To convey, or not convey …?
The effect and usefulness of the National Early Warning Score to support paramedics' decisions to convey patients to hospital or treat closer to home.

Nadya Stephanie Essam

A thesis submitted in partial fulfilment of the requirements of the
University of Lincoln for the degree of Doctor of Philosophy

This research programme was carried out in collaboration with
an English ambulance NHS Trust

June 2019

Abstract

Background: The ambulance service studied introduced the National Early Warning Score (NEWS) to help paramedics decide whether patients could be appropriately treated closer to home, via an alternative non-emergency care pathway, or needed conveying to hospital. I investigated the effectiveness and usefulness of the NEWS to support paramedics' decisions to appropriately treat patients closer to home.

Methods: I adopted a pragmatic approach and used mixed methods.

I used an interrupted time-series design and autoregressive integrated moving average (ARIMA) methods to analyse ambulance data. My analysis focused on the change in outcome and trend in outcome, before and after NEWS was introduced. Primary outcomes measured were numbers and proportions of patients not conveyed to the emergency department (i.e. treated closer to home), which included those treated and left at scene and those conveyed to a minor injury unit or similar. Secondary outcomes measured were numbers and proportions treated and left at scene who recontacted the ambulance service within 24-hours. Numbers of 999-calls attended, patients treated and left at scene and life-threatening calls were also analysed to provide a baseline measure and enhance understanding about primary and secondary outcomes.

A self-selected sample of paramedics participated in semi-structured interviews and a non-participant observation study. Semi-structured interviews were conducted to gain insight of perceived effectiveness and usefulness of the NEWS to support decision-making. Non-participant observations were conducted to observe how the NEWS was used in context.

Results: Baseline measures showed no significant difference in the numbers of emergency calls attended to by ambulance, although numbers of life-threatening calls increased significantly. Despite the increase in life-threatening calls, the numbers and proportion of patients being treated closer to home remained constant. While a significant decline was found in the numbers of patients left at scene, the numbers and

proportions of patients who recontacted within 24-hours did not differ significantly.

Sixteen paramedics were interviewed. Those interviewed did not perceive the NEWS to have affected their decision-making or clinical practice. Other factors influenced their decision to convey or treat closer to home more than NEWS. They would use the NEWS to inform a decision only at times of uncertainty. NEWS was considered ineffective and not useful when assessing patients with complex conditions. NEWS was more readily adopted in localities where other healthcare providers were familiar and were using the NEWS.

Eight paramedics were observed as they worked in the clinical setting. Those observed rarely calculated, documented or verbalised a NEWS. Half the NEWS documented, were calculated or documented incorrectly. There was no visible evidence of the NEWS tool being used; any scores documented were calculated from memory.

Conclusions: The effectiveness and usefulness of the NEWS to support paramedics' decision-making to appropriately treat patients closer to home was compromised by a lack of coherence between service providers and practitioners, and lack of accessibility to alternative care pathways. My findings will be of value to service providers seeking to achieve NHS England's ambition to increase the uptake of the NEWS to 100%, and those responsible for redesigning and commissioning integrated care services.

Acknowledgements

Summary contents

List of Contents

List of Tables

List of Figures

List of Appendices

Glossary

Ambulance and associated abbreviations, acronyms and key terminology

A&E   **Accident and Emergency** - Hospital department specialising in acute care and emergency medicine, directly accessible to the public without an appointment 24-hours a day, 7-days a week. Sometimes referred to as ED.

AMB-X   A regional NHS English ambulance service commissioned to deliver urgent and emergency prehospital care and patient transport; anonymised for the purpose of this study.

AMPDS   **Ambulance Medical Priority Dispatch System** - An electronic triage system used by ambulance services that prioritises emergency 999-calls.

AQI   **Ambulance Quality Indicator** - A NHS England-led performance management system which measures aspects of ambulance operational service delivery and specified clinical standards of care across England.

CAT   **Clinical Assessment Team** - A team consisting of paramedics and nurses who assess and offer clinical advice to patients and ambulance clinicians over the telephone.

Category A call   An emergency 999-call that has been prioritised as being either immediately life-threatening (Red1) or life-threatening (Red 2).

CCG   **Clinical Commissioning Group** - GP-led groups responsible for planning and commissioning local health care services.

CTLs   **Clinical Team Leads** - Paramedics who mentor and provide clinical support to staff at the point of care delivery. They perform clinical audits, conduct staff personal development reviews and investigate complaints and untoward incidents.

COPD   **Chronic Obstructive Pulmonary Disease** - A collective term to describe progressive lung diseases such as chronic bronchitis, emphysema and refractory (non-reversible) asthma.

DCA   **Double Crewed Ambulance** - An ambulance vehicle able to convey patients that is staffed by two ambulance care personnel.

ECA   **Emergency Care Assistant** - An ambulance care assistant trained to provide basic first aid and life support.

ED   **Emergency Department** - Hospital department specialising in acute care and emergency medicine, directly accessible to the public without an appointment 24-hours a day, 7-days a week. Sometimes referred to as A&E.

Ambulance and associated abbreviations, acronyms and key terminology

ECP   **<u>Emergency Care Practitioner</u>** - A higher trained and qualified paramedic with advanced clinical skills and able to provide advanced life-support.

EMT   **<u>Emergency Medical Technician</u>** - A medical healthcare provider who is more highly trained than an Emergency Care Assistant and able to provide emergency care, medical aid and basic life support, but not trained to intubate patients in cardiac arrest or able to administer the same range of drugs as a paramedic.

EWS   **<u>Early Warning Score</u>** - A physiological track-and-trigger scoring system used to support the timelier detection and response to clinical deterioration.

FRV   **<u>Fast Response Vehicle</u>** - A paramedic working alone who attends to an emergency call in a car or on a motorbike in advance of the double crewed ambulance.

GP   **<u>General Practitioner</u>** - A medical doctor who provides primary care at a community-based medical practice, urgent care centre, minor injury unit or Walk-in Centre.

Green 1 call   A serious but not life-threatening 999-call. Ambulance response to arrive on-scene within 20-minutes of call.

Green 2 call   A less serious and non-life-threatening 999-call. Ambulance response to arrive on-scene within 30-minutes of call.

Green 3 call   A non-emergency 999-call to be assessed by a clinician over the telephone and resolved by providing advice where possible within 20-minutes of call.

Green 4 call   A non-emergency 999-call to be assessed by a clinician over the telephone and resolved by providing advice where possible within 60-minutes of call.

Hear & Treat   A 999-call that has been assessed and resolved over the telephone.

HCP   **<u>Health Care Practitioner</u>** - A medically trained individual responsible for the delivery of health care.

HCPC   **<u>Health and Care Professions Council</u>** - The regulatory and registration body for health, psychological and social work professionals.

IHCD   **<u>Institute of Health Care Development</u>** - Institute providing recognised clinical training and qualifications for Emergency Medical Technicians and paramedics in the UK.

Ambulance and associated abbreviations, acronyms and key terminology

IMD **Index of Multiple Deprivation** - A UK comparative measure of deprivation includes income, employment, health and disability, education, housing and environment and crime.

MAU **Medical Assessment Unit** - A short-stay hospital ward often linked to the emergency department where patients can be admitted for further observation and assessment.

MIU **Minor Injury Unit** - A GP-led facility that provides medical treatment to those with urgent but not life-threatening clinical complaints or injuries.

MTS **Manchester Triage System** - A triage systems that prioritises patients' clinical need based on the signs and symptoms observed.

MEWS **Modified Early Warning Score** - A modified version of the original Early Warning Score (see EWS above) which is a physiological track-and-trigger scoring system used to support the timelier detection and response to clinical deterioration.

NEWS **National Early Warning Score** - A physiological track-and-trigger scoring system used to support the timelier detection and response to clinical deterioration; developed and recommended to be used NHS-wide by the Royal College of Physicians.

NHS **National Health Service** - Public funded healthcare system for the United Kingdom.

NHS 111 An urgent medical healthcare service provider able to deliver medical advice over the telephone or refer patients to receive face-to-face clinical care from GP, dentist, nurse or ambulance.

NHS England Public body responsible for the commissioning and delivery of health services in England.

Paramedic A medical healthcare provider who is more highly trained than an Emergency Medical Technician and able to provide emergency care, medical aid and advanced life support.

Paramedic Pathfinder A triage system based on the Manchester Triage System that includes an early warning score. The system enables paramedics to make accurate face-to-face clinical assessment and identify the appropriate care pathway for the patient.

PHEWS **Prehospital Early Warning Score** - A modified physiological track-and-trigger scoring system. Developed to support the assessment of patients in the prehospital emergency care setting and detect those at increased clinical risk.

Ambulance and associated abbreviations, acronyms and key terminology

PMEWS   **Physiological-social Modified Early Warning Score** - A modified physiological track-and-trigger scoring system that includes social factors (e.g. lives alone/social isolation). Developed to support the assessment of patients in the prehospital emergency care setting and detect those at increased clinical risk.

RCP   **Royal College of Physicians** - Professional body of medically qualified doctors who are dedicated to improving the practice of medicine. The RCP developed and recommended the NEWS to be used NHS-wide in the UK.

Red 1 call   Emergency 999-call prioritised as immediately life-threatening. Initial ambulance response to arrive on-scene within 8-minutes of call, and a double-crewed ambulance able to convey patient to hospital to arrive within 19-minutes of emergency call.

Red 2 call   Emergency 999-call prioritised as immediately life-threatening. Initial ambulance response to arrive on-scene within 8-minutes of call, and a double-crewed ambulance able to convey patient to hospital to arrive within 19-minutes of emergency call.

SAS Tool   **Scottish Ambulance Sepsis Tool** - A tool to support the identification of sepsis and appropriate clinical management of patients presenting with acute infection.

SBAR   **Situation Background Assessment Recommendation** - A communication support tool designed to convey patient information succinctly.

See & Treat   A 999-call that has been attended to face-to-face by an ambulance clinician.

SST   **Sepsis Screening Tool** - A tool supporting the identification of sepsis and appropriate clinical management of patients presenting with acute infection.

UCC   **Urgent Care Centre** - A GP-led facility that provides medical treatment to those with urgent but not life-threatening clinical complaints or injuries.

UTI   **Urinary Tract Infection** - common infection of the bladder, kidneys and connecting tubes.

WiC   **Walk-in Centre** - A GP-led facility that provides medical treatment to those with urgent but not life-threatening clinical complaints or injuries.

ViEWS   **VitalPAC Early Warning Score** - An electronic web-based and mobile computerised application of the National Early Warning Score system.

1 Introduction

1.1 The beginning of the ambulance service and triage systems

The very first ambulance was a rudimentary, horse-drawn two-wheeled wagon, with two stretchers but no room for treatment in the rear (Nestor, 2014). Introduced during the French revolution by Baron Dominique Jean Larrey (1766-1842), the ambulance was developed to evacuate soldiers to a place of safety where treatment could be delivered (Nestor, 2014). Larrey also introduced a systematic means of sorting patients known as triage (Robertson-Steel, 2006, Nestor, 2014). Triage requires patients to be assessed and sorted quickly, with those most critically injured being given treatment first (Nestor, 2014). Both systems, ambulance and triage, were quality improvement initiatives introduced to expedite patient care and improve patients' chances of survival (Nestor, 2014). Whilst the original systems may have been modernised, the aims are still upheld by urgent and emergency care service providers today.

1.1.1 Changing patient needs

There are many triage systems still in use. Most were initially designed and validated to support the assessment of patients who had suffered traumatic injuries; general tools such as the Trauma Score (Champion et al., 1981) and Revised Trauma Score (Champion et al., 1989), and injury specific tools like the Ottawa ankle rule (Stiell et al., 1994). There has however been a marked decrease in trauma related incidents being attended to by ambulance services (Department of Health, 2009, Munjal et al., 2011). The decrease in traumatic injuries has been the result of an improved health and safety culture, precipitated by legislation stipulating expected standards of safety that have led to the improved ergonomic designs of equipment, tools and working practices. Whilst the numbers of trauma related incidents has decreased across the United Kingdom (UK), there remains a year-on-year increase of approximately 6% per annum in emergency 999-calls being received by ambulance services (Department of Health, 2009). Rather than traumatic injuries, the increase is due to medical complaints such as breathing difficulties, loss of consciousness and chest pains, many of which are associated with the increase in life expectancy and changing lifestyles of the UK

population (Department of Health, 2009). The change in patients' clinical needs has led to the development and integration of medically-based triage systems, such as the Early Warning Score (Morgan et al., 1997).

1.2 The development and evolution of the Early Warning Score

1.2.1 The Early Warning Score

The Early Warning Score (EWS) was designed to be used in the hospital setting to support the identification of clinical deterioration of patients who were developing critical illness (Morgan et al., 1997). Nurses who had been trained to use the tool were found to have made more timely and more appropriate decisions to refer patients to a higher level of care (Morgan et al., 1997). Like many trauma triage tools, the EWS includes assessments of patients' vital signs, including respiratory rate, heart rate, systolic blood pressure and level of consciousness. The key difference between the EWS and trauma-based triage systems is that the EWS also includes the assessment of temperature. The assessment of patients' temperature is important because it supports the identification of those medically unwell, who may be deteriorating from infectious or inflammatory illnesses (Morgan et al., 1997), where fever is a particular feature.

Each physiological measure assessed is attributed an individual parameter score ranging from zero to three (Figure 1.1, p.25). A score of zero would signify the patient's physiological measure is within the normal range. A score of one, two or three denotes the extent to which the physiological measure is deviating from normal. A score of three suggests the measure is seriously abnormal. The score attributed is determined by identifying where the physiological measure lies within the depicted range. For example, in Figure 1.1 (p.25) a respiratory rate of 16 breaths per minute would be attributed an individual parameter score of one, and a heart rate of 92 beats per minute would be attributed a parameter score of zero. The individual parameter scores are then aggregated to provide a total EWS.

Figure 1.1: An image of the early warning score developed by Morgan et al. (1997)

SCORE	3	2	1	0	1	2	3
HR		<40	41-50	51-100	101-110	111-130	130
BP	<70	71-80	81-100	101-199		>200	
RR		<8		9-14	15-20	21-29	>30
TEMP		<35	35.1-36.5	36.6-37.4	>37.5		
CNS				A	V	P	U

The assessment process is repeated at predetermined time intervals. The time intervals are determined by the well-being of the patient; i.e. those more seriously unwell and at increased critical risk will be assessed more frequently. The EWS obtained from each assessment is compared and tracked over time to assess whether there is an improvement or decline in the patient's condition. Aggregated scores are also assigned specified actions, so for example Morgan et al. (1997) established an aggregated score of three as the trigger threshold for referral to the high dependency care team.

