clear if this was at the request of the nurse. Another patient (Pt 15) was reported as being drowsy and wheezy by the nurse on the evening shift, but there is no evidence that the doctor was informed. The night nurse requested a medical review within an hour of commencing duty, as the patient had become diaphoretic. The patient was seen by the doctor on five more occasions. Another patient (patient 17) was reported as being very sleepy, yet the doctor was not informed until four

hours later when the patient had become confused, agitated and not obeying commands (part of the GCS assessment). In a patient (Pt 20) who became distressed and developed acute dyspnoea a nurse notified the doctor immediately and applied oxygen.

The documentation indicates that the medical staff were not made aware of more than half of the patients abnormal signs and symptoms. A patient (28) was reported as being drowsy on the evening shift of which there was no evidence of the doctor being informed. It was not until the patient demonstrated abnormal cardiovascular clinical signs and symptoms that the doctor was asked to review the patient, some four hours after the night shift started. Patient 22's family expressed concern regarding the patient's condition. This patient had eight abnormal clinical signs and symptoms over a period of nine hours. The doctor had reviewed the patient on four occasions during this time.

The following section provides details of the number of patients who had abnormal vital signs, abnormal clinical signs and symptoms or both. The type of systems that were abnormal for both vital signs and clinical signs and symptoms are compared to establish whether they mirror one another. That is, if a patient has abnormal cardiovascular vital signs such as hypotension, did they exhibit abnormal cardiovascular clinical signs and symptoms, such as cool peripheries or clammy skin? Also abnormal vital signs from one system can impact upon the clinical signs and symptoms of another, such as a low SpO₂ can cause confusion. Finally, the patient's survival in relation to demographic and clinical data and whether there was a nursing response are presented.

Overall abnormal physiological observations pre-arrest

Only three (11%) of the 28 patients had no recorded abnormal vital signs, abnormal clinical signs and symptoms or both (Table 17). The patient's notes were examined to identify the system most likely to deteriorate in the pre-arrest period. This was done by establishing whether the patient had abnormal respiratory, cardiovascular or neurological vital signs and/or clinical signs and symptoms. It was found that 16 of the 25 patients had a documented abnormal respiratory system, 14 had an abnormal cardiovascular system and 14 had an abnormal neurological system (patients could have more than one abnormal system at any one time).

Table 17. Patients by group who had abnormal vital signs and/or abnormal clinical signs and symptoms recorded

	Group 1 <12hrs n = 4	Group 2 >12 hrs n = 24	Total N = 28*
Abnormal vital signs only	0 (0%)	1 (4%)	1 (4%)
Abnormal signs & symptoms only	1 (25%)	7 (29%)	8 (28%)
Both abnormal vital signs & abnormal signs & symptoms	3 (75%)	13 (54%)	16 (57%)
Either abnormal vital sign and/or abnormal signs & symptoms	3 (75%)	22 (91%)	25 (89%)

*Percentage does not equal 100 because the number of patients with abnormal vital signs differed from the number of patients with abnormal clinical signs and symptoms

There were eight patients who had abnormal clinical signs and symptoms with no abnormal vital signs. There was only one patient with abnormal vital signs who did not have any abnormal clinical signs and symptoms. The majority of the sample (89%) had abnormal vital signs and/or abnormal clinical signs and symptoms in the pre-arrest period. The documentation showed that the nurses responded to 21 of the 25 patients with abnormal vital signs and/or abnormal clinical signs and symptoms. Of the four patients whose abnormal observations were not acted upon, one patient had abnormal vital signs and abnormal clinical signs and symptoms and three patients had abnormal clinical signs and symptoms only. Whilst the nurses responded to most of the patients abnormal observations, the nursing documentation demonstrates that this was often limited to increasing the frequency of observations and nil else. Appendix 3 provides four vignettes of individual patients' documented deterioration in the pre-arrest period.

The documentation showed that the medical staff were only informed of or asked to review half of the 25 patients with abnormal vital signs or abnormal clinical signs and symptoms. Table 18 presents the number of patients who exhibited comparable abnormal vital signs and clinical signs and symptoms. Additionally the number of patients with abnormal respiratory and cardiovascular vital signs and abnormal neurological clinical signs and symptoms were also included as hypoxia or reduced cardiac output can also lead to an altered mental status.

There were six patients with abnormal cardiovascular vital signs who did not have any recorded abnormal cardiovascular clinical signs and symptoms. Likewise there were four patients with abnormal respiratory vital signs who did not have any documented abnormal clinical signs and symptoms. The one patient (Pt 1), who was recorded as being

unresponsive on the AVPU scale, did not have any documented abnormal clinical signs and symptoms. There were 10 patients with abnormal respiratory or cardiovascular vital signs who also had abnormal neurological signs and symptoms.

Table 18. Patients with comparable abnormal vital signs and abnormal clinical signs and symptoms

	Group 1 <12hrs n = 4	Group 2 >12 hrs n = 21	Total N = 25
Abnormal <u>respiratory</u> vital signs and abnormal <u>respiratory</u> signs & symptoms	1 (25%)	5 (24%)	6 (25%)
Abnormal <u>cardiovascular</u> vital signs and abnormal <u>cardiovascular</u> signs & symptoms	0 (0%)	3 (14%)	3 (12%)
Abnormal <u>neurological</u> vital signs and abnormal <u>neurological</u> signs & symptoms	0 (0%)	1 (5%)	1 (4%)
Abnormal <u>respiratory</u> vital signs and abnormal <u>neurological</u> signs & symptoms	1 (25%)	4 (19%)	5 (21%)
Abnormal <u>cardiovascular</u> vital signs and abnormal <u>neurological</u> signs & symptoms	1 (25%)	4 (19%)	5 (21%)

Finally, the outcome of the 28 patients according to demographic and clinical data and whether there was a nursing response to the abnormal findings are reported. As can be seen in Table 19, men were three times more likely to survive to hospital discharge than women. None of the patients under the age of 60 survived to hospital discharge. Only one of the three patients with no abnormal vital signs or abnormal clinical signs and symptoms survived to hospital discharge and most of the patients with abnormal vital signs or abnormal clinical signs and symptoms died in hospital. A large proportion (71%) of the patients still died, despite a nursing action or intervention.