Since its introduction, the EWS has been modified and evaluated for use on adult and paediatric patients worldwide. Its utility has been assessed in a variety of settings, including the emergency department (ED), medical assessment unit (MAU) and hospital ward (Subbe et al., 2001, Gardner-Thorpe et al., 2006, Green and Williams, 2006, Egdell et al., 2008, Griffiths and Kidney, 2012, Jo et al., 2013, Junhasavasdikul et al., 2013, Bradman et al., 2014, Ennis, 2014, Fuijkschot et al., 2015). Modifications to the tool included changing the ranges of the physiological measures included and evaluating the efficiencies of different trigger thresholds for action. Tools were also modified to include and exclude different physiological measures. For instance, some tools include the measurement of patients' urine output (e.g. Stenhouse et al., 2000) and/or the assessment of oxygen saturation levels (e.g. Goldhill, 2005), whilst others excluded temperature (e.g. the PREAMBLE tool evaluated by Carmichael et al., 2011). The exclusion of temperature would however undermine the principle of the EWS

system, as this physiological measure is what medically distinguishes an EWS from a trauma score.

In 2007, the National Institute for Health and Care Excellence (NICE) made recommendations for England, that to improve the recognition and response to acute illness, the physiological measures assessed by a clinician should include heart rate, respiratory rate, systolic blood pressure, level of consciousness, oxygen saturation and temperature. NICE (2007) also recommended that these measures should be linked to an EWS track-and-trigger system, but they did not stipulate which EWS tool should be used. At the time, there was considerable variability in the clinical utility and predictive accuracy of the different EWS systems in circulation, which compromised both consistency of care delivery and patient outcomes. This problem was acknowledged by a collaborative of senior physicians, and between 2006 and 2012, the National Early Warning Score Development and Implementation Group (NEWSDIG) researched and refined one EWS system to achieve an optimum tool (Prytherch et al., 2006, Smith et al., 2006, Smith et al., 2008a, Smith et al., 2008b, Mohammed et al., 2009, Prytherch et al., 2010). Their EWS system was found to be better at identifying patients at risk of clinical deterioration and/or mortality than all other track-and-trigger systems previously evaluated (Smith et al., 2013).[1] The National Early Warning Score (NEWS) was subsequently launched in 2012 by the Royal College of Physicians (RCP).

The NEWS includes all six physiological measures recommended by NICE (2007), plus a weighted parameter for the administration of supplemental oxygen (Figure 1.2, p.27 and Figure 1.3, p.28).

---

[1] The area under the receiver operator characteristic curve (AUROC) for the NEWS being able to discriminate cardiac arrest, unanticipated admission to intensive care unit (ICU) or death was 0.873, 95% confidence interval (CI) = 0.866-0.879 compared to next best performing EWS system proposed by Paterson et al., (2006) AUROC = 0.834, 95% CI 0.826-0842 and the original EWS developed by Morgan et al., (1997) AUROC = 0.820, 95% CI 0.812-0.829.

Figure 1.2: The National Early Warning Score Tool (Royal College of Physicians, 2012, p.14)

Figure 1.3: The National Early Warning Score Thresholds & Triggers (Royal College of Physicians, 2012, p.15)

The National Early Warning Score (NEWS) thresholds and triggers

NEW scores	Clinical risk
0	
Aggregate 1 – 4	Low
RED score* **(Individual parameter scoring 3)** **Aggregate 5 – 6**	Medium
Aggregate 7 or more	High

The NEWS trigger system aligned to the scale of clinical risk
***RED score** refers to an extreme variation in a single physiological parameter (i.e., a score of 3 on the NEWS chart, coloured RED to aid identification and represents an extreme variation in a single physiological parameter). The consensus of the NEWS Development and Implementation Group (NEWSDIG) was that extreme values in one physiological parameter (e.g., heart rate ≤40 beats per minute, or a respiratory rate of ≤8 per minute or a temperature of ≤35°C) could not be ignored and on its own required urgent clinical evaluation

Please see next page for explanatory text about this chart.

Royal College of Physicians

NHS
Training for Innovation

The same evaluation process applies, where a parameter score is allocated to each physiological measure. These are then aggregated to provide a total NEWS. A NEWS totalling four or less indicates a low clinical risk. A score of five or six, or any individual parameter scoring three (i.e. a red score) is deemed to be a medium risk. A score of seven and above indicates the patient is at high clinical risk. They should be promptly assessed by medical staff with critical care expertise and if appropriate, transferred to a unit with the ability to deliver high dependency care.

1.2.2 The NEWS in the prehospital setting

The Royal College of Physicians (2012) recommended the NEWS should replace all other EWS systems in use, and it should be used in hospital, prehospital and community care settings, to standardise the assessment of acutely ill patients.

> *'The NEWS should be used in the prehospital assessment of acutely ill patients by 'first responders', e.g. ambulance services, primary care and community hospitals, to identify and improve the assessment of acute illness, triage and the communication of acute-illness severity to receiving hospitals.' (Royal College of Physicians, 2017, p.xvii)*

It was argued, utilisation of EWS systems, like the NEWS, in the prehospital setting, could support the earlier identification of patients at increased risk of mortality from sepsis (Robson and Daniels, 2011). Sepsis is a life-threatening illness that can affect anyone, young and old. It is responsible for approximately 37,000 deaths in the UK each year, and is caused by the body's overreaction to what could originally have been a minor injury or medical infection, such as a urinary tract (UTI) or a chest infection (NHS England, 2015). The risk of mortality has been reported to increase by 7.6% for each hour antibiotics are delayed (Kumar et al., 2006). Ambulance paramedics have a critical role to play in supporting the earlier identification and treatment of those at risk, as they can raise the alert prior to their arrival at ED with any patient suspected as having sepsis (NHS England, 2015). By raising the alert, they could significantly reduce 'door to needle' time for the administration of antibiotics at ED (NHS England, 2015, Carberry and Harden, 2016). EWS systems may also mitigate the risk of over-

triaging, thereby supporting paramedics to alert ED only when it is appropriate (Brown and Bleetman, 2006, Challen and Walter, 2010, Fullerton et al., 2012).

1.3   Transformation of urgent and emergency care

The NEWS and similar systems began to be introduced in ambulance services in 2013/13. This was in response to the National Health Services' (NHS) drive to transform healthcare delivery across the UK. The majority of healthcare delivered in the UK is free at the point of delivery, with 98.8% being funded directly from taxation and National Insurance contributions (The King's Fund, 2017). Responsibility is divided between four public bodies which includes NHS England, NHS Scotland, NHS Wales and Health and Social Care in Northern Ireland. NHS England is responsible for leading, commissioning and setting the priorities for NHS provisions in England.

Urgent and emergency care delivery models in England needed to be transformed because of the increasing demands on hospital resources, and the changing needs of patients (NHS England, 2013b). All NHS providers, including ambulance services, were being encouraged to consider how they could redesign existing community, primary, prehospital and acute care services to provide an integrated service model (NHS England, 2014). Their aim was to safely avoid hospital admissions and support patient care being delivered closer to home (NHS England, 2013b).

1.3.1   Systematic review of existing evidence

Research conducted previously had suggested EWS systems could provide paramedics with the confidence to use alternative 'non-emergency' care pathways (Challen and Walter, 2010, Gray et al., 2010, Ebrahimian et al., 2012), although at this time, little was known of their practical utility in this context. I therefore undertook a systematic literature review to gain greater insight into the effectiveness and usefulness of EWS systems when used by paramedics. I present my search strategy and discuss my findings in detail in Chapter 2. To summarise, I found there was a paucity of evidence providing insight into the utility and effect of EWS in prehospital settings, and the evidence that existed was of questionable quality.

Despite the limited evidence, the English NHS ambulance service which I studied, henceforth referred to as AMB-X (for the purpose on anonymity), began implementing the NEWS in 2014, as part of their Paramedic Pathfinder Programme. AMB-X introduced the NEWS at that time to support the effective treatment and management of patients in the community setting, and reduce the numbers of patients being conveyed to ED. Since then, NHS England has set up a cross-system working group to standardise the implementation and increase the uptake of the NEWS to 100% by March 2019, in acute health and ambulance care settings (Ingham Clark, 2018, NHS England, 2018, NHS Improvement, 2018).

1.3.2 Paramedic Pathfinder and the NEWS

In addition to the NEWS, the Paramedic Pathfinder Programme at AMB-X included the introduction of two 'Paramedic Pathfinder' triage tools, one medical and one trauma-based (Figure 1.4, p.32 and Figure 1.5, p.33). Created by Mark Newton, a consultant paramedic employed by North West Ambulance Service NHS Trust, and Dr David Ratcliffe, a general practitioner (GP), the tools were developed to support prehospital triage and clinical decision-making by ambulance clinicians (Newton et al., 2013).

The Paramedic Pathfinder tools are based on the Manchester Triage System, or MTS (Mackway-Jones et al., 2013), which uses the signs and symptoms assessed by paramedics as 'discriminators'. The discriminators differentiate whether the patient should be conveyed to ED, or whether the patient could be treated closer to home, via an alternative care pathway; e.g. the patients' own GP, or at the local GP-led Urgent Care Centre (UCC), Walk-in Centre (WiC), minor injury unit (MIU), or referral to another allied health or social care practitioner (HCP).

The Pathfinder tools, introduced at AMB-X, included the NEWS as part of the inclusion/exclusion criteria for the application of the Paramedic Pathfinder tool (i.e., as illustrated in Figure 1.4, p.32 and Figure 1.5, p.33). It was decided that any patients presenting with a NEWS greater than four, or a single parameter score of three, are excluded from Paramedic Pathfinder and should be transported to ED, whereas patients with low clinical risk scores (i.e. a score of four or less) may be more

appropriately treated closer to home (Mills et al., 2014, AMB-X NHS Trust, 2015a). Table 1.1, p.34, provides a comparison of the key characteristics of both initiatives - the text highlighted in yellow illustrates where the thwo initiatives overlap.

Figure 1.4: AMB-X's (2014a) Paramedic Pathfinder – Medical Tool
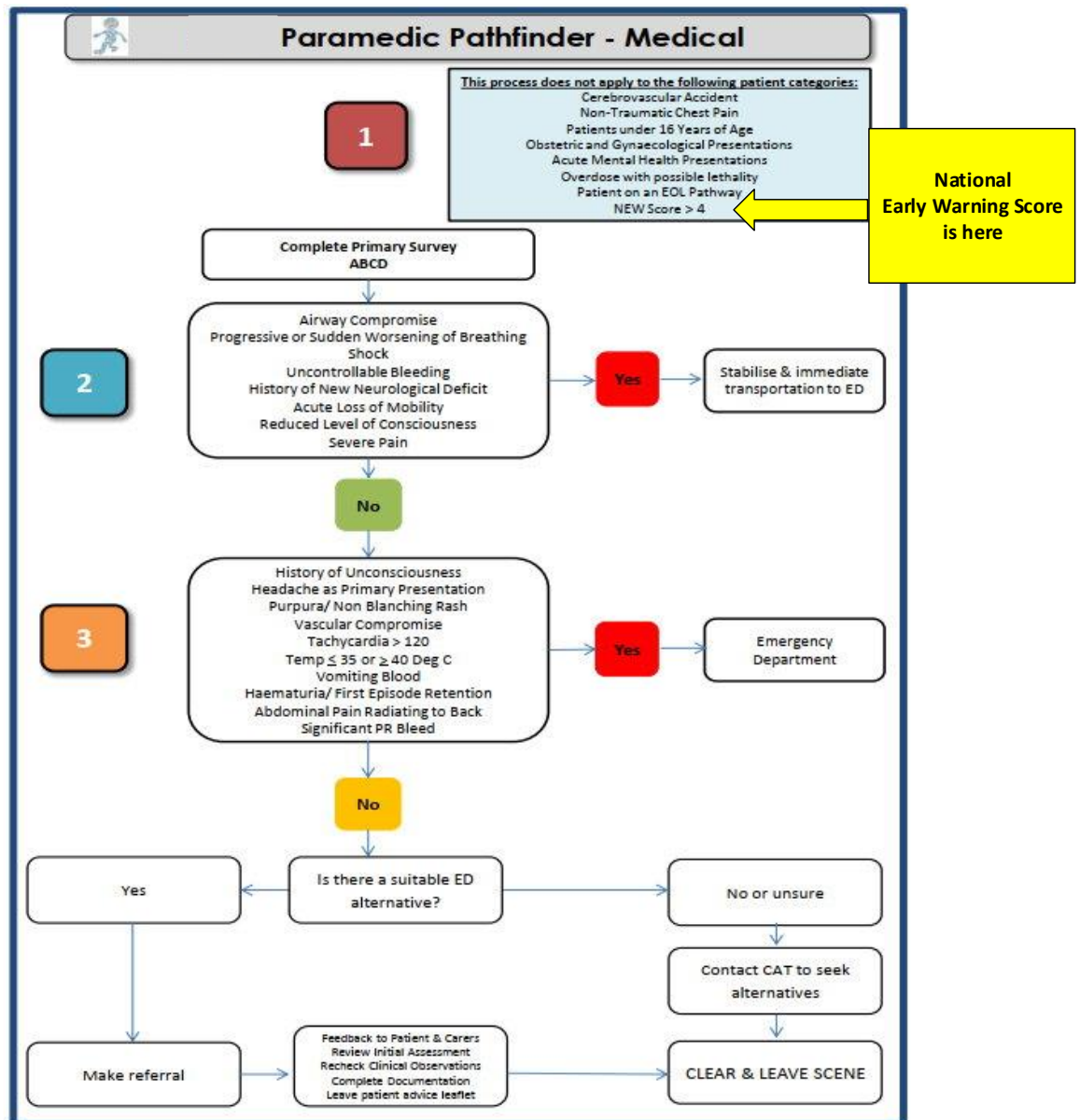
Figure 1.5: AMB-X's (2014a) Paramedic Pathfinder – Trauma Tool
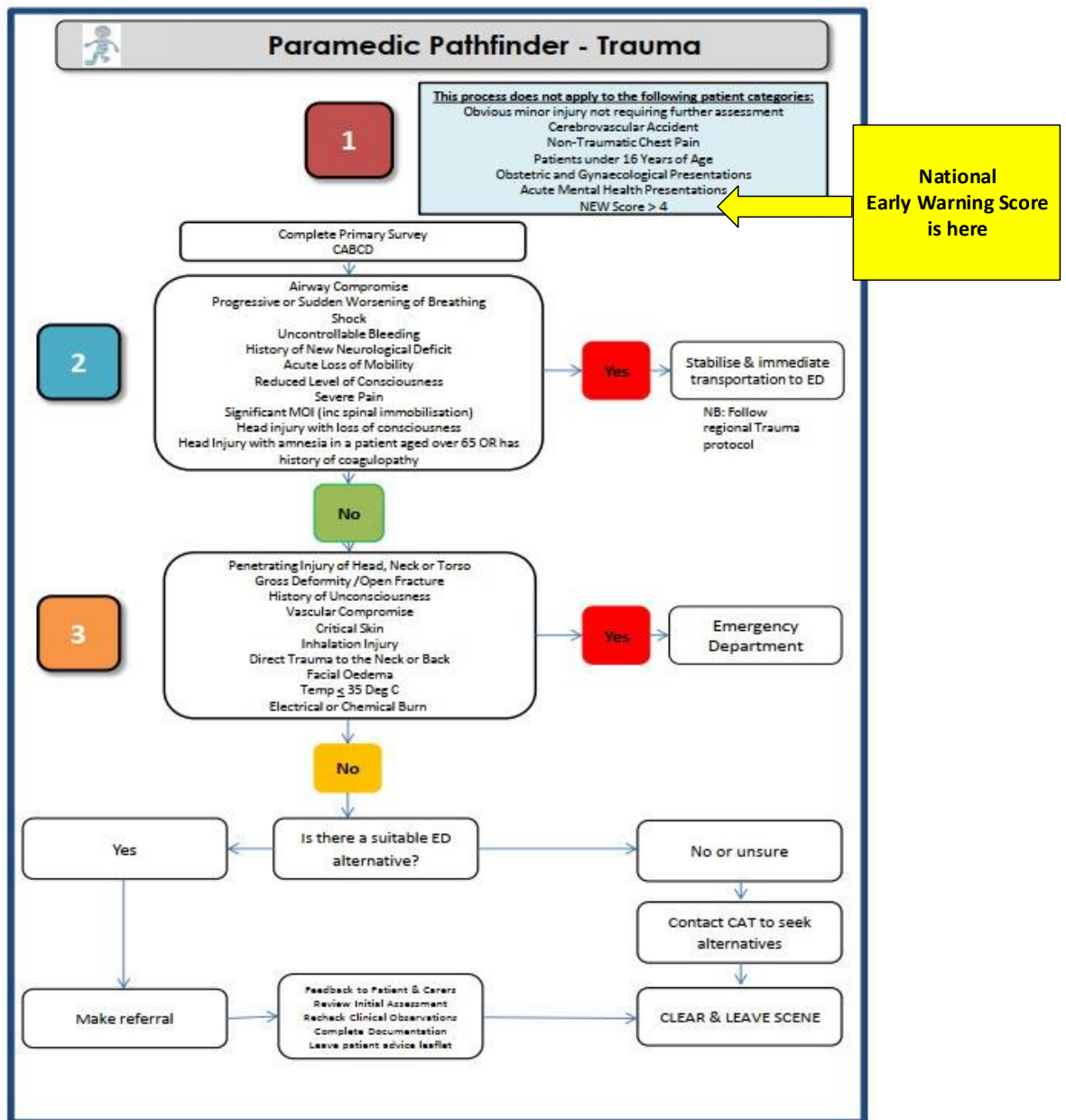
Table 1.1:Comparison of Paramedic Pathfinder and NEWS Tools

	National Early Warning Score	**Paramedic Pathfinder - Medical**	**Paramedic Pathfinder - Trauma**
Exclusions of use:	• Patients < 16 years of age • Women who are pregnant	• Patients < 16 years of age • Obstetric & Gynaecological presentations • Cerebral Vascular Accident • Non-traumatic chest Pain • Acute mental health presentations • Overdose with possibility of lethality • Patient with End of Life (EOL) pathway • NEWS >4	• Patients < 16 years of age • Obstetric & Gynaecological presentations • Cerebral Vascular Accident • Non-traumatic chest Pain • Acute mental health presentations • Obvious minor injury not requiring further assessment • NEWS >4
Clinical assessment includes:			
Airway (A)	• Measurement of patients' oxygen saturation rate • Administration of any supplemental oxygen	• Measurement of patients' oxygen saturation rate as part of primary survey ABCD • Airway compromise – intermittent, total or partial obstruction of the airway or loss inhalation reflexes. • Stridor – snoring or bubbling sounds during inspiration or expiration. • Drooling - Saliva drooling from the mouth due to inability to swallow	• Measurement of patients' oxygen saturation rate as part of primary survey ABCD • Airway compromise – intermittent, total or partial obstruction of the airway or loss inhalation reflexes. • Stridor – snoring or bubbling sounds during inspiration or expiration. • Drooling - Saliva drooling from the mouth due to inability to swallow

	National Early Warning Score	**Paramedic Pathfinder - Medical**	**Paramedic Pathfinder - Trauma**
Breathing (B)	• <mark>Measurement of patients respiratory rate</mark>	• <mark>Measurement of patients respiratory rate as part of primary survey ABCD</mark> • Progressive or sudden worsening of Breathing – i.e., increasing in severity or extent in relation to their normal respiratory pattern and depth. • Acute shortness of breath that comes on suddenly or a sudden exacerbation of chronic shortness of breath. • Unable to talk in sentences despite treatment. • Exhaustion – Exhausted patients appear to reduce effort to breathe despite continuing respiratory insufficiency. This pre-terminal.	• <mark>Measurement of patients respiratory rate as part of primary survey ABCD</mark> • Progressive or sudden worsening of Breathing – i.e., increasing in severity or extent in relation to their normal respiratory pattern and depth. • Acute shortness of breath that comes on suddenly or a sudden exacerbation of chronic shortness of breath. • Unable to talk in sentences despite treatment. • Exhaustion – Exhausted patients appear to reduce effort to breathe despite continuing respiratory insufficiency. This pre-terminal. • Inhalation injury

	National Early Warning Score	**Paramedic Pathfinder - Medical**	**Paramedic Pathfinder - Trauma**
Circulation (C)	• Measurement of patients' pulse rate • Measurement of patients' blood pressure • Tachycardia: A pulse rate of 91-110 BPM is deemed a low clinical risk; 111-130 BPM is a medium clinical risk and ≥ 131 is a high clinical risk.	• Measurement of patients' pulse rate as part of primary survey ABCD • Measurement of patients' blood pressure as part of primary survey ABCD • Uncontrolled major and minor bleeding • Vascular compromise • Tachycardia: Patients with a heart rate >120 are recommended to be conveyed to ED.	• Measurement of patients' pulse rate as part of primary survey ABCD • Measurement of patients' blood pressure as part of primary survey ABCD • Uncontrolled major and minor bleeding • Vascular compromise
Disability (D)	• Measurement of the patients' level of consciousness using Alert-Verbal-Pain-Unresponsive (AVPU) criteria	• Measurement of the patients' level of consciousness using Alert-Verbal-Pain-Unresponsive (AVPU) criteria and Glasgow Coma Scale (GCS) • History of unconsciousness • History of new neurological deficit • Headache as a primary presentation • Acute loss of mobility • Severe pain • Purpura / Non-blanching rash • Vomiting blood • Haematuria • Urine retention • Abdominal pain radiating to back • Significant PR Bleed	• Measurement of the patients' level of consciousness using Alert-Verbal-Pain-Unresponsive (AVPU) as part of primary survey ABCD criteria and Glasgow Coma Scale (GCS) • History of unconsciousness • History of new neurological deficit • Acute loss of mobility • Severe pain • Significant mechanism of injury • Direct trauma to the neck or back • Head injury with loss of consciousness • Head injury with amnesia in patients > 65 years or history of coagulopathy

	National Early Warning Score	Paramedic Pathfinder - Medical	Paramedic Pathfinder - Trauma
		• Combined signs and symptoms associated with shock (sweating, pallor, tachycardia, hypotension and reduced level of consciousness)	• Penetrating injury of head, neck or torso • Gross deformity / open fracture • Critical skin - where a fracture or dislocation may leave fragments or ends of bone pressing so hard against the skin that the viability of the skin is threatened. • Facial oedema • Electrical or chemical burn • Combined signs and symptoms associated with shock (sweating, pallor, tachycardia, hypotension and reduced level of consciousness)
Exposure (E)	• Measurement of patients temperature • Hypo and hyperthermia: Patients' with a temperature within the range 35.1-36.0◦C or 38.1-39.0◦C are deemed to be at low clinical risk; ≥39.1 = medium clinical risk; and ≤35.0◦C at high clinical risk.	• Measurement of patients temperature as part of primary survey ABCD • Hypo and hyperthermia: Patients with a temperature ≤ 35◦C or ≥ 40◦C are recommended to be conveyed to ED	• Measurement of patients temperature as part of primary survey ABCD • Hypothermia: Patients with a temperature ≤ 35◦C are recommended to be conveyed to ED

1.4 Modelling the effect and evaluating the usefulness of the NEWS to support paramedics' decision-making

I was clinically trained as an EMT and have approximately 20-years' work experience in the prehospital ambulance care setting; gained working at the frontline and as a manager during my employment in two English ambulance services. It was whilst working as a clinician that I first became interested in sepsis recognition. Whilst, I have not practised clinically since 2002, my interest in sepsis recognition continued. My interest was fuelled by the increasing literature and development of pre-hospital sepsis screening and EWS tools, and the subsequent suggestion for their utilisation in the prehospital setting - not only to support the recognition of critical illness and deterioration, but to help identify patients that could be treated via alternative care pathways. This aspect is discussed in Chapter 2. Based on these suggestions, and prior to formally commencing my PhD studies, I conducted a pilot study. The pilot study evaluated the use of a modified EWS to support paramedics' conveyance decisions (see Essam et al., 2015). I found from conducting this pilot that the modified EWS had no effect on transport or revisit rates, and scores were frequently not calculated or recorded, or were calculated incorrectly.

Whilst I had intended to go on and develop this research (the plan being to conduct a cluster randomised control trail, and to adopt a collaborative approach, with on-going clinical training and feedback to support adoption) a decision had been made by the ambulance service to begin implementing the NEWS trust-wide. This decision was made despite the fact the NEWS had not been designed or validated for use in the prehospital setting. I therefore undertook this case study and used the introduction of the NEWS at AMB-X as an opportunity to add knowledge to the limited evidence base, and to provide greater insight and understanding of how the NEWS was used by paramedics in the prehospital setting.

1.4.1 Research aim

AMB-X's aim was to provide better care and increase the number of patients accessing care away from ED. It was envisaged that this would be achieved by implementing a

safe and consistent on-scene assessment process using Paramedic Pathfinder and the NEWS (Mills et al., 2014, pp.6-7). Using this as the foundation for my research, my aim was to evaluate the effectiveness and usefulness of the NEWS to support paramedics' decision-making to appropriately treat patients closer to home.

1.4.2 Research questions

My objective was to seek answers to the following four questions.

- What was the effect of the NEWS on the numbers and proportions of patients not conveyed to ED?
- What was the effect of the NEWS on numbers and proportion of patients discharged at scene, who recontacted AMB-X within 24-hours?
- How useful and effective did paramedics perceive the NEWS to be in supporting them in their decision to convey or treat patients closer to home?
- How was the NEWS being used by paramedics in the emergency prehospital care setting?

Answers to these questions would enable me to address the overarching question: *How effective and useful was the NEWS when used by paramedics to support their decision-making to appropriately treat patients closer to home?*

I proposed two possible outcomes:

<u>Proposition 1.</u> The introduction of the NEWS will be effective and useful in supporting paramedics' decision-making to appropriately treat patients closer to home.

<u>Proposition 2.</u> The NEWS will be ineffective and not useful in supporting paramedics' decision-making to appropriately treat patients closer to home.

1.4.3 Method

To achieve my aim and objectives, I adopted a pragmatic methodological approach and used mixed methods. I describe and discuss my approach in detail in Chapter 3.

To ascertain whether the NEWS had a significant effect on paramedics' decision-making, I quantitatively evaluated the numbers and proportions of patients being

treated closer to home, and the numbers and proportions of those left at scene who recontacted within 24-hours. I compared rates before and after the NEWS was introduced using an interrupted time series method. This method is a statistical modelling technique that considers pre-existing (secular) trends, such as the year-on-year increase in emergency 999-call demands, when determining whether there has been a statistically significant change. The quantitative methods adopted are discussed in more detail in Chapter3, section 3.5, sub-sections 3.5.1-3.5.9, pp.90-106. The results are presented in Chapter 4.

There is a vast body of evidence exploring the various information sources used by clinicians to support their decision-making process. Different theories describe how this information is used, and how decision models are developed and cognitively analysed; such as by deductive and inductive reasoning, pattern recognition, repetitive hypothesising, mental representations and using clinical intuition (see Roberts and Sonnenberg, 2000, Croskerry, 2002, Dowding and Thompson, 2002, Smith et al., 2008c, Mackway-Jones et al., 2013, Collen, 2017 for more details). Theories are often classified as being normative, or descriptive or prescriptive. Normative theories focus on how decisions are *'best made',* whereas prescriptive theories focus on how decisions *'should be made'.* I adopted a descriptive theoretical approach and focused on how decisions *'are made'* using the NEWS. I wanted to provide practical real-world insight and understanding of the usefulness of the NEWS when used by paramedics in context.

To achieve this insight and understanding, I conducted semi-structured interviews and undertook non-participant observations with a self-selected sample of paramedics employed by AMB-X. I gained an understanding of how useful and effective paramedics perceived the NEWS to be in supporting them with their decisions to convey or treat closer to home. I obtained insight by observing when and how the NEWS was being used in the clinical field. The interview and observation methods adopted are described in more detail in Chapter 3, section 3.6 p.109. My findings can be found in Chapters 5 and 6.

1.4.4   Integration

Pattern-matching is an approach in which the results from the three individual workstreams (i.e. my analysis of the quantitative data, semi-structured interviews and non-participant observations) were compared to my theoretical propositions. My theoretical propositions were proposed before data collection commenced and were derived from the existing evidence discussed in Chapter 2. The method of integration is discussed in more detail in Chapter 3, section 3.9, p.118 and the integrated findings from pattern-matching are presented and summarised in Chapter 7. Overall, I found the use of the NEWS in the prehospital setting to be complex, although according to Petticrew (2011, p.397), *"there are no 'simple' or 'complex' interventions, and that simplicity and complexity are instead pragmatic perspectives adopted by researchers to help describe and understand the interventions in question".*

1.4.5   Theoretical development

I took Petticrew's (2011) advice, and in Chapter 8 I 'unpacked' the complexity into its component parts. I used several pre-existing theories to explain my findings, such as Normalization Process Theory developed by May et al. (2015), which identifies social and contextual factors that facilitate and inhibit complex interventions, like the NEWS, from becoming embedded and normalised into everyday working practice. I also used Chapman and Sonnenberg's (2000) scheme of medical decision-making to illustrate how the NEWS can be cognitively outcompeted, because of intrinsic and extrinsic influencing factors. Reason's (2009) generic-error modelling system was used to provide a conceptual framework for discussing individual clinical decision-making practices, and the malpractices associated with the NEWS.