Table 19. Cardiac arrest outcome by demographic, clinical and nursing response

	Died in hospital n = 24	Survived to hospital discharge n = 4
Gender Male	14 (58%)	3 (75%)
Female	10 (42%)	1 (25%)
Age < 40	1 (4%)	0 (0%)
41 – 60	5 (21%)	0 (0%)
61 +	18 (75%)	4 (100%)
Abnormal vital signs*	16 (94%)	1 (6%)
Abnormal signs & symptoms*	21 (88%)	3 (12%)
No abnormal vital signs or signs & symptoms*	2 (67%)	1 (33%)
Nursing response	17 (71%)	3 (75%)

* Percentage does not equal 100 as the number of patients with abnormal vital signs or abnormal clinical signs and symptoms differ

Conclusion

This study has demonstrated considerable inconsistencies with the frequency and comprehensiveness of patient vital signs. A significant number of vital signs were missing in the hour before cardiac arrest (yet this was when most of the abnormalities were identified) and only one patient met the hospital's minimum standard of four hourly vital signs. The SBP and SpO₂ were the most frequently recorded vital signs and RR and LOC the least. Most of the patients exhibited abnormal vital signs and/or abnormal clinical signs and symptoms in the pre-arrest period. It was found that patients exhibited abnormal clinical signs and symptoms for significantly longer periods than abnormal vital signs. This is supported by the fact that most of the patients also had asystole or PEA as their initial cardiac arrest rhythm. All but one patient with abnormal vital signs also had abnormal clinical signs and symptoms. An abnormal SBP and SpO₂ were the most frequently abnormal vital signs and an altered neurological state the most common abnormal clinical sign and symptom. The overall system that was most likely to deteriorate prior to a cardiac arrest was the respiratory system.

The nurses recognised and responded to the majority of the abnormal physiology. However the response was limited to increasing the frequency of observations and/or informing the doctor. The nurses did not respond to or only partially responded to eight (32%) patients with abnormal physiology and all of these patients died. The documentation showed that the medical staff were not made aware of more than half of the patients with documented abnormalities and there were occasions where there were significant delays. The nurses were less likely to respond to patients with abnormal clinical signs and symptoms, in particular abnormal neurological signs and symptoms. These were tolerated for prolonged periods of time and were not responded to in 62% of patients or there were delays in doing so.

There were issues with the administration of oxygen. This was delivered at very low rates in the presence of hypoxaemia, reduced or removed as soon as patients SpO₂ improved, removed in patients for trial periods off oxygen and the method of delivery frequently changed to modes that did not meet the patient's oxygen requirements. This study identified that the survival rate of outliers or those who had a cardiac arrest out of office hours was dismal. The findings of this research will be discussed in further detail in the following chapter.

Chapter 5: Discussion

Introduction

The purpose of this research was to determine what physiological observations nurses documented in the pre-arrest patient and how they responded to abnormal findings. The abnormal physiological observations included vital signs and clinical signs and symptoms. This study identified that nurses do respond to abnormal physiology, however the response was often limited to increasing the frequency of observations and/or informing the doctor. A key finding was that the nurses did not respond to eight patients with abnormal physiology, none of whom survived. The majority of patients exhibited abnormal signs and symptoms for prolonged periods, often before vital signs became deranged. The nurses were less likely to respond to these, in particular an altered LOC. Other areas of concern included inconsistencies with vital sign recording, appropriate use of oxygen, lack of or delays in conveying clinical abnormalities to the medical staff and the mortality associated with outliers and cardiac arrests that occur out of hours. This chapter will discuss these in further detail and present the limitations of the study.

Comprehensiveness of vital sign documentation

This study established that nurses are not documenting patient vital signs. Whilst there were 478 vital signs recorded, these were not evenly distributed amongst the patients, with one patient having only three vital signs recorded in the 12 hours pre-arrest. A significant number of patients had no vital signs recorded at all within 30 minutes of cardiac arrest. Given that most of the abnormal vital signs were recorded within one hour of cardiac arrest, these patients may have had deranged physiology that could have been detectable had they been taken. There was a distinct lack of compliance with the hospitals observation policy. Only one patient met the minimum standard of four hourly complete vital signs. This is unsafe practice, as a lack of vital signs means patient deterioration will not be recognised. Thus, the remaining patients deteriorated unnoticed, as their vital signs were missing.

Only eight of a possible 78 sets of complete vital signs were performed on three patients. Given the findings and recommendations of the Health and Disability Commission (2007) investigation this practice in NZ should have improved. What is even more concerning is that none of the complete sets were recorded within one hour of cardiac arrest or in any of the patients who were newly admitted. Obtaining baseline recordings are

a fundamental aspect of the admission process, which are used to inform patient care planning. Without these it is impossible to compare future recordings and identify any deviations, which may result in patient deterioration being missed. This lack of documenting vital signs discredits the nursing profession, as the standards of professional nursing practice are not being upheld. Furthermore, the Nursing Council of New Zealand, Code of Professional Conduct (2009) considers inadequate observations and/or documentation as professional misconduct. In a court of law nurses could only say that they complied with the hospital policy and did all they could to prevent the patient from dying in only one patient scenario.