1.4.6   Reflexivity

Owing to my personal experience and interest in this subject, I had to be mindful and mitigate the risk of researcher expectancy effects and bias; i.e., the tendency for researchers to subconsciously influence outcomes, and/or to only see and hear what they want or expect rather than reality. Therefore, before summarising and drawing my conclusions in Chapter 10, I reflect on my research in Chgapter 9.

I was conscious throughout that my insider knowledge of the ambulance service was at the time superior to that of an acceptably incompetent fieldworker; i.e. an experienced researcher who is unfamiliar with the culture or setting (Lofland et al., 2006, p.70). Such knowledge could provide me with some advantages, for instance I had a greater understanding of the culture and normal working practices than an outsider would have, which would enable me to identify and question anything unusual or unexpected (Lofland et al., 2006). Being an insider also enabled me to gain easier access to participants and other information sources; e.g., I would know who to contact for additional information, where additional information such as Board reports and minutes could be obtained, and which organisational policies and procedures would be relevant to the study. I was also able to use my insider knowledge so participants felt more comfortable and connected with me – I spoke their language as it were.

Nevertheless, I was aware that my knowledge and experience also presented a risk of 'going native', i.e. getting involved, influencing, misinterpreting or manipulating events as they occurred (Neyland, 2008, p.81). To mitigate such risks, I endeavoured never to put 'words in to the mouths' of those I interviewed, nor took any active part in the clinical assessments or decision-making observed – not only because I did not wish to influence outcomes, but also because my clinical knowledge and practical experience was outdated and no longer viable for clinical practice. I would carry and fetch equipment, as requested by the paramedic, which helped me blend into the background, but otherwise I did nothing; I just made notes of what I observed and heard and would only speak when spoken to.

Mid-way through my studies, and after considerable deliberation, I left permanent full-time employment with AMB-X; instead, I worked part-time as a Management Consultant, working in the healthcare sector. I continued my studies under an honorary bank contract at AMB-X, without pay. This decision was made out of necessity, as I needed more time to focus on my PhD research. Fortunately, it had no

negative impact on my research. If anything, this decision allowed me to take a step-back and reflect on the findings more objectively, from an outside perspective.

In Chapter 9, section 9.2.6, p.259 and section 9.5, p. 272, I provide details of the quality and trustworthiness criteria I used to support my reflexivity; to assist the evaluation of the methods used and approach adopted to mitigate the underlying risks of research bias. I also consider how other aspects may have influenced the results found, before making some recommendations. The recommendations could be of value to the NEWS networks currently being introduced across the NHS, who are seeking to achieve NHS England's ambition of 100% uptake of the NEWS, plus those responsible for the transformation of integrated care services.

2 Exploring the use of early warning score systems by ambulance clinicians: a systematic review

Brown and Bleetman (2006) recommended a Modified Early Warning Score (MEWS) system should be introduced in the prehospital emergency care setting, to support ambulance clinicians' decision-making and improve the identification of critically ill patients. Following their suggestion, various MEWS tools were compared and validated for use by ambulance clinicians. Many proclaimed their adoption and use in the prehospital setting would support the timelier and more accurate identification of patients at risk who required conveyance to hospital, and more appropriate identification of those who could be diverted from ED to an alternative care pathway (see Challen and Walter, 2010, Gray et al., 2010, Ebrahimian et al., 2012, Fullerton et al., 2012, Ebrahimian et al., 2014b, Bayer et al., 2015, Silcock et al., 2015, Gaumont et al., 2016, Leung et al., 2016, Ebrahimian et al., 2017, Shaw et al., 2017, Abbott et al., 2018, Najafi et al., 2018). EWS have also been used to improve prehospital care systems in developing countries (Sun et al., 2012).

At first glance, much of the evidence seemed to be theoretical, based on retrospective evaluation of ambulance data of what could be achieved *if* an EWS was used, rather than results obtained from the prospective use of an EWS system in the clinical field. This included the ambulance based studies cited by the Royal College of Physicians (2017), who advocated the use of the NEWS in the prehospital setting. Results acquired from retrospective data analysis would also not necessarily portray a true effect of the NEWS being used by ambulance clinicians in the real-world context. This is because clinical decisions are influenced by a wide-range of factors including the attributes of the task (e.g. ease or difficulty and the availability of necessary resources to complete the task) plus the decision-makers' ability (e.g. their level of skill, confidence and professional expertise) and/or other organisational and socio-environmental factors (Smith et al., 2008c, O'Hara et al., 2014). I therefore believed it was necessary to explore the existing evidence systematically. My aim was to gain insight into the effectiveness and usefulness of EWS systems, like NEWS, when they were used by

paramedics to support their decision-making in the emergency prehospital setting. In accordance with my overarching research question, I wanted to know: *how effective and useful are EWS systems when used by paramedics to support their decision-making in the emergency prehospital setting?*

2.1   Method

I adopted a systematic literature review methodology, which is defined as…

> *'a review of a clearly formulated question that uses systematic and explicit methods to identify, select and critically appraise relevant research and to collect and analyse data from the studies that are included in the review.' (Moher et al., 2009, p.1)*

I conducted the review using guidance provided by Popay et al. (2006), the Centre for Reviews and Dissemination (2009) and Pluye and Hong (2014).

2.1.1   Search strategy

I searched several databases for papers written in English and published between January 1997 and March 2018. Databases searched included Academic Search Complete, BMJ, CINAHL, Cochrane, Google Scholar, MEDLINE, PubMED and Science Direct. Table 2.1 and Table 2.2 (p.46), provide an example of search terms and strategy used to source literature from Academic Search Complete. Search-terms were broken down more simplistically for certain journal search engines and databases (e.g. BMJ and Google Scholar), whilst still ensuring all permutations were searched (e.g. search 1 = Ambulance "Early Warning Score", search 2 = pre-hospital "Early Warning Score", search 3 = prehospital "Early Warning Score"). Reference lists were also reviewed for relevant papers.

Table 2.1: Terms used to search for relevant literature

#1. Ambulance terms (Abstract OR Title OR Keywords)
"pre-hospital" OR "prehospital" OR ambulance OR "emergency medical service*" OR EMS OR "emergency care practitioner*" OR ECP OR paramedic* OR "ambulance technician*" OR "emergency medical technician*" OR EMT
#2. Early Warning Score terms (Abstract OR Title OR Keywords)
"Early Warning Score" OR "*EWS" OR "#EWS" OR "track and trigger"
#3. Paramedic Pathfinder (Abstract OR Title OR Keywords)
"Paramedic Pathfinder"
#4. Prehospital Sepsis Screening Tool terms (Abstract OR Title OR Keywords)
"Sepsis Score" OR "Sepsis Screen*" OR "Sepsis Screen#" OR "Sepsis Tool"

Table 2.2: Search strategy applied

#1 AND #2
OR
#1 AND #3
OR
#1 AND #4

2.1.2   Eligibility criteria

To be included:

- The study must be evidenced-based (i.e., not a personal review or discussion paper), reported in full-text and have been peer-reviewed; e.g. papers published in journals, conference proceedings and dissertations.

- Ambulance clinicians must have used the EWS in the prehospital setting.

- The score system used should be medical-based, not trauma-based. Therefore, the tool had to include as a minimum the six vital sign measures recommended by NICE (2007).

- Quantitative, qualitative or mixed methods designs were eligible for inclusion.

Exclusions included:

- Papers not written in English, owing to translation difficulties and cost.

- Discussions, commentaries, recommendations and guidelines.

- Tool development and/or validation studies where EWS were retrospectively applied by the researchers.

- Studies where the tool did not include all six physiological measures, specified by NICE (2007).

- Studies exploring the use of EWS solely in the hospital setting, including ED.

- Helicopter Emergency Service or inter-facility transfers. These were excluded because patients conveyed were more likely to have experienced severe trauma or a life-critical medical emergency, and those providing care during transfers were more likely to be hospital-based and/or with specialised training, skills and knowledge.

2.1.3 Study selection

It was not always possible to determine whether studies met the inclusion criteria from the abstract alone. This was because EWS were sometimes embedded within other tools (e.g. Paramedic Pathfinder), or because the physiological measures were obtained in conjunction with other measures under the auspices of another clinical tool (e.g. prehospital sepsis screening tool). Full-text versions were therefore screened wherever possible to confirm eligibility.

2.1.4 Data collection

Having searched the academic databases and reviewed cited references in the papers sourced, the authors of four papers were contacted directly. Three requests were made for full-text copies of papers, of which two were obtained - neither of these two paper met the inclusion criteria. No response was received to my third request. I did however find additional material which showed the tool used in the study only measured five of the six physiological measures required for inclusion in my review. With regards to the fourth paper, I had sourced a full-text version but still needed to clarify which vital signs were measured. This was because the information about the

tool used was unclear, and the weblink to the supplementary information was broken. I subsequently received information from a paramedic who participated in the study, the information confirmed the tool used included all six physiological measures.

2.1.5 Quality assessment

Risks of bias and the quality of all papers that met the inclusion criteria were assessed; in the first instance by me, and then checked by a co-assessor (NS). The reason for assessing quality of included studies was to provide transparency regarding the strength of the evidence and subsequent conclusions drawn.

> *'If studies of poor methodological quality are included in the review   in an uncritical manner then this will affect the trustworthiness of the synthesis.'*
> *(Popay et al., 2006, p.15)*

There are various appraisal tools available. Each designed to assess different methodological designs. Rather than using different tools, developed by different researchers, to assess different designs, I used the Mixed Methods Appraisal Tool (MMAT) v2011, developed by Pluye et al. (2011).

The MMAT begins with two screening questions. The first screening question relates to the research question(s) or objective(s). The second, relates to the appropriateness of the data collected. The MMAT includes a questions that relate to five methodological domains; i.e. four questions each for qualitative research, randomised control trials, non-randomised and quantitative descriptive studies and three questions for mixed methods studies (Souto et al., 2015). In this instance, I only used the questions that related to qualitative research and non-randomised quantitative studies.

The MMAT was assessed for efficiency and reliability by Souto et al. (2014) and Souto et al. (2015). It takes an average 11-minutes to complete (range: 7.4 to 18.7 minutes) and inter-rater reliability ranges from fair to perfect using the Kappa measure of agreement (see Appendix 1, p.319).

Quality is accredited by the assessor attributing an asterisk (*) for each criterion met. A percentage quality score is subsequently derived by dividing the number of criteria met, by the total number of criteria assessed (e.g. **/**** = 2/4, or 50%).

2.1.6 Data extraction and analysis

Findings from included studies were narratively synthesised using a thematic analysis method (i.e. convergent qualitative synthesis (Pluye and Hong, 2014)). Narrative synthesis is as an approach adopted to support the systematic review and synthesis of findings from numerous studies that relies principally on the use of words to explain and summarise the findings from the synthesis (Popay et al., 2006). The thematic analysis process itself is iterative. It involves categorising and organising recurrent themes found in the scripts, from numerous studies, to identify similarity and differences and to build a deeper understanding of the subject matter (Popay et al., 2006). For this review, I considered each sentence in the results section of each paper using the following questions as prompts:

- Does this statement provide insight of when or how the EWS was used?
- Does this statement provide insight of an effect or outcome?
- Does this statement provide insight of a factor facilitating or inhibiting use or an effect?

Statements which provided insight were selected. Patterns were then identified and developed into themes. The themes were then narratively synthesised. I used Microsoft Excel 2016 to record and analyse data related to the search process and used NVivo version 10 software (QSR International Pty Ltd., 2012) to code and thematically analyse the extracted statements.

2.2   Search results

I found a total of 334 papers. In accordance with Preferred Reporting Items for Systematic Review and Meta-Analyses (Moher et al., 2009), I have provided the results of my search process in Figure 2.1 below. Table 2.3 (p.51) provides a breakdown of where the papers were sourced. The seven papers sourced by hand were found by searching cited references. Having removed duplicates (n=164), the remaining papers were screened for eligibility. A summary of the six papers which met the inclusion criteria are provided in Table 2.4 (pp.52-57). A list of excluded papers and reasons for their exclusions can be found in Appendix 2 (p.320).

Figure 2.1: Illustration of the literature search process
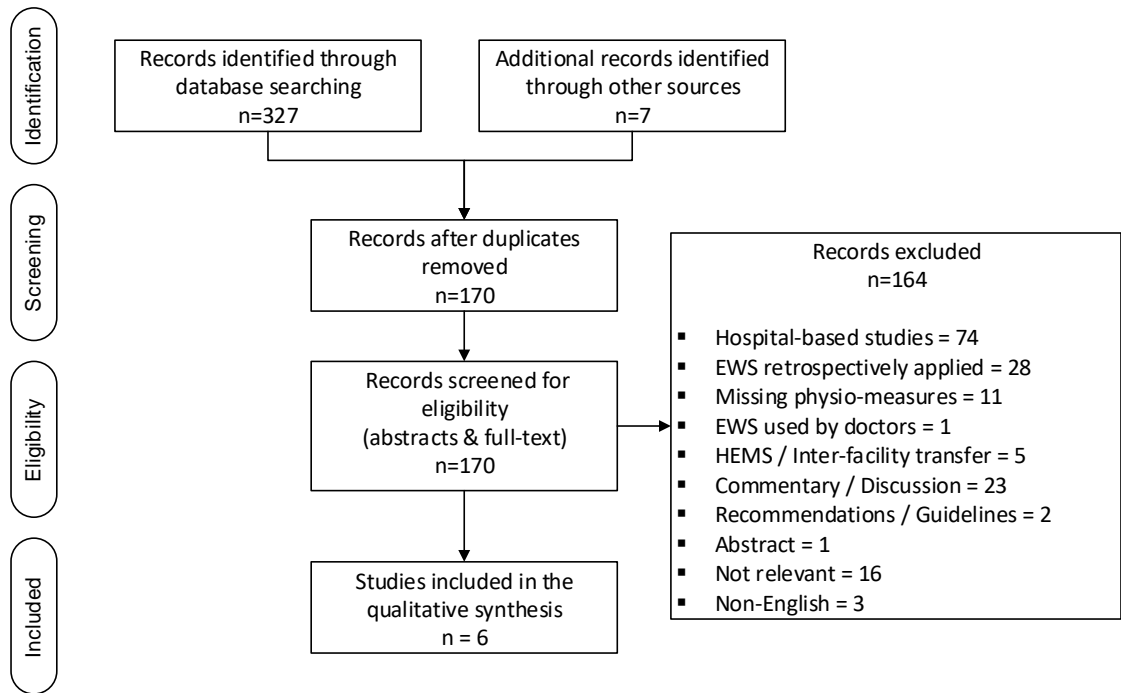
Table 2.3: A breakdown of where papers were sourced

Source	n
Academic Search Complete	37
BMJ	31
CINAHL	28
Cochrane (includes CENTRAL)	3
Emerald Insight	1
Google Scholar	23
MEDLINE	55
ProQuest	8
PsychINFO	1
PsychARTICLES	0
PubMed	58
Science Direct	30
Scopus	51
Taylor & Francis	1
Hand	7

2.3 Quality assessment

Complete (100%) inter-rater agreement was achieved when assessing the quality of the included manuscripts. The quality assessments of all six papers are summarised in Table 2.4 (pp.52-57).

Two studies, those conducted by Newton et al. (2013) and Ebrahimian et al. (2014b), did not fulfil the screening question criteria. Neither provided a clear research question or objective, only study aims. Also, the data collection and analysis undertaken by Newton et al. (2013) was considered inadequate to fulfil the study aim stated, which was to evaluate the clinical utility and safety of Paramedic Pathfinder tool using a mixed clinician sample. However, they only collected data relating to patients conveyed to ED. No evaluation was undertaken of the tools' utility or safe application on patients left at scene. At the time of evaluation, this equated to 18.5% of the patients attended.

Table 2.4: Summary of included papers

Author(s)	Clinical group & setting	Methodology	EWS System	Outcome measure(s)	Findings	Quality issues & risks of bias
Newton et al. (2013).	Emergency Medical Technicians (EMTs) grade 2 and above. North West Ambulance Service NHS Trust, England.	Prospective cross-sectional diagnostic accuracy study.	Paramedic Pathfinder includes Prehospital EWS (PHEWS). Appendix 3, p.327 & Appendix 5, p.329.	Patients needing non-emergency and emergency care.	Ambulance clinicians using Paramedic Pathfinder demonstrated acceptable levels of sensitivity, i.e. correctly identifying patients who required care at ED. Medical patients = 367 (76.3%) of which 77 (20.9%) were deemed non-emergency cases by clinicians. Trauma patient = 114 (23.7%) of which 35 (30.7%) were deemed non-emergency cases by clinicians. Decision agreement between clinician using tool & expert panel = 387 (80.5%) cases. Medical tool: sensitivity = 94.83% (95% CI: 90.7%-96.7%) & specificity = 57.9% (95% CI: 49.4%-65.9%). Trauma tool: sensitivity = 96.4% (95% I: 87.9%-99%) & specificity = 60.3% (95% CI: 47.5%-71.9%). 33 patients were incorrectly deemed appropriate for urgent care pathway. Five had a PHEWS of 0. None had a PHEWS > 4. 38 (7.9%) patients' PHEWS = > 4, 35 of whom needed treatment at ED.	Criteria met: */4 Score: 25%. Data collection/analysis did not fulfil the study aims. Limited recruitment information; no patient demographics or information of participating clinicians. Analysis methods not described & analysis deemed incomplete. Appendix 6, p.330.

Table 2.4: (continued)

Author(s)	Clinical group & setting	Methodology	EWS System	Outcome measure(s)	Findings	Quality issues & risks of bias
Ebrahimian et al. (2014b).	EMTs. Tehran, Iran.	Prospective cross-sectional diagnostic accuracy study.	Physiological-social Modified Early Warning Score (PMEWS). Appendix 7, p.333.	Patients needing non-emergency and emergency care.	EMTs can use PMEWS ≥ 4 to identify patients at increased risk. Mean age 50.58 ± 22.15. Male = 55.3.7%. Mean PMEWS for patients conveyed to ED = 1.97 ±2.86. Mean PMEWS = 2.71 (±3.55). 97.6% of patients with a PMEWS ≥4 needed emergency care. AUROC = 0.738 (95% CI: 0.708-0.767).	Criteria met: **/4. Score: 50%. Study-setting and recruitment information was limited. Patient sample/data collected was not necessarily representative and therefore not generalisable. No ethical statement provided. Description of analysis methods were limited. Appendix 8, p.334.

Table 2.4: (continued)

Author(s)	Clinical group & setting	Methodology	EWS System	Outcome measure(s)	Findings	Quality issues & risks of bias
McClelland (2015).	Paramedics. North East Ambulance Service NHS Trust, England.	Retrospective cross-sectional observational study.	National Early Warning Score (NEWS). Figure 1.2, p. 27	Number of calls suitable for NEWS. Prevalence of NEWS usage. Completeness of documented physiological measures related to NEWS. Patient demographics related to NEWS. Changes in pre-Alerts related to NEWS ≥ 7.	NEWS not documented, despite most of the necessary physiological measures being recorded. 90% of 999-calls may be suitable for the NEWS. NEWS documented <1% (n=6) of patient cases. 95% of observations included 4 or more physiological measures related to NEWS, although Temperature was not consistently recorded. Population described according to NEWS using mean imputation: Male = 53%, mean age = 61 years (±23, range: 17-94). Mean NEWS = 2.0 (±2.3, range: 0-11); Low NEWS = 82.0%; Medium NEWS = 12.9%; and High NEWS= 5.0%). No change in pre-alerting behaviour found when conveying patients with a NEWS ≥ 7.	Criteria met: */4 Score: 25%. Validity, reliability and generalisability of the study was compromised by data quality, sample size and questionable methods used to measure certain outcomes (e.g. prevalence of NEWS usage). Appendix 9, p.336.

Table 2.4: (continued)

Author(s)	Clinical group & setting	Methodology	EWS System	Outcome measure(s)	Findings	Quality issues & risks of bias
McClelland and Jones (2015).	Unspecified. North East Ambulance Service NHS Trust, England.	Retrospective cross-sectional observational study.	Sepsis Screening Tool (SST). Appendix 10, p.339.	Sensitivity and specificity of recognition of sepsis & severe sepsis. Prevalence of SST usage. Treatment delivered related to sepsis and severe sepsis.	Ambulance clinicians diagnosed sepsis without consistently using the SST to support their decision-making. Sample = 49 patients, of which 42 were diagnosed with sepsis (n=15) or severe sepsis (n=27). Ambulance clinicians correctly identified 18 (of the 42) patients as having sepsis or severe sepsis; sensitivity = 43% and specificity = 14%. And, correctly identified 8 (of the 27) patients with severe sepsis; sensitivity = 30% and specificity = 77%). Treatment delivered was found to be inconsistent.	Criteria met: ***/4. Score: 75%. Only ICD code A41 sepsis was collected. No reason given of why other types of sepsis were not included (e.g. ICD A40 streptococcal sepsis). No summary of data collected, making replicability difficult. Appendix 11, p.340.

Author(s)	Clinical group & setting	Methodology	EWS System	Outcome measure(s)	Findings	Quality issues & risks of bias
Carberry and Harden (2016).	Paramedics. NHS Lanarkshire, Scotland.	Prospective cross-sectional evaluation study.	Scottish Ambulance Service (SAS) Tool. Appendix 12, p.343.	Improvement in time taken to identify sepsis. Improvement in time taken to deliver antibiotics. Percentage improvement of care-bundle delivered within 60 minutes. Incidence of false pre-alerts. Perceived increase in workload.	Sepsis pre-alerts by paramedics reduced time taken to deliver Sepsis 6 care bundle. Pre-alerts: 43 (86%) had a MEWS ≥ 4. Mean time to triage sepsis patients improved by 82%; reduced from 17 to 3-minutes (p=0.01). Mean time to antibiotic improved by 39%; reduced from 49 to 39-minutes. 78% of patients received antibiotics within 60-minutes of leaving home. No significant increase in workload was reported.	Criteria met: **/4. Score: 50%. Information relating to patient & paramedic sample was limited, making comparability difficult to assess. Study-setting may not be representative and is likely to have had some effect on certain outcomes measured. No ethical statement was provided. Appendix 13, p.344.

Table 2.4: (continued)

Author(s)	Clinical group & setting	Methodology	EWS System	Outcome measure(s)	Findings	Quality issues & risks of bias
McClelland and Haworth (2016)	Paramedics. North East Ambulance Service NHS Trust, England.	Qualitative interview study.	National Early Warning Score (NEWS). Figure 1.2, p. 27	Paramedics opinions about the NEWS system and reasons (barriers and/or facilitators) for low level of use.	Negative reception, or lack of perceived value when the NEWS was used during clinical handover of care at hospital, acted as a disincentive to continued use by paramedics. Paramedics were not averse to the NEWS. They use NEWS to support decisions made rather than triggering a decision. The calculation of NEWS may need to be prompted. If NEWS is not positively acknowledged or acted upon by other healthcare professionals at the receiving destination, then this acts as a barrier to use.	Criteria met: **/4 Score: 50%. Difficult to ascertain whether small sample was representative, because participants information was limited. Inconsistent interview methods adopted. Limited information provided regarding analysis methods. No methods employed to assess researcher bias post-analysis. Appendix 14, p.346.

2.4 Thematic analysis

2.4.1 Patient-type

The EWS systems were used to assess a wide range of patient types. Most patients attended were male. The patients' ages ranged from 12 to 100 years, with the average age ranging from 51 to 69 years (Ebrahimian et al., 2014b, McClelland, 2015, McClelland and Jones, 2015). Unfortunately, generalisability was difficult to determine because Newton et al. (2013) and Carberry and Harden (2016) did not provide information about their patient sample. The provision of this information would have been useful from the study conducted by Newton et al. (2013), as Paramedic Pathfinder can be used to support the assessment of patients aged five years and above, yet the PHEWS used as a discriminator appeared to be an adult-based tool. The sepsis screening tools were used mostly to assess patients presenting with UTI and chest infections (McClelland and Jones, 2015, Carberry and Harden, 2016), although, they were also applied in cases where patients presented with abdominal pain, indwelling devices, cellulitis (McClelland and Jones, 2015) and neutropenia (McClelland and Jones, 2015, Carberry and Harden, 2016).

2.4.2 Identification of serious conditions and timelier delivery of care

From the information provided, most patients assessed with an EWS tool were found to have a low to medium score (Ebrahimian et al., 2014b, McClelland, 2015). Whilst many patients with a low EWS were still conveyed to ED (McClelland, 2015), such decisions were not necessarily inappropriate (Newton et al., 2013, Ebrahimian et al., 2014b). The EWS systems were generally found to improve and support the accurate identification of serious illness (Newton et al., 2013, Ebrahimian et al., 2014b, Carberry and Harden, 2016) and facilitate timelier delivery of care (Carberry and Harden, 2016, McClelland and Haworth, 2016). A cut-off score ≥ 4 was most frequently considered a good indicator for patients needing a higher level of care (Newton et al., 2013, Ebrahimian et al., 2014b, Carberry and Harden, 2016); the higher the patients' score, the higher the probability the patient would be conveyed to ED (Ebrahimian et al., 2014b, McClelland, 2015). However, the introduction of the NEWS had not influenced any significant change in pre-alerting behaviour (McClelland, 2015).

Pre-alerts are a practice undertaken by paramedics in which they notify the hospital, prior to arrival at ED with a seriously ill or injured patient. ED nursing staff are advised of the patient's age, sex and brief history of what has occurred, stating the injury or illness and patient's condition, and their estimated time of arrival. McClelland (2015) highlighted pre-alerting practice tended to be influenced more by protocols associated with specific clinical complaints, than the EWS. This is because some clinical complaints do not necessarily produce a high EWS, e.g. complaints such as acute myocardial infarction or stroke. For this reason, Newton et al. (2013) excluded these conditions and others (e.g. mental illness, gynaecological and obstetric conditions) because they were considered less amenable to the Paramedic Pathfinder process.

Pre-alerting practices and expedited care delivery seemed more likely to occur when a sepsis screening tool was used than an EWS system, (McClelland and Jones, 2015, Carberry and Harden, 2016), although even then, pre-alerts were found to be inconsistently used (McClelland and Jones, 2015). Prehospital clinical practice remained driven by pre-alerting protocols, or individual physiological measurements than aggregated results from scoring and screening tools (McClelland, 2015, McClelland and Jones, 2015).

2.4.3   Appropriate utilisations of resources

Newton et al. (2013), Ebrahimian et al. (2014b) and McClelland and Haworth (2016) all highlighted how EWS systems can improve the utilisation of resources, either by deflecting patients from ED to more appropriate care pathways in the community (Newton et al., 2013, McClelland and Haworth, 2016), or via direct access to hospital wards (McClelland and Haworth, 2016). To reduce unnecessary demands in ED, some hospitals permitted direct access to the MAU by ambulance clinicians, using a specified EWS as a cut-off. This appears to have incentivised the prehospital use of the NEWS in some instances (McClelland and Haworth, 2016).

2.4.4   Clinical task and workload

When interviewed, ambulance clinicians thought EWS systems could and should be used (McClelland and Haworth, 2016). Their use was considered practicable and was

not perceived to unduly increase clinicians' workload (Carberry and Harden, 2016). Although from interviews and observations, the NEWS was found to be calculated retrospectively (Carberry and Harden, 2016, McClelland and Haworth, 2016), this was *'due to the nature of prehospital working methods and time constraints'* (Carberry and Harden, 2016, p.4). The constituent physiological measures were also not always evaluated completely. Where completeness of physiological measurements was evaluated, 5-7% of records were missing one or two of the measures needed to calculate an EWS (Ebrahimian et al., 2014b, McClelland, 2015). Temperature was the measurement most often missing (McClelland, 2015, McClelland and Jones, 2015).

Where the NEWS and the sepsis screening tools had been introduced together, the sepsis screening tool was more likely to be used than the NEWS (McClelland and Haworth, 2016). This was because the NEWS was considered too generic for the prehospital setting (McClelland and Haworth, 2016). Overall, there was little evidence of either the NEWS or the sepsis tool being used to support clinical decision-making in the everyday real-world context (McClelland, 2015, McClelland and Jones, 2015, Carberry and Harden, 2016).

Ambulance clinicians considered the information provided by the EWS system to be additional or supplementary, not primary information (McClelland and Haworth, 2016). And, whilst ambulance clinicians stated they were more likely to document EWS when patients were left at scene, this was not necessarily a decision they had made themselves, but more a behaviour undertaken in accordance with operational prompts and requirements (McClelland and Haworth, 2016).

As the paramedics were not calculating the NEWS, Carberry and Harden (2016) had to implement a process in their study where the constituent physiological measures were communicated to ED staff prior to arrival, i.e. during the pre-alert call. This enabled the ED staff to calculate the NEWS for themselves. This method was found to be so effective that other ambulance clinicians, not involved in the study, adopted the pre-alert process of their own volition. However, McClelland and Haworth (2016) found

that when the NEWS was calculated and communicated to HCPs, it was often disregarded. This subsequently inhibited future use of the NEWS by paramedics.