The most frequently recorded vital signs were BP (27%), HR (27%), and SpO₂ (24%). This concurs with other studies that also identified these as the most commonly recorded vital signs (Smith, 2010; Goldhill, White & Sumner, 1999; NCEPOD, 2005). It has been suggested that the most likely reason for this is that automated machines are widely used in the hospital and these vital signs are easily obtained (McBride, Knight, Piper, & Smith, 2004). Given that the vital signs not measured by these machines, specifically RR, were the least recorded vital signs this might indicate nurses only record those vital signs that are acquired through automated machines.

Other vital information may be missed when using automated machines (Wheatley, 2006). For instance when the pulse is palpated manually the regularity or volume of the pulse can be obtained, the colour of the patient and the temperature of the skin (Hogan, 2006). This provides information as to the patients cardiac output or the presence of an arrhythmia, which the machines cannot detect. It is essential that nurses understand the limitations with such technology and take these into account when using electronic equipment (Clark, Giuliano, & Chen, 2006).

The RR was poorly documented in this study, with three patients having no RR recorded at all in the hours prior to a cardiac arrest and five patients only had one RR. There is a growing body of evidence to suggest that the RR may be the most sensitive and specific of all vital sign observations in predicting an adverse event (Considine & Botti, 2004; Cretikos et al., 2007; Goldhill & McNarry, 2004). It is therefore critical that nurses understand and appreciate the clinical significance of the RR, if acutely unwell patients are to be recognised and deterioration is to be prevented.

In addition this study identified that the LOC was only recorded on the observation chart in five patients. Similar findings have previously been reported (Endacott et al., 2007). The GCS was only recorded in one patient who was admitted to a neuro-surgical

ward. The purpose of the GCS tool is to enable healthcare professionals to make a rapid assessment of a patient's LOC (Fulton et al., 2005). However, the complexity of the GCS scale can make it difficult to remember, for those who do not use it regularly. The most likely reason it was recorded in this patient is because the nurses in this ward use the tool frequently. A more user friendly version is the AVPU scale. However, despite its simplicity this was only used in four patients. It may be that nurses do not know how to use these tools and that this is an area that requires attention.

Prevalence of abnormal vital signs and clinical signs and symptoms

This study identified that 61% of patients demonstrated abnormal vital signs and 86% abnormal clinical signs and symptoms pre-arrest. However, given the number of missing vital signs this figure could be grossly underestimated. There was only one patient with abnormal vital signs who did not exhibit abnormal clinical signs and symptoms. This would suggest that abnormal clinical signs and symptoms are equally as important as vital signs in determining changes in the patient's condition. However, it is thought that nurses rely heavily on abnormal vital signs to recognise patient deterioration (Endacott et al., 2007). Consequently, nurses need to perform regular assessments of the patient, rather than only using objective data to inform them of changing health status.

A deterioration of the cardiovascular and respiratory system was the most prevalent abnormalities. Ten patients with abnormal vital signs had an abnormal HR or SBP on at least one occasion and 10 had an abnormal SpO₂ or RR at least once. Numerous studies have reported respiratory dysfunction and a decreased BP as the most common derangement pre-arrest (Crispin & Daffurn, 1998; Kause et al., 2004; Nurmi et al., 2005; Rich, 1999). It has even been reported that a change in SBP is an independent predictor of cardiac arrest (Hodgetts et al., 2002a). Conversely, Cuthbertson et al. (2007) argues that the BP is not of any benefit and should be removed from the EWS systems. However, this study established that a decreased SBP was the most frequently occurring abnormality accounting for 38% of all abnormal vital signs. This could be attributed to the fact that this was one of the most frequently recorded vital signs.

Many studies report an altered respiratory function as the system most likely to deteriorate pre-arrest (Buist et al., 2004; Nurmi et al., 2005; Sandroni et al., 2007; Schein et al., 1990). This study found that a decreased SpO₂ of <90% was the second most frequently occurring abnormal vital sign accounting for 32% of all abnormal vital signs. This is thought to be associated with an increased risk of cardiac arrest (Santiano et al., 2009). It

was concerning to find that there were 10 occasions in six patients where the RR was not recorded when there was a documented SpO₂ <90%. As stated by NCEPOD (2005) the SpO₂ should not replace the RR and should be recorded at the same time as other vital signs. Whilst it has been established that an increased RR is an important predictor of an impending cardiac arrest, this was not identified in this study. Only four patients were found to have an abnormal RR. However, as this was not regularly documented and missing altogether in some patients, this number could be significantly higher. In this study abnormal respiratory clinical signs and symptoms were present in 12 patients. The most prevalent respiratory abnormality was dyspnoea which was present in seven patients. Five of these patients had dyspnoea for more than four hours and two for at least 12 hours. Dyspnoea is recognised as a sign of potential deterioration and has consequently been added to some medical emergency criteria (Hodgetts et al., 2002a).

An altered LOC has been identified as a key indicator of physiological instability (Goldhill et al., 1999). This study found that there was only one patient who was reported to be unresponsive (U on the AVPU scale) however, there were three other patients who were documented as being responsive to voice only (V on the AVPU scale). Whilst this is not within the abnormal criteria used for this study, it does suggest an altered LOC. A decreased LOC was the most common abnormal clinical sign and symptom, occurring in 13 patients. Of these, eight patients had at least two descriptions of abnormal LOC, four had more than three and one patient had as many as six. This demonstrates that these were not one off isolated events. However, had the patient's notes not been examined for reports of abnormal clinical signs and symptoms, this finding would not have been identified. This would have provided an inaccurate reflection of the actual number of patients with an abnormal LOC. This indicates that nurses are more likely to record the patient's neurological state as a descriptive term rather than using the GCS or AVPU scales. This would suggest that nurses are not familiar with or are reluctant to use these assessment tools.