2.4.5 Decision-making

When it came to the prehospital sepsis screening tool, clinicians needed to have already considered sepsis as a possibility, before the tool was used (McClelland and Jones, 2015). Thus, like the NEWS, the sepsis screening tool appeared to be used retrospectively to confirm a decision, rather than prospectively to inform it. Ebrahimian et al. (2014b) felt PMEWS was particularly useful when ambulance clinicians had some doubt whether to transport patients to ED, or not. The paramedics themselves claimed they were more likely to use NEWS when they were considering treating and leaving the patient at scene, rather than when the decision had been made to convey patients to ED (McClelland and Haworth, 2016).

2.4.6 Risks and safety

Decisions made using Paramedic Pathfinder and PMEWS were found to be accurate and safe (Newton et al., 2013, Ebrahimian et al., 2014b). However, no tool is perfect and both Paramedic Pathfinder and PMEWS were found to have limitations. For example, when initially tested, the medical Paramedic Pathfinder tool did not accurately differentiate between cardiac and musculoskeletal chest pain (Newton et al., 2013). The tool was subsequently adjusted. The adjustments increased sensitivity to the detriment of specificity (Newton et al., 2013), to what degree is difficult to discern as data relating to sensitivity and specificity, subsequent to the adjustments made, were not provided.

The sensitivity and specificity of PMEWS was found to improve when additional patient variables were taken into consideration, such as age, physical ability and social status (Ebrahimian et al., 2014b). The tool used initially by Carberry and Harden (2016) required paramedics to pre-alert when two or more Systemic Inflammatory Response Syndrome (SIRS) criteria for sepsis were met in association with signs of infection. This was found to be overly sensitive and resulted in inappropriate pre-alerts. The tool was subsequently refined to include an EWS ≥4. Even when the tools had been refined to

achieve optimum results, some risk remained. For example, McClelland and Jones (2015) found more than half of the patients with sepsis were not identified, despite the implementation of both an EWS system and prehospital sepsis screening tool, and respective training being delivered Trust-wide.

2.5   Discussion

2.5.1   Summary of findings

Initial evidence suggested that EWS systems, used by ambulance clinicians, could be employed prospectively to support safer, more appropriate and timelier decisions for a wide-range of patients. However, when EWS systems had been implemented into everyday practice (i.e. real-world, as opposed to a research study context) there was little evidence of them being used, or used accurately, despite paramedics considering the tools to be easy and practicable to use. If they were used, they were used retrospectively to confirm that decisions made were appropriate, rather than prospectively, which would seem to compromise the 'identification' ability of the tool. Use of the EWS was more successful and effective when the tool had been introduced with a protocol, algorithm or other method of prompt, driving desired actions and outcomes.

2.5.2   Effectiveness and usefulness of EWS systems in prehospital setting

Three authors (i.e. Newton et al., 2013, Ebrahimian et al., 2014b, McClelland and Jones, 2015) provided results relating to sensitivity and specificity, or area under receiver operator characteristic curve (AUROC) as a measure of accuracy, or appropriateness of decisions made. The low sensitivity results of paramedics' decisions reported by McClelland and Jones (2015) i.e. 0.43 for sepsis and 0.30 for severe sepsis, led them to conclude the tool was not being used. These results are of value as they add weight to the argument that ambulance clinicians should use EWS systems to support their decision-making. The retrospective application of a similar tool was found to achieve sensitivity ranging from 0.75 (Wallgren et al., 2014) to 0.95 (Bayer et al., 2015).

The PMEWS used in the study by Ebrahimian et al. (2014b), performed slightly better when used by paramedics as a discriminator for patients requiring hospital treatment,

than when it had been retrospectively applied by Challen and Walter (2010); AUROC=0.738 compared to AUROC=0.710 respectively. Both these results fall within the 95% confidence interval range found when the NEWS was assessed as a discriminator for hospital admission; arrival at ED: AUROC = 0.664, 95% CI: 0.599-0.728, and within 60-minutes of arrival at ED: AUROC = 0.687 95% CI: 0.620-0.754 (Alam et al., 2015).

The descriptive analysis of the NEWS conducted by Shaw et al. (2017), using prehospital data, found patients discharged from ED had a median NEWS of 1 (range: 0-8, mean 1.72, SD 1.91, 95% CI: 1.34-2.10) and those admitted to a ward had a median NEWS of 3 (range: 0-12, mean 3.13, SD 2.59, 95% CI: 2.61-3.65). The median and mean NEWS for admission being lower than the PHEWS and PMEWS cut-off scores used to determine patients that should be conveyed to ED (Newton et al., 2013, Ebrahimian et al., 2014b). Clinical risk analysis illustrated that 65% of patients who were admitted to a ward, 14% of patients admitted to intensive care, and 13% of patients who died in ED had a NEWS ≤4 (Shaw et al., 2017). This confirmed the findings of Ebrahimian et al. (2014b) and Newton et al. (2013) that decisions to convey patients with low scores are not necessarily inappropriate. EWS should therefore be used to support clinical decision-making, not as a substitute.

EWS systems are often cited as being useful for improving the communication between HCPs (Andrews and Waterman, 2005, Page et al., 2008, Mohammed et al., 2009, Neary et al., 2015, Academic Health Science Network, 2017, Grespan, 2018). Used in association with the Situation-Background-Assessment-Recommendation (SBAR) tool, the NEWS provided a means of communicating, succinctly and efficiently, information about the patients physiological status (West of England Academic Health Science Network, 2016). By enhancing decision-making and providing a means of quantifying observed changes, EWS systems provide nurses with a sense of empowerment, and greater confidence when communicating and seeking assistance from doctors (Andrews and Waterman, 2005, Page et al., 2008, Neary et al., 2015). McClelland and Haworth (2016) however found the communication of the NEWS between paramedics

and other HCPs to have been a less positive experience, and inhibited uptake of the NEWS.

2.5.3 Low levels of compliance

Others exploring the prospective use of EWS systems by nurses, midwives and doctors also found evidence of low compliance. One reason being that the vital signs necessary to calculate a score were not measured in the first instance (Thomson et al., 2007, Ludikhuize et al., 2012, Niegsch et al., 2013, Essam et al., 2015, Odell, 2015). As McClelland (2015) and McClelland and Jones (2015) found, temperature was the one measure often not recorded (Clifton et al., 2015, Odell, 2015). As highlighted previously, the measurement of temperature is vital to support the identification of those who are acutely ill and at risk of clinical deterioration. Even when vital signs were measured, the summation of the score was often inaccurate, and/or responded to inappropriately (Smith and Oakey, 2006, Edwards et al., 2010, Christensen et al., 2011, Hands et al., 2013, Niegsch et al., 2013, Clifton et al., 2015, Essam et al., 2015, Odell, 2015). Odell (2015) claims non-compliance and high level of inaccuracies to be the main reason why EWS systems have failed to be found effective.

2.5.4 Preference to rely on intuition and clinical judgement

Effectiveness and usefulness may be compromised because of a poorness of fit between the EWS systems and the context in which they are being used. Even though the results from the systematic review would suggest EWS are easy and practicable, others have found during episodes of high workload, decisions are made independently of the EWS, with many clinicians preferring to rely on their intuitions (Smith and Oakey, 2006, Thompson et al., 2009, Christensen et al., 2011, Hands et al., 2013, Essam et al., 2015, Neary et al., 2015, Niegsch et al., 2013, Martin, 2015, Odell, 2015). When under pressure, HCPs can make less optimal decisions (Thompson et al., 2009).

According to Hammond (1980) decision-making involves various related modes of cognition that lie on a continuum. At one end of the cognitive continuum lies intuition, at the other end lies analysis, in between is quasi or bounded rationality, which is a

restricted mode of thinking that may need to be supported. Figure 2.2 below and Table 2.5 (p.66) also show how the cognitive method employed is dependent on task complexity, ambiguity and how the information is presented (Hamm (1988).

Figure 2.2: Illustration of Hamm's (1988) Cognitive Continuum Theory
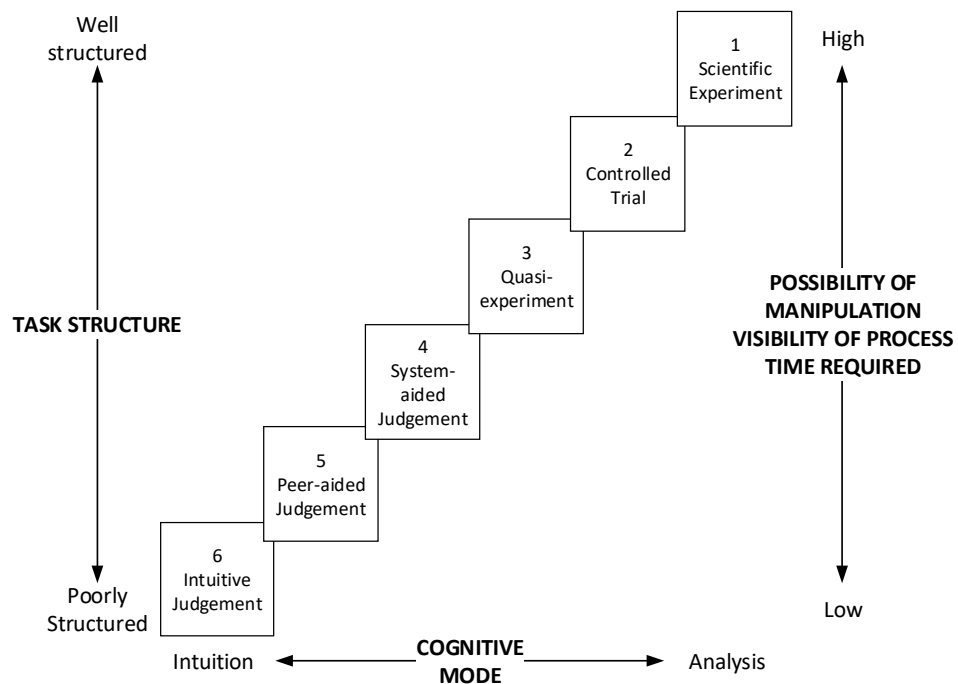
(Adapted from Thompson et al., 2004, p.70)

Intuition is a valuable asset, as it is based on acquired wisdom from professional experience and clinical practice (Higgs and Titchen. 2011 as cited by Loftus and Smith, 2008, p.208). However, relying solely on one's intuition and knowledge can result in biased judgements and decision errors, particularly when it comes to evaluating patients at risk (Thompson, 2003, Thompson et al., 2009). Having compared nurses unaided decision-making (intuition) of predicted risk of a critical event occurring, to the predicted risk according to a MEWS, Thompson et al. (2009) found nurses were more likely to overestimate risk. This is contrary to the findings presented by McClelland and Jones (2015) in which out of 27 patients with severe sepsis, paramedics only pre-alerted 11 cases before arrival at ED. If paramedics were relying on their own intuition, rather than using the sepsis tool, as McClelland and Jones (2015) proposed, they would seem to be under-estimating risk.

Table 2.5: The cognitive continuum and clinical intuition and analysis (Hamm, 1988, pp.5-6)

Task complexity	Number of cues	More pertinent cues that are provided the more likely the clinician will use intuition.
	Redundancy of cues	The more cues that can be predicted from each other, the more likely intuition will be used.
	Organising principle	If the task is simple, whereby a simple linear weighted average organizing principle is known to be accurate, then this will encourage the clinician to use intuition. Whereas, a complicated task, where the most accurate or appropriate outcome is derived from combining evidence, then an analytical approach will be used.
Task ambiguity	Availability of the organising principle	The analytical approach using the organising principle will only be adopted if it is readily available.
	Task familiarity	Unfamiliarity of the task, or lack of organizing principle will induce the clinicians to adopt an intuitive approach, whereby available cues are averaged.
	Possibility of increasing accuracy	If accuracy will be improved by conducting certain tests or treatments, then an analytical approach is more likely to be adopted.
Task presentation	Task decomposition	Tasks and sub-tasks that are presented in a step-by-step or sequential manner will induce analytical thinking.
	Cue definition (information presentation)	Pictorial cues/information will induce intuition. Objective measures presented in quantitative form induces analysis.
	Time	The less time available the more likely intuition will be used.

Even when EWS were used, Smith and Oakey (2006) found the assessment of risk to be compromised by high incidence of mis-scoring, with the tendency for error to be in the direction of *underscoring* patients' risk; i.e. 65.7% of patients with a true score of two, were erroneously scored as zero or one; 76.7% with a true score of three, were mis-scored as zero, one or two; and 84.6% with a true score of four, were mis-scored as zero, one, two or three. The mis-scoring of an EWS led them to question whether scores were calculated biasedly, to align with their own clinical impressions and intuition. Clifton et al. (2015) would however argue that clinicians are able to sense and use additional information that enables them to correctly predict improvement or deterioration in advance of the EWS system. They found actions deemed inappropriate initially, in relation to the EWS, were subsequently found to be appropriate and in accordance with the next set of observations recorded (Clifton et al., 2015). Such occurrences could lead clinicians to question the validity of EWS systems, as their own clinical decision-making and predictive ability would appear to out-perform the tool being used.

2.5.5 Resistance, scepticism and mistrust

Resistance, scepticism and mistrust can result from an ineffective implementation strategy (Niegsch et al., 2013) that fails to change the existing culture (Christensen et al., 2011, Ludikhuize et al., 2011, Hands et al., 2013, Martin, 2015). Winning the hearts and minds of those expected to adopt new methods is necessary to reassure and eradicate scepticism about the tool and its validity, and suppress unfounded reasons of why new methods have been introduced (Niegsch et al., 2013, Martin, 2015, Neary et al., 2015). For instance, when midwives were interviewed, it was found they had formed no positive conceptual link between EWS and patient benefits, because the rationale for implementation had not been communicated (Martin, 2015). The midwives had also not been actively involved in the implementation process, they had therefore perceived the changes as a means of reducing their autonomy and de-skilling the workforce (Martin, 2015). The perceived nonsensical increase in workload, precipitated by the patient reporting system requiring observations to be documented twice, exacerbated the nurses' resistance (Martin, 2015).

2.5.6 Ergonomic shortcomings

In addition to Martin (2015), others have found ergonomic shortcomings (i.e. poorness of fit) between new processes associated with the EWS system and existing working practices, which can inhibit the effective adoption of the EWS system (for examples see Prytherch et al., 2006, Odell et al., 2009, Edwards et al., 2010, Robb and Seddon, 2010, Christensen et al., 2011, Ludikhuize et al., 2011, Hands et al., 2013, Niegsch et al., 2013, Clifton et al., 2015, Essam et al., 2015, Neary et al., 2015). The voluntary nature of measuring and manual recording of the EWS, without prompts or reminders, in high demand environments, can result in omissions. The inclusion of symbols like <, ≤, > and ≥ on the tool itself can cause confusion. Even the original EWS tool published by Morgan et al. (1997) includes an error, with a heart rate of 130 being attributed an individual parameter score of 2 *and* 3 (see Chapter 1, Figure 1.1, p.25). Inaccessibility to resources (e.g. thermometers) can inhibit clinicians' ability to obtain the physiological measures necessary to calculate an EWS. And, unclear protocols, lack of monitoring and subsequent feedback can impact on compliance.