A variety of descriptions were used to describe a change in the patient's LOC. The most frequently recorded abnormal sign or symptom was a drowsy or sleepy patient. This was present in 10 patients and was often the first abnormal sign or symptom recorded. This is supported by Endacott et al. (2007) who state that an altered LOC is often the first reported sign of patient deterioration. Drowsiness was frequently accompanied with agitation and/or confusion. There were three patients who were described as being anxious or distressed who were also reported as having dyspnoea and another patient who was

drowsy and confused was also hypotensive. Clearly each system is linked and can impact upon the other.

Nursing response to abnormal clinical findings

A significant finding of this study is that although the nurses responded to most of abnormal physiological observations, there were eight (32%) patients with abnormal vital signs and/or abnormal signs and symptoms where there was either no response or a partial response from the nurse. None of these patients survived. As part of the Nursing Council of New Zealand competency framework (2007) nurses are responsible for taking action in situations that compromise patient safety. This study demonstrates that this did not always occur and as a result patients died. This has significant implications for the patient and for nurses.

The nursing documentation revealed that the response was often limited to repeating the observation or increasing the frequency of observations. As can be observed in the patient vignettes in Appendix 3, there were few other responses. Simply increasing the frequency of observations is not sufficient to prevent further deterioration. As stated by Kisiel and Perkins (2006) nurses need to analyse the information to make it meaningful, communicate the findings and implement appropriate interventions. In this study there were also occasions where once the nurse had informed the doctor of the abnormal vital signs, no other action was taken. This may mean that nurses consider informing the medical staff as absolving them from further intervention. One patient who dies from a lack of a nursing response is one patient too many.

Table 2 (page 18) was used as a framework to identify interventions that may have been implemented by the nurses to improve the patient's abnormal physiology. In this study the abnormal vital sign that the nurses were most likely to respond to was a decreased BP, and the response was mainly informing the doctor. This indicates that nurses may consider the patient to be more at risk of acute deterioration with hypotension than other abnormal vital signs. There were no apparent themes with regards to the abnormal vital signs that were not responded to as these included HR, RR and SpO₂.

The most common response to an abnormal vital sign was to increase the frequency of observations. This occurred in over half of the patients. When an abnormal vital sign was recorded the nurse measured the vital sign within two hours, in 76% of the patients. In the remaining patients the vital sign was not repeated. If patient deterioration is to be detected vital signs must be repeated regularly. The fact that abnormal vital signs were not

repeated or took up to two hours, highlights the deficiencies with recording patient vital signs in this study.

This study identified that nurses were cautious with the provision of oxygen. There were many occasions where the oxygen was reduced or the mode of delivery was changed as soon as the patients SpO₂ improved. This may be due to an awareness that too much oxygen in patients with chronic respiratory disease may lead to carbon dioxide retention and possibly a respiratory arrest. However, this only occurs in a small percentage of patients when they are given uncontrolled amounts of oxygen (Smith, 2003). Furthermore, the oxygen was on extremely low flow rates despite patients demonstrating a low SpO₂ and when the oxygen was increased, the amount was frequently insufficient for the patients needs. As stated by Hodgetts et al. (2002a) most patients on the general wards are desperate for oxygen. Nurses need to understand that patients who are hypoxic die without oxygen and even those with chronic respiratory disease will have a cardiac arrest if their oxygen levels are allowed to become too low.

This study showed that the nurses did not appear concerned about patients with a change in LOC. This was apparent in that abnormal neurological signs and symptoms were documented for many hours in 13 patients, with no response to 62% of these. A blood glucose level was only performed in one of the 13 patients. Given that the cause of a decreased LOC may be secondary to hypoglycaemia, this test should be performed early in all patients with an altered GCS (Smith, 2003). These findings plus the lack of documenting patients GCS/AVPU would suggest that nurses do not understand the clinical meaning of abnormal neurological signs or appreciate the significance of this in relation to patient deterioration.

According to the documentation, the medical staff were aware of less than half of the patients with abnormal vital signs and/or clinical signs and symptoms. This is consistent with previous studies who have reported similar findings (Kause et al., 2004; Rich, 1999; Schein et al., 1990; Smith & Wood, 1998). It has been argued that nurses often have difficulties convincing doctors of their concerns or are unable to articulate their findings (McArthur-Rouse, 2001). This breakdown in communication may lead to prolonged delays in the patient being seen by the doctor. This was evident in this study when in some cases it took two hours for the doctor to arrive. This is detrimental to the patient as it prevents the patient from receiving appropriate and timely treatment. This has seen the introduction of variety of communication tools that enable nurses to articulate

patient issues in a systematic way (Smith, 2003). This facilitates communication and should result in an appropriate response.

Duration of deterioration

Almost half of all abnormal vital sign recordings were documented within four hours of cardiac arrest. The median period of instability was three hours, which is in direct contrast to the 6.5 hours reported by DeVita et al. (2010). This has implications for the frequency of recording patient vital signs, in that most patient deterioration is going to be missed if they are only performed 12 hourly. This study demonstrated that patients exhibited abnormal clinical signs and symptoms for significantly longer periods than abnormal vital signs. There were 8% of patients with abnormal clinical signs and symptoms in the four hours prior to cardiac arrest, versus 70% with abnormal vital signs for the same time period and 54% versus 29% between nine and 12 hours respectively. This is almost three times the number of patients who demonstrated abnormal vital signs for the same time period. If these are recognised and treated early it is possible that the derangement in vital signs could be prevented and possibly patient death.

Time of cardiac arrest

This study established that the majority of the cardiac arrests occurred out of office hours and that most of these patients did not survive (89%). This is congruent with previous studies who report patients are twice as likely to die if they have a cardiac arrest at night (Hajbaghery, Mousavi and Akbari, 2005; Herlitz, Bang, Alsen, & Aune, 2002). There are several possible reasons for this increased mortality rate. Firstly, there are generally fewer senior staff available at night, so this may affect the skill level of the emergency response (Herlitz et al., 2002). Secondly, more futile resuscitation attempts may occur overnight as the patient's consultant may not be available to make a do not resuscitate decision (Sandroni et al., 2007). Finally, patients are observed less frequently overnight and as such their collapse may go unnoticed for longer periods of time, leading to a delay in resuscitation (Matot et al., 2006). This is most often because patients are sleeping and nurses do not regularly take observations overnight (NPSA, 2007). This has implications for organisations to ensure that the same level of support and skill level of the staff are available 24 hours a day.

Outliers

There were three patients in this study who were admitted to wards that were inappropriate for their admitting diagnosis. This is thought to have a negative impact upon survival from a cardiac arrest (Weil & Fries, 2005). This was evident in this study, as none of these patients survived. Patients who require critical care beds may be nursed in the general wards due to a lack of resources in these areas. It has been highlighted that bed shortages, high occupancy or a failure to appreciate the seriousness of the patient's condition may lead to patients being admitted to inappropriate areas (Hodgetts et al., 2002b). This leads to a disparity between the needs of the patient and available resources and patients are cared for by nurses who have limited skills and scope of practice (Mailey et al., 2006). This is supported by Castle et al. (2003) who argues that patients who are admitted to inappropriate areas are often poorly managed. A potential rationale for this is that the staff may be unfamiliar with the needs of the patient and there may be some confusion over who to call when the patient deteriorates (NPSA, 2007). Furthermore, in order for the emergency department to meet their targets and the ICU to free up beds for elective cases or acute admissions, patients may be sent to the wards too soon and may be not actually be well enough. This leaves the nurses on the wards caring for a seriously unwell patient without the resources, skills and knowledge to manage them effectively.

Health status

In this study the clinical data indicates that most of the patients in the sample had been unwell for some time. Almost half of the sample had been in hospital for more than one week prior to having a cardiac arrest, with the mean length of stay for Group 2 being 12 days. Similar findings were reported by Endacott et al. (2007) who identified the median length of stay in hospital pre-arrest was 10 days. It has been suggested that patients who are in hospital for prolonged periods of time pre-arrest, have a higher mortality rate (Danciu et al., 2004). The poor health status of the sample was further emphasized with all of the patients having at least two co-morbidities. Heart disease was the most prevalent co-morbidity which was present in at least 57% of patients and the primary diagnosis in 61% of patients was cardiac. This number of cardiac diagnosis is twice that previously reported by Rich (1999). This could indicate an increase in heart disease during the last two decades. Danciu et al. (2004) reported no association between the presence of co-morbidities and survival from a cardiac arrest. However, this study found that patients with more than six

co-morbidities did not survive. This would suggest that nurses need to be more vigilant with assessment and monitoring of vital signs in these high risk patients.

Limitations of the study

There were several limitations to this study. These include a small sample size in comparison to other studies. However, it is felt that this is representative of the population as they were cardiac arrests that had occurred over a period of 20 months. During this time the education and cardiac arrest management protocols had not changed. A major limitation of retrospective chart reviews is the reliance on others having recorded the information and the accuracy of the data. As suggested by Kause et al. (2004) if data is missing the actual occurrence of abnormal physiology may be much higher. It may also be that missing vital signs were normal, that there were charting errors and interventions that were performed but not recorded. Furthermore, this study did not include people who did not have a cardiac arrest, who may also have demonstrated the same abnormal physiology. Finally, it may be that the doctor was already present at the bedside at the time of the abnormality and consequently was not documented in the patient's notes. As stated by McArthur-Rouse (2001) assumptions cannot be made about what was or was not done, if it is not documented.

Conclusion

This chapter has discussed the key findings of this study. Multiple issues have been raised that have implications for patient outcomes, nursing practice and organisations. These include educational strategies and policy review to improve the documentation of patient vital signs, communication between nursing and medical staff, the use of oxygen therapy and increasing awareness of the importance of abnormal signs and symptoms, in particular an altered LOC. Patients are dying because their vital signs are not being recorded, nurses are not applying timely or appropriate interventions. The following chapter will discuss the implications of these findings and recommendations for the future.

Chapter Six: Conclusion

Introduction

The aims of this study were to establish what vital signs and/or clinical signs and symptoms were documented in the pre-arrest patient, identify whether any of these were abnormal and what if any actions or interventions were performed by the nursing staff in response to the abnormal findings. This research identified that the documentation of patient vital signs was abysmal with only one patient meeting the hospitals minimum standard and a complete set of vital signs being performed in only three patients. The nursing responses were limited to increasing the frequency of observations or informing the doctor. There were few other interventions to treat abnormal physiology. There were eight patients who had either no response or a partial response to their abnormal vital signs or abnormal signs and symptoms, all of whom died. The nursing documentation demonstrated that abnormal neurological observations were tolerated for significant periods of time, with no nursing response in 62% of these patients. These have serious implications for patient survival, the nursing profession, organisational resources and staff education. This chapter highlights the significance of the findings from this study and makes recommendations based upon these.