Non-compliance (task avoidance) can however be a coping strategy adopted by individuals to regulate effort and maintain an acceptable level of performance (Hockey, 2000). Such strategies can lead individuals to forgo certain tasks which they consider to be of low-priority, and focus only on those tasks considered to be important (Hockey, 2000). Performance protection strategies can be driven by an individual's subjective interpretation, thought-processes, emotions and evaluation relative to effort and the working goal (Figure 2.3, p.69). It is therefore unlikely a tool will be used if the effort needed exceeds perceived benefits.

Figure 2.3: An adaptation of Frankenhaeuser's (1986) performance protection strategies (Hockey, 2000, pp.220-222)

	INPUT		OUTPUT	
ENGAGEMENT	*Effort without distress*	**EFFORT:** *Demands within bounds of routine activity not exceeding individuals' capabilities*	**PERFORMANCE LEVEL:** *High level of effort & performance*	**EMOTION:** *Enthusiasm & elation*
DISENGAGEMENT	*Distress without effort*	**EFFORT:** *High effort. Demands greater than expected & exceed individual capabilities*	**PERFORMANCE LEVEL:** *Low effort. Reduced level of accuracy & speed. Disengaging from certain tasks*	**EMOTION:** *Distress, depressed, worried & fatigued*
STRAIN	*Effort with distress*	**EFFORT:** *High effort. Demands greater than expected & exceed individual capabilities*	**PERFORMANCE LEVEL:** *High effort. Strive & struggle to overcome environmental demands*	**EMOTION:** *Tense, weary, difficulty relaxing or sleeping*

Such issues have led to the development of computerised systems like the VitalPAC Early Warning Score (ViEWS), where scores are calculated automatically from the individual physiological measures entered by the clinician (Prytherch et al., 2010). However, the paramedics interviewed by McClelland and Haworth (2016) were of two minds whether auto-calculated or manually calculated scores would be more useful and effective in the prehospital setting. Some paramedics believed manual calculations would at least ensure the scores were consciously considered during the clinical decision-making process (McClelland and Haworth, 2016). Even when automated systems have been introduced, physiological measures were still not obtained, recorded, or acted upon according to policy (Hands et al., 2013). Non-compliance in such circumstances was presumed to be due to other contextual factors such as, *'staffing levels, monitoring equipment availability and the need to carry out other necessary clinical activities'* (Hands et al., 2013, p.724).

2.5.7   Encouraging adoption through collaboration

Task avoidance may also be the product of shortage of skills and/or lack of knowledge, creating low levels of confidence. Passive methods of implementation (e.g. one-hour teaching and discussion session as described by McClelland (2015) and McClelland and Jones (2015)) can often fail to engage staff effectively, leading to low levels of compliance (Christensen et al., 2011). The midwives, interviewed by Martin (2015), believed the training delivered to them had been inadequate, and the method of implementation left them feeling the changes had been imposed upon them. However, even well-designed training programmes can fail, if the training has not taken into account the influences of the wider context (Patrick, 2000).

Quality improvement collaboratives, as used by Carberry and Harden (2016), require a greater level of active participation from all those deemed to be critical for the initiative's success. Relative to this discussion, a collaborative should include frontline ambulance staff, other HCPs and patients who possess relevant knowledge and expertise, to work together collectively to achieve the desired outcome of the initiative being implemented. A collaborative approach enables conflicts between the changes

being implemented, and existing working practices to be identified and resolved effectively. They have proven to be effective in encouraging adoption of EWS in hospital settings (Robb and Seddon, 2010), and effective in facilitating other changes and improvements in ambulatory and prehospital care domains (Siriwardena et al., 2014, Wells et al., 2018). Unlike the midwives interviewed by Martin (2015), the frontline ambulance staff engaged by Siriwardena et al. (2014) appeared to have an understanding that the changes introduced were to improve patient care, rather than for other arbitrary or contentious reasons, and subsequently had taken ownership of the changes being implemented. Similar results would seem to have been achieved by Carberry and Harden (2016), leading to the changes they introduced being successfully adopted and sustained.

2.5.8 Strengths and limitations

There have recently been two other papers published that have systematically reviewed the ability of the EWS to identify patients with sepsis (Smyth et al., 2016) and critical illness in the prehospital setting (Williams et al., 2016). To my knowledge, this review is the first to have systematically reviewed evidence focusing on the effectiveness and usefulness of EWS systems, when used in the real-world context by ambulance clinicians. My findings have confirmed there are potential advantages to implementing EWS systems in the prehospital setting to support paramedics' decision-making, such as improved identification of patients needing a higher level of care, timelier delivery of care and appropriate utilisation of resources. I have also shown and discussed other factors that can facilitate or inhibit the successful adoption of EWS systems that need to be considered, prior to their implementation.

The number of manuscripts included in my review was nevertheless limited. This may have occurred because of the tight scope and search criteria applied. These were considered necessary for my research aim to be achieved. The numbers however do seem comparable to those included by Smyth et al. (2016, n=9) and Williams et al. (2016, n=8), as we had all used similar search terms and strategies. A key difference

between their search strategies and mine being they searched EMBASE, which I could not access owing to costs.

Whilst many researchers (e.g. Rollin et al., 2010, Stevinson and Lawlor, 2004, Kelly and St Pierre-Hansen, 2008, Bayliss et al., 2014) found MEDLINE to be the major source of the literature searched, Cochrane Collaborations Methodological Expectations of Cochrane Intervention Reviews (MECIR) requires literature to be searched across CENTRAL, MEDLINE *and* EMBASE to optimise results (Higgins and Green, 2011). Depending on the topic, searches may need to be further supplemented using other databases (Aagaard et al., 2016). Thus, not including EMBASE in my search strategy presents a risk that some literature was not captured. Considering EMBASE specialises in drug and pharmacological research, and less on general medicine and nursing than MEDLINE, the literature missed is likely to be minimal. Having reviewed the reference lists in Smyth et al. (2016), Williams et al. (2016) and other related systematic reviews (i.e. McNeill and Bryden, 2013, Alam et al., 2014, Downey et al., 2017), my search results were found to be comparative. I believe the literature included in this systematic review was limited primarily because of the paucity of evidence in this field, rather than the search strategy I applied. A similar conclusion was drawn by Williams et al. (2016) regarding their search result.

Only one manuscript included in this review provided qualitative insight. Whilst the insight provided was of value, there were inconsistencies with interview methods adopted and a lack of information about the analysis methods applied. The quantitative results from the other studies were mostly descriptive. The quality of data used by some, raised doubts regarding the reliability and validity of their study. For example, McClelland (2015) made no reference to the data being checked or cleaned. Then, in the results, the upper range for respiratory rate in one sample of data was 60 respirations per minute, which could relate to heart rate. Similarly, the lower range for heart rate was 14 beats per minute, which could relate to respiratory rate. Such results lead one to question whether there was a possibility that measurements had been inverted; either by the ambulance clinicians when recording physiological measures on

the patient report forms (PRFs), or by the researcher, when manually extracting information from the PRFs, in preparation for the analysis.

It was also unclear from the study conducted by Ebrahimian et al. (2014b), whether one or more ED specialists were used to evaluate accuracy of the decisions made by the ambulance clinicians - if more than one, no inter-rater reliability was provided. And, whilst the study undertaken by McClelland and Jones (2015) was found to be of a higher quality than the other five manuscripts included in my review, Smyth et al. (2016, p.8) found the study conducted by McClelland and Jones (2015) provided *'very low-quality evidence'*, owing to risk of bias, indirectness and imprecision, which meant they had very little confidence in the effect estimated.

Homogeneity and heterogeneity were difficult to discern, because not all the authors provided information about their patient sample or the paramedics using the tools. Considering the locations where each study took place, it is highly possible that the results of my review are not generalisable. Three of the six papers were written by the same author and related to care delivered within one English ambulance trust. Five related to care delivery by neighbouring ambulance services in the UK; i.e. North East Ambulance Service, North West Ambulance Service and Scottish Ambulance Service NHS Trusts. Only one paper related to care delivery outside of the UK. Whilst I did specify language within my exclusion criteria, I did not specify geographical exclusions. Studies from certain countries may nevertheless have been indirectly excluded, owing to differences in national guidelines that meant the EWS systems used in some countries did not meet my inclusion criteria.

2.6   My rationale for conducting further research

Having reviewed the literature, I considered there to be a paucity of trustworthy evidence providing insight into the effectiveness and usefulness of EWS systems when used by paramedics in the prehospital context. Despite the lack of evidence, the NEWS began being introduced by AMB-X in April 2014. AMB-X required paramedics to apply the NEWS in conjunction with Paramedic Pathfinder, to support and confirm all

conveyance, referral and self-care decisions. AMB-X acknowledged ED may be appropriate for some patients, but…

> *'…for many patients, a full holistic assessment in conjunction with Paramedic Pathfinder, NEWS and clinical guidance will determine an appropriate referral to an alternative care provider with a clinician-to-clinician handover, or self-care advice with robust safety netting and signposting to alternative healthcare providers as the optimum outcome.'*
> *(AMB-X NHS Trust, 2016, p.6)*

The effect of the NEWS on conveyance decisions was of primary important for AMB-X, owing to NHS England's (2014) Five Year Forward View, which encourages health service providers to develop and deliver integrated services (i.e. community, primary and acute care systems), and utilise out-of-hospital care alternatives (NHS England, 2014). However, a previous literature review found a lack of evidence indicating a clinically safe approach to identifying patients who do not need to be conveyed to ED (Snooks et al., 2004). The review did find a significant minority of those not conveyed were at risk of deterioration, and subsequently needed further emergency care (Snooks et al., 2004). The review concluded that further evidence was needed, concerning the benefits of triage conducted by ambulance crews on scene, and decision made regarding appropriate care pathways (Snooks et al., 2004). I therefore used the implementation of the NEWS at AMB-X as an opportunity to conduct a case study to address the evidence gap.

2.6.1 Research aim and objectives

As mentioned previously in Chapter 1, section 1.4.1, my research aim was to evaluate the effectiveness and usefulness of the NEWS to support paramedic decision-making to appropriately treat patients closer to home.

I define effectiveness as the quantifiable effect the implementation of the NEWS had on ambulance non-conveyance and recontact rates; the latter being a measure that takes into consideration AMB-X's aim for the implementation of the NEWS (in conjunction with Paramedic Pathfinder) to support paramedics to make optimum decisions (i.e. appropriate and safe decisions to convey or not convey). The perceived effectiveness of the NEWS in supporting optimum decisions would also be explored

qualitatively, both with those using the tool (i.e., paramedics) and the management team responsible for ensuring the safe implementation and evaluation of the NEWS as part of the Paramedic Pathfinder Programme.

I define usefulness as the degree to which the paramedics themselves subjectively found the NEWS to be practical (i.e., fit for purpose and worthwhile using in prehospital setting) and helpful in supporting them with their decision-making.

As per the research questions presented in Chapter 1, section 1.4.2, p.39, I sought to identify the effect that the implementation of the NEWS at AMB-X had had on the numbers and proportions of patients not conveyed to ED, who were treated closer to home; either at scene or via an alternative care pathway. And, of those patients treated and left at scene, I wanted to know if the decision had been made appropriately; that is, did the introduction of the NEWS have any effect on the numbers and proportions of those patients who recontacted AMB-X within 24-hours. I also wanted to know how useful and effective paramedics perceived the NEWS to be in supporting them in their decisions to convey or treat closer to home. And lastly, I wanted to know when and how the NEWS was being used by paramedics in the real-world context.

2.6.2   Theoretical propositions

In addition to my research questions, Yin (2014, pp.29-30) proclaims a case study should also have theoretical propositions, to strengthen construct validity. Theoretical propositions are predicted patterns or articulated outcomes that are expected based on prior evidence. The results from each research method should then be compared to the proposed propositions to identify the best match. In circumstances where neither of the proposed patterns are found to match, then alternative explanations should be retrospectively proposed (Yin, 2014).

I therefore proposed two possible outcomes. My first proposition was based on NHS England's Urgent and Emergency Care review (2013b) in which it is stated half of all patients attended could be managed at the scene, or referred to an alternative health care provider. Plus, prior evidence that suggests EWS systems may support safer and

more appropriate decision-making by paramedics in the prehospital setting (Challen and Walter, 2010, Gray et al., 2010, Fullerton et al., 2012, Newton et al., 2013, Ebrahimian et al., 2014b).

Proposition 1. The introduction of the NEWS will be effective and useful in supporting paramedics' decision-making to appropriately treat patients closer to home: The introduction of the NEWS, at AMB-X, would support safer and more appropriate decisions and therefore will have a significant effect on non-conveyance rates and recontact rates. Paramedics would consider the NEWS supportive (i.e. useful and effective) in most circumstances and would use it compliantly (i.e. frequently and accurately), as part of their decision-making and in accordance with AMB-X's policy.

However, as discussed in this chapter, there are many factors that may inhibit the successful adoption and accurate use of the EWS. The physiological measures needed to calculate an EWS may not always be assessed or recorded on the PRFs, and when they are, the EW score itself may not be calculated, or may be calculated inaccurately. Non-compliance and inaccuracies as described, will compromise the effectiveness of the EWS, by inhibiting the early identification of patients at risk, or whose condition is deteriorating. I therefore propose a second rival proposition, a null hypothesis as it were, as follows.

Proposition 2. The NEWS will be ineffective and not useful in supporting paramedics' decision-making to appropriately treat patients closer to home: The introduction of the NEWS at AMB-X would have no significant effect on non-conveyance or recontact rates. This would be because paramedics considered the NEWS to be supportive in some situations and not others; that is, the effectiveness and usefulness of the NEWS would be context dependent. Subsequently, there will be a lack of compliance; that is, the NEWS would be used infrequently to support decision-making, and when used it will often (≥ 20% of occasions)[2] be calculated/recorded inaccurately.

---

[2] This figure is based on previous evidence (e.g. Prytherch et al (2006), Smith & Oakey (2006) Edwards et al (2010), Ludikhuize et al (2011) and Essam et al (2015)).