Improving patient outcomes

This study has reinforced previous research and found that a significant number of patients exhibit abnormal vital signs and clinical signs and symptoms for prolonged periods of time. However, many of these physiological derangements are treatable and early intervention has been shown to significantly reduce mortality in these patients. As a consequence the focus has changed towards prevention, of which nurses play a pivotal role. The key to recognising patient deterioration is through regular, complete and accurate vital signs and patient assessment. It is essential that these are performed by staff with the necessary skills and knowledge to interpret the data and understand their clinical meaning if the patient is to receive appropriate treatment.

Improving the recording of vital sign observations

There is a substantial amount of evidence to show that the documentation of patient vital signs is poor and are often incomplete. The findings of this study add to this evidence, with some seriously unwell patients having missing vital signs. The frequency and comprehensiveness of patient vital signs were to an unacceptable standard and best practice

did not occur. This is problematic for nurses as they are not practicing in accordance with the Nursing Council of New Zealand, Code of Professional Conduct and risk losing their registration. For patients the outcome is much worse as their quality of care and safety is being compromised and they are dying because of this. Nurses need to be educated to improve their knowledge on the importance of measuring vital signs, recognising trends and their role in identifying the at risk patient. Nurses must be competent to measure, interpret and respond to abnormal vital signs.

Responding to physiological abnormalities

There is a clear link between abnormal physiology and mortality. This study identified that most of the patients with abnormal vital signs did not survive. Given that treatment is more likely to be effective when implemented early, it is essential that these abnormalities are recognised and acted upon. The recognition of abnormal physiology significantly impacts upon the ability to respond. The nurses failed to treat abnormal vital signs or signs and symptoms in eight patients. This is unacceptable practice given the patient outcome. Nurses need be provided with regular in-service training and mock scenarios to improve recognition of the deteriorating patient and how to respond with simple but life saving interventions. Such training also facilitates teamwork, communication and confidence in dealing with such patients.

Period of instability

Given the level of missing data, the exact time frames of clinical instability and the vital signs most likely to become deranged, prior to a cardiac arrest are not known. However, this study demonstrated that of the patients with abnormal vital signs documented, most of these occurred within four hours of cardiac arrest. Vital signs should therefore be recorded more frequently than the recommended 12 hourly, to detect deterioration. Conversely, abnormal clinical signs and symptoms were present for much longer, most of which occurred within nine to 12 hours. This should provide ample opportunity for nurses to recognise and respond to the deterioration. An abnormal neurological status was tolerated for extended periods of time before a response was initiated or not at all. This would indicate that nurses do not appreciate the significance of an altered LOC in the acutely unwell patient. It is essential that nurses are taught how to recognise abnormal signs and symptoms and respond to these in a timely manner to prevent further deterioration.

Areas requiring further attention

The nursing documentation identified numerous issues. These were the amount of oxygen administered, delays in informing the doctor of the abnormal physiology and the survival of outliers and patients who have a cardiac arrest out of office hours. None of these findings are unique to this study, as they have all widely reported in the literature. However, what is concerning is that these issues still exist despite their known existence.

There were many occasions in this study where patients were on low levels of oxygen, the oxygen was reduced, the mode of delivery was changed to give even lower concentrations, was not commenced or was removed in patients with clinical signs of hypoxia. Removing a patient's oxygen to assess how they manage without it is unnecessary and potentially harmful. This occurs as routine practice in some clinical areas and should be discontinued. This is not unlike removing a patient's oxygen to measure their arterial blood gas, which is dangerous and completely unnecessary. The oxygen should be titrated to the patients SpO₂ and overall respiratory function. Oxygen is a drug and therefore must be prescribed by the doctor. This should include the flow rate, the method of delivery and duration. Doctors often prescribe oxygen to achieve specific SpO₂ levels or a range of flow rates (i.e. 2 - 4 litres) and so leave this to the clinical judgement of the nurses. However, in this study nurses had a tendency to use the least amount of oxygen possible. Therefore, nurses need to be educated about oxygen therapy, how much to use, appropriate methods of delivery and evaluating the efficacy, as should occur with the administration of any drug.

The documentation showed that the medical staff had not been made aware of over half of the patients with abnormal physiology and there were frequent delays in informing the doctor of the abnormality. This would indicate that nurses either did not recognise the abnormality, did not appreciate the significance of the abnormality or they tried to manage it on their own. It is imperative that nurses communicate their clinical findings and involve the medical staff early so that the further deterioration can be prevented. It may be that the junior doctor is not experienced enough to manage such a complex patient on their own, which is why they have access to senior medical staff for advice and support. However, this cannot occur if they are not aware of the patient's condition in the first instance.

This study identified that some of the patients were admitted to areas that were inappropriate for their medical condition, with none of these patients surviving. It is acknowledged that outliers are at an increased risk of having a cardiac arrest and consequently increased mortality. This often occurs as the result of a lack of ICU or high dependency beds and inadequate staffing levels. As such patients who require critical care

beds are often nursed on the general wards. This results in complex patients, with serious medical problems being cared for by nurses who may not have the knowledge and skills to adequately manage them. This study also found that almost all of the patients who had a cardiac arrest out of office hours did not survive. It is essential that the same level of support and expertise is available 24 hours a day so as not to compromise the level of care provided or patient safety. These are organisational issues that require strategic planning and appropriate allocation of resources.

Recommendations for organisations

To reduce the incidence of adverse events and improve patient safety it is recommended that patients are admitted to areas suitable for their admitting diagnosis, level of acuity and are cared for by staff with the appropriate skills and knowledge. This has implications for bed management, critical care resources, staffing levels and education. The NICE (2007) guidelines should be implemented which includes the type and frequency of vital signs to be measured with a monitoring plan for each patient, an EWS system with a graded response strategy and education aimed at the early recognition and management of the deteriorating patient. Other strategies such as patient/family/visitor initiated MET calls should be included to widen the safety net. Observation charts should be standardised and based upon the premise of the ADDS chart to assist with the recognition of abnormal physiology. This co-ordinated approach may facilitate more timely admissions to ICU, leading to a reduced length of stay in ICU, a decreased number of admissions to ICU and reduced length of stay in hospital. Regular case reviews should be performed following all adverse events to establish causal factors and identify solutions to prevent the reoccurrence. Regular audits of documentation generally should also be performed to ascertain compliance with organisational policies and targeted education introduced where standards of documentation are problematic.

Recommendations for nursing practice

Management of the deteriorating patient is reliant upon the early recognition of abnormal physiology. For this to occur, nurses need to measure and record patient vital signs regularly and comprehensively, so that abnormalities and trends can be detected. If these are not documented patient deterioration will be missed, treatment cannot be initiated and patients will continue to die. These observations should be recorded in accordance with organisational policies or as outlined in the NICE (2007) guidelines. Nurses need to

recognise abnormal signs and symptoms, intervene accordingly and communicate their findings if patient outcomes are to be improved. In particular it is crucial that nurses appreciate the significance of an altered LOC and the value this has in determining the health status of the patient. The use of communication tools may assist with conveying patient information during nursing handovers and when conversing with medical staff. Such tools are also beneficial in articulating the seriousness of the situation and the response required. Nurses need to learn about oxygen therapy and have a good understanding of the underlying principles. Knowledge of the various methods of delivery is essential if patients are to receive adequate oxygenation.

Recommendations for future research

There are several key areas that require further investigation. These include identifying nurses' knowledge and understanding of an altered LOC, nurses' attitudes regarding taking patient vital signs, their understanding of the importance of regularly recording these and the barriers associated with measuring them. Finally there is a need for more research to understand the factors that influence nurse's decision making when abnormal physiological observations are observed.

Summary

This study demonstrated that best practice did not occur. Vital signs were poorly documented, resulting in deterioration going unnoticed and abnormal physiology was not responded to appropriately. Barriers to these issues must be addressed and solutions sought if patient mortality is to be improved. A patient who dies because their vital signs were not recorded or because a nurse did not respond to their abnormal physiology is unacceptable. Nurses need to improve upon these practices as there is no excuse for not recording patient vital signs or responding to patient deterioration. All hospitals in NZ need to review current practice to ensure that the quality of care and patient safety is maintained.

Appendices

Appendix 1. Ethical approval from Regional Ethics Committee

27 June 2008

Ms Tara Marie Ryton

Dear Tara

CEN/08/22/EXP
Abnormal Physiological observations and Nursing Interventions in the Pre-Arrest Patient: A descriptive Study.

Thank you for your letter received in this office on 6 June 2008 with enclosed documents for the above study. The **Chairperson** of the Central Regional Ethics Committee has considered this information and concluded that this study falls within the definition of audit under paragraph 11.9, page 23 of the *Ethical Guidelines for Observational Studies: Observational Research, Audits and Related Activities*, NEAC, December 2006, and because of this no ethics committee review is required.

Yours sincerely

Jiska van Bruggen
Central Regional Ethics Committee Administrator

Appendix 2. Ethical approval from Victoria University ethics committee

Phone 0-4-463 5676
Fax 0-4-463 5209
Email Allison.kirkman@vuw.ac.nz

MEMORANDUM

TO	Tara Ryton
COPY TO	Dr Katherine Nelson, Supervisor
FROM	Dr Allison Kirkman, Convener, Human Ethics Committee
DATE	October 20, 2008
PAGES	1
SUBJECT	Ethics Approval: No 16065, Physiological observations and nursing interventions in the pre-arrest patient: a descriptive study.

Thank you for your application for ethical approval, which has now been considered by the Standing Committee of the Human Ethics Committee.

Your application has been approved from the above date and this approval continues until 30 June 2009. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Allison Kirkman
Convener

Appendix 3: Patient vignettes

Patient 3 complained of dyspnoea eight hours before the cardiac arrest. The nurse responded to this by administering a medication. No vital signs were documented at this time or for a further three hours, despite the nurse documenting in the medical records that the patient was 'short of breath at times' throughout the shift. The patient's RR was 32, five hours before the cardiac arrest, however there was no documented action to correct this. Despite the abnormal RR there were no further vital signs recorded for over three hours. When these were documented the patient's SpO₂ was recorded as 91% on room air. Despite the low SpO₂ the RR was not recorded and oxygen was not commenced. There were no further recorded vital signs. The patient became breathless after walking to the toilet and collapsed.

Patient 9 had abnormal vital signs for 12 hours before having a cardiac arrest. These were a high diastolic pressure, which was attributed to the patient being anxious and a SpO₂ of 82% on three litres of oxygen. The nurse reported that the patient's SpO₂ had previously been "like that" and that the doctor was aware. The same nurse recorded the vital signs four hours later and the SpO₂ was 86%. The RR was not recorded on either occasion. There was no increase in oxygen. The nurse on the following shift documented that the patient was anxious and short of breath at the start of the shift. Morphine was given for anxiety. The nurse reassured the patient and was encouraged to deep breath. The SpO₂ was recorded at 84% on two litres of oxygen. There were no further vital signs recorded and the oxygen was not increased. Two hours pre-arrest it was documented that the patient was breathing rapidly, although the rate was not documented. A patient in the next bed rang the emergency bell when the patient had a cardiac arrest. The nurse was contacting the doctor at this time.

A nurse documented that patient 14's vital signs were stable, however there were no vital signs recorded on the observation chart for the entire shift. The nurse on the following shift documented vital signs three and a half hours into the shift. It was noted that the SpO₂ was 88% when trialled on room air. The vital signs were recorded quarter hourly during administration of an intravenous drug, for 75 minutes. However, there were no further vital signs recorded for six hours prior to cardiac arrest. The patient complained of feeling nauseous and the nurse responded to this by giving an anti-emetic. The patient was observed 20 minutes before being found in a state of cardiac arrest.

Patient 16 had vital signs recorded on admission, however these were written in the medical records rather than on the observation chart. It was documented that the patient was able to mobilise independently to the bathroom, but had to be taken back to bed by chair as they were too short of breath to walk. There is no evidence of any intervention to address this and no further vital signs were recorded by the nurse for the remainder of the shift. The patient had two sets of vital signs recorded on the following shift. It was documented that the patient was short of breath and the bed was elevated. There was no RR recorded throughout this shift. The nurse on the following shift recorded the patient's vital signs, however this did not include a RR. All of the recorded vital signs were within normal ranges. Three hours later it was documented that the patient was short of breath. The SpO₂ was recorded as 80% and the nurse increased the oxygen from two to three litres to correct this. The patient requested a face mask for oxygen delivery rather than nasal prongs. No other vital signs were recorded and it is not clear whether the medical staff were informed of this deterioration. The patient was found in a state of cardiac arrest one hour later.

Appendix 4: Data extracted from patients notes

Patient Number	
Gender	Male
	Female
Age	
Ethnicity	NZ European
	Maori
	Pacific Island
	Asian
	Other
Length of stay in hospital	
No. of previous hospital admissions	
Survival	
Primary diagnosis	Cancer
	Renal
	Respiratory
	Cardiac
	Gastrointestinal
	Sepsis
	Neurological
	Vascular

Coronary artery disease	
Left ventricular failure	
Diabetes	
Previous stroke	
Obesity	
Pulmonary disease	
Impaired renal function	
Arrhythmias	
Hypertension	
Angina	
Peripheral vascular disease	
Dyslipidaemia	
Total No. of co-morbidities	
Time of cardiac arrest	
Location of cardiac arrest	Medical
	Surgical
	CCU
	Interventional radiology
	Other
Initial cardiac arrest rhythm	VF
	VT
	PEA
	Asystole
	Other
Return of spontaneous circulation	

Recorded systolic blood pressure		Recorded SpO2	
12 hours pre-arrest		12 hours pre-arrest	
11 hours pre-arrest		11 hours pre-arrest	
10 hours pre-arrest		10 hours pre-arrest	
9 hours pre-arrest		9 hours pre-arrest	
8 hours pre-arrest		8 hours pre-arrest	
7 hours pre-arrest		7 hours pre-arrest	
6 hours pre-arrest		6 hours pre-arrest	
5 hours pre-arrest		5 hours pre-arrest	
4 hours pre-arrest		4 hours pre-arrest	
3 hours pre-arrest		3 hours pre-arrest	
2 hours pre-arrest		2 hours pre-arrest	
1 hour pre-arrest		1 hour pre-arrest	
30 minutes pre-arrest		30 minutes pre-arrest	

Recorded heart rate		Recorded GCS	
12 hours pre-arrest		12 hours pre-arrest	
11 hours pre-arrest		11 hours pre-arrest	
10 hours pre-arrest		10 hours pre-arrest	
9 hours pre-arrest		9 hours pre-arrest	
8 hours pre-arrest		8 hours pre-arrest	
7 hours pre-arrest		7 hours pre-arrest	
6 hours pre-arrest		6 hours pre-arrest	
5 hours pre-arrest		5 hours pre-arrest	
4 hours pre-arrest		4 hours pre-arrest	
3 hours pre-arrest		3 hours pre-arrest	
2 hours pre-arrest		2 hours pre-arrest	
1 hour pre-arrest		1 hour pre-arrest	
30 minutes pre-arrest		30 minutes pre-arrest	

Recorded respiratory rate		Recorded AVPU	
12 hours pre-arrest		12 hours pre-arrest	
11 hours pre-arrest		11 hours pre-arrest	
10 hours pre-arrest		10 hours pre-arrest	
9 hours pre-arrest		9 hours pre-arrest	
8 hours pre-arrest		8 hours pre-arrest	
7 hours pre-arrest		7 hours pre-arrest	
6 hours pre-arrest		6 hours pre-arrest	
5 hours pre-arrest		5 hours pre-arrest	
4 hours pre-arrest		4 hours pre-arrest	
3 hours pre-arrest		3 hours pre-arrest	
2 hours pre-arrest		2 hours pre-arrest	
1 hour pre-arrest		1 hour pre-arrest	
30 minutes pre-arrest		30 minutes pre-arrest	

Abnormal vital sign at 12 hours pre arrest	
11 hours pre-arrest	
10 hours pre-arrest	
9 hours pre-arrest	
8 hours pre-arrest	
7 hours pre-arrest	
6 hours pre-arrest	
5 hours pre-arrest	
4 hours pre-arrest	
3 hours pre-arrest	
2 hours pre-arrest	
1 hour pre-arrest	
30 minutes pre-arrest	

If abnormal vital sign what was recording	
Was there a nursing response	
If yes what was response/intervention	
Was there an abnormal sign or symptom recorded within 12 hours of cardiac arrest	
If yes what was abnormal sign or symptom	
Which system was affected	Neurological Cardiovascular Respiratory
Was there a nursing response	
If yes what was response/intervention	

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