2.7 Summary

The use of EWS systems in the prehospital emergency care setting can help paramedics to make safer, more appropriate decisions. EWS can also support communication during clinical handover of patient care. Yet, the utilisation and application of such systems can often be compromised by a wide-range of factors. Some factors compromising utilisation relate to practicality of the tool, such as confusion caused by the mathematical symbols used on the tool, others relate to environmental issues, such as clinical workload. For desired outcomes to be achieved, EWS systems may need to be supported by protocol, algorithms or other prompts that specify, or remind ambulance clinicians of required actions. Some barriers are however more inherent within the individual, such as scepticism and mistrust of the tool. Adopting a collaborative approach during implementation may support positive behavioural changes that can lead to desired outcomes being more effectively sustained.

Whilst the findings from this review are of value, the evidence sourced was limited, and the trustworthiness was compromised by the methodological quality of the studies included. Therefore, to add knowledge to the limited evidence base, and to provide greater insight of the effectiveness and usefulness of the NEWS in supporting paramedic decision-making in context, I proposed using the implementation of the NEWS at AMB-X, as an opportunity to undertake my own case study. In Chapter 3, I discuss the methodological approach adopted. In Chapters 4, 5, and 6 I present the results from my research. In Chapter 7, my results are integrated and summarised, then discussed in Chapter 8.

3   Methodology

In the previous chapter, I highlighted that there was a lack of trustworthy evidence providing insight into the effectiveness and usefulness of EWS systems when used by paramedics in the real-world context. I subsequently proposed undertaking further research to fill the evidence gap, by using the implementation of the NEWS at AMB-X as a case study. I begin this chapter by presenting the research design and philosophical approach that I adopted. I then introduce the research methods used and the ethical issues that I considered before commencing my research. I provide further insight into the context in which the study took place, before describing the data collected, and how these were analysed and integrated.

3.1   Research design

Research design is the planned approach of inquiry adopted by researchers to achieve their research aim (Denzin and Lincoln, 2011, p.99). In this instance, I adopted a single case study design to a) measure the effect of the NEWS on non-conveyance and recontact rates over a specified time-period; b) to gain insight from paramedics and managers of the perceived effect and usefulness of the NEWS; and c) gain insight into how the NEWS was being used in context to support paramedics' decision-making.

According to Yin (2014, p.16), *'…a case study is an empirical inquiry that investigates a contemporary phenomenon (the "case") in depth and within its real-life context, especially when the boundaries between phenomenon and context may not be clearly evident'*. A single case study, such as this, is able to provide a detailed account of an organisation where the focus is on contextual factors, perceptions and attitudes preceding a known outcome, and explores possible causes, determining factors, processes and experiences contributing to that outcome (Robson, 2011).

Case studies are the preferred strategy to address 'how' or 'why' questions and where the researcher has little situational control (Yin, 2014). This lack of control has led some to consider case studies to be of little value and only to be used as an exploratory tool prior to undertaking more substantive inquiries (Campbell, 1975, Platt, 1992).

However, even Campbell who had himself contested case studies, was eventually persuaded that case studies were equal to other scientific (more experimental) methods. He agreed case studies support and enable the development of…

> *'…valid inferences from events outside the laboratory while at the same time retaining the goals of knowledge shared with laboratory science.'(Campbell's Foreword in Yin, 2014, p.xvii)*

3.1.1 Philosophical approach

Before seeking new knowledge, researchers are required to consider their research philosophy (or paradigm); that is, the thoughts and beliefs that will underpin their study (Guba and Lincoln, 1994).

I knew theoretically, from prior research, that the use of EWS systems can provide an objective measure of a patients' physiological well-being, and this measure could be useful in supporting paramedics' decision-making in the prehospital setting (e.g. Challen and Walter, 2010, Gray et al., 2010, Fullerton et al., 2012, Silcock et al., 2015, Royal College of Physicians, 2017). This is because EWS systems were developed and analysed based on normative and prescriptive theories of how decisions are best made and should be made, but this does not consider how decisions are made in context. Logically, if an EWS system is going to have any effect, then it must be used. But, again from previous research, I knew the use and adoption of EWS system could be limited (Ludikhuize et al., 2011, McClelland, 2015, McClelland and Jones, 2015, McClelland and Haworth, 2016). The NEWS is more likely to be used to support decision-making (a hard skill) when the paramedic possesses the desire, attitude and willingness (soft skills) influencing them to do so (Haines, 1998, Clements and Mackenzie, 2005).

When the NEWS is used, it could be used in a variety of ways. Ambulance policy requires a paramedic to conduct two physiological assessments, referred to as observations. Some paramedics may calculate two scores; one score from each observation. Whereas other paramedics may calculate just one score; a score acquired from either the first or second observation, or one score calculated from a combination of measures acquired from each observation. Some paramedics may calculate a NEWS

for all their patients; regardless of the patient's clinical complaint or social circumstances. Other paramedics may use the NEWS in some situations, such as when the patient is suspected to have sepsis, but not in others. There may be occasions when a paramedic forms a decision using the NEWS, but their decision may be overruled; either by the patient refusing to go to hospital, or by the GP insisting the patient is conveyed. Alternatively, the paramedic may have to convey the patient to hospital, because no alternative care pathways are available. Such pre-existing theories needed to be validated empirically, in context. To achieve my aim and objectives, and to provide greater descriptive understanding of how decisions are made by paramedics using the NEWS, I believed it was necessary and appropriate to adopt a pragmatic approach.

Pragmatists share many beliefs with the other philosophical positions (Lipscomb, 2011), such as constructivism and objectivism (Table 3.1, p.81). Pragmatists believe reality is whatever is relevant and can be known perceptively and/or experientially in context. Epistemologically, pragmatists accept that knowledge and understanding is transitory. Research and understanding may need to be revised as new knowledge is acquired (Dewey, 1937 as cited p.901 by Ormerod, 2006). This is because the event of interest always occurs in contexts that are historically, culturally and politically influenced (Creswell, 2014). Methodologically, pragmatists tend to use a mixed methods approach, to generate practical real-world understanding and solutions (Creswell, 2014).

Table 3.1: Contrasting dimensions and viewpoints of three research paradigms

	CONSTRUCTIVISM (INTERPRETIVISM)	PRAGMATISM	OBJECTIVISM (POSITIVISM/POSTPOSITIVISM)
ONTOLOGY – *the nature of reality (that which can be known)*	There are multiple realities, socially and experientially constructed	Reality is transitory. It is whatever is relevant and can be known perceptively and/or experientially in context at that timepoint	Reality is 'common sense'; everyone sees reality the same way
EPISTEMOLOGY – *is the relationship between the researcher (knower) and the participant (the known)*	Subjective; reality is mentally, socially and experientially co-constructed between the researcher and the participant.	Objective and subjective; dependent on stage in research cycle	Objective dualism/modified dualism; the individuals and their beliefs are independent from external reality (i.e. dualistic)
AXIOLOGY – *the role and influence of personal values and beliefs*	Value-bound inquiry; personal values and beliefs are important and strongly influential to the inquiry	Personal values and beliefs are important when interpreting the results	Inquiries are value-free, or at least can be controlled
METHODOLOGY – *the approach to seeking knowledge*	Qualitative. An inductive logical approach, where inferences are constructed from observations and interactions	Mixed methods, both qualitative and quantitative. Inductive, hypothetico-deductive and abductive approach	Quantitative. A hypothetico-deductive approach usually causes seeking an effect, but sometimes an effect seeking a cause
ROLE OF THE RESEARCHER	Interpreter	Interpreter/Translator	Translator

(Developed from Teddlie and Tashakkori, 2009, pp.86-93)

3.2   Research method

I used a mixed method approach, where multiple sources of evidence were obtained and analysed using quantitative and qualitative methods. I objectively measured, using quantitative data, the effect the implementation of NEWS had had on non-conveyance and recontact rates (i.e. to address research questions 1 and 2), and constructed understanding, from qualitative data, of when and how paramedics were using the NEWS, and if/when it is not used, the reasons why (i.e. to address research questions 3 and 4). Adopting a mixed methods approach increases the construct validity of case studies (Yin, 2014)

Quantitative data were extracted from monthly data sets submitted by AMB-X to NHS England. The data gathered captured two key outcomes; numbers and proportion of patients not conveyed to hospital, and numbers and proportions of patients (treated and left at scene) who recontacted the service within 24-hours of the original emergency call. These data were analysed as recommended by Cochrane, using an interrupted time series (ITS) method, where the same variables are compared before and after a clearly defined point in time, at which an intervention occurred (Cochrane Effective Practice and Organisation of Care, 2017). The quantitative methods adopted are discussed in more detail in section 3.5, sub-sections 3.5.1-3.5.9, pp.90-106. The results are presented in Chapter 4.

It was difficult to discern from quantitative methods alone if any effect was due to the NEWS, as the NEWS was introduced concurrently with Paramedic Pathfinder. It was therefore imperative to gain further insight and understanding of effectiveness and usefulness of the NEWS from those who were implementing the NEWS and those using the NEWS to support their decision-making. This was explored using qualitative methods.

Qualitative data, in the form of quotations obtained from semi-structured interviews with paramedics, were analysed to gain insight and understanding of how useful and effective the NEWS was perceived to be in supporting decisions to convey patients to

hospital or to treat them closer to home. The interview methods adopted are described in detail in section 3.6, subsections 3.6.1-3.6.4, pp.109-111. The results are presented in Chapter 5.

Whilst interviews facilitate deeper insight from an individuals' perspective (Goodley et al., 2003), individual accounts and perspectives can be unreliable and subject to bias. Participants may not describe their experiences, actions or behaviour accurately or truthfully (Fox, 2009). To overcome such biases, Trochim (1989) recommends that researchers should also observe the objects of interest within context, on multiple occasions and with different participants, and then consider the degree of similarity and differences between these.

Non-participant observations were therefore also conducted to improve reliability and validity of this study. Non-participant observations are where the researcher does not intrude or overtly engage with the social interactions that takes place (Williams, 2008). Whilst observations in the healthcare setting can be challenging and time-consuming (Walshe et al., 2012), they are considered an effective and valid method of investigating individuals and their interactions with other external influences in the real-world setting (Emerson et al., 2001, Walshe et al., 2012). This method would enable me to directly observe how paramedics were using the NEWS to support their clinical practice and decision-making, rather than relying on how they proclaim to use it. I describe the observation methods adopted in more detail in section section 3.6, p. 109, subsections 3.6.1, p.110 and 3.6.5-3.6.7pp. 114-115. The results are presented in Chapter 6.

There are various mixed methods designs which could be adopted. For example, exploratory or explanatory sequential mixed methods designs are where data are gathered and analysed using one method followed by another. An exploratory design might involve gathering and analysing qualitative data before commencing the quantitative research, to inform the quantitative research design. Whereas, an explanatory design would involve gathering and analysing qualitative data after the quantitative research, to provide greater understanding about the quantitative

findings. I adopted a convergent mixed method design. Rather than gathering data sequentially, I gathered quantitative and qualitative data concurrently and analysed the three workstreams independently. A pattern-matching technique was then used to *converge* or integrate the findings. This was achieved by comparing the results from each of the three workstreams to my theoretical propositions (Trochim, 1989, Yin, 2014). The method adopted is illustrated in Figure 3.1 (p.85).

Some may argue that my approach is multimethod research, not mixed methods, because the research is not being integrated (mixed) until the concluding stage (see Bazeley in Johnson et al., 2007). However, even Bazeley uses the term mixed methods to describe multimethod research when in need of a generic term (Johnson et al., 2007). I have used the term mixed methods to describe my approach as it fits with many definitions proposed, including that provided by Tashakkori and Teddlie who describe a mixed method approach as…

> *'… a type of research design in which QUAL and QUAN approaches are used in types of questions, research methods, data collection and analysis procedures, and/or inferences.' (Tashakkori and Teddlie, 2003, p.711)*

Figure 3.1: Conceptual framework – Evaluating the effectiveness and usefulness of the NEWS to support paramedics' decision-making to appropriately treat patients closer to home

RESEARCH AIM

To evaluate the effectiveness & usefulness of NEWS
to support paramedics' decision-making to appropriately treat patients closer to home

RESEARCH QUESTIONS

What is the effect of NEWS on numbers & proportions of patients not conveyed to ED?

What is the effect of NEWS on numbers & proportions of patients discharged at scene who recontact EMAS within 24-hours?

How useful & effective do paramedics perceive NEWS to be in supporting them in their decision to convey patients or treat closer to home?

How is NEWS used by paramedics in the emergency prehospital care setting?

THEORETICAL PROPOSITIONS

NEWS would have a significant effect

NEWS would be considered useful and effective in most circumstances

NEWS would be used frequently and accurately to support paramedics' decision-making.

OR

OR

OR

NEWS would have no significant effect

NEWS would be considered useful and effective in some situations and not others (i.e., context dependent)

NEWS would be calculated and used to support paramedics' decision-making only occasionally. When used, it would often be calculated/ recorded inaccurately.

METHODOLOGY & METHODS

Quantitative
- Objectively measure number & proportions of patients not conveyed to ED, before and after NEWS.
- Objectively measure number & proportions of patients who recontact EMAS within 24-hours of discharge at scene, before and after NEWS

Qualitative
- Gain subjective insight and understanding of factors influencing, facilitating or inhibiting the use of NEWS
- Gain subjective insight and understanding of how NEWS is being used to support decision-making in practice

Integration of QUAN & QUAL results

3.3 Ethics

Prior to commencing my PhD research, ethical approval was sought to conduct a quantitative pilot study using a Modified Early Warning Score. Approval was sought from the local Health Research Authority Research Ethics Committee, using the Integrated Research Application System (Appendix 15, p.348). NHS permissions was obtained from the ambulance service's Clinical Governance, Audit and Research department (Appendix 16, p.352).

When it came to seeking approval to conduct the the main case study as part of my PhD research, approval from the NHS Research Ethics Committee was deemed unnecessary by the ambulance service's Head of Clinical Governance, Audit and Research. This was because the NEWS had already been implemented by the ambulance service, independent of me and my PhD research. Instead of research, my case study was deemed to be a service evaluation (Appendix 17, p.355).

According to the Health Research Authority (2017), a service evaluation is a study that is:

- Designed and conducted to define and judge the standard of care and services abeing delivered;
- Involves an intervention in use, where the choice of treatment, care or services is that of the care professional and patient according to guidance, professional standards and/or patient preference;
- Involves analysis of existing data, but may also include the administration of interviews or questionnaires;
- Involves no allocation to intervention – the care professional and patient have chosen intervention before service evaluation; and
- Involves no patient/participant randomisation.

I therefore only needed to obtain NHS permissions from the ambulance service and approval from the Research Ethics Committee at the University of Lincoln prior to the start of data collection (Appendix 18, p.359 and Appendix 19, p.360).

To obtain ethics approval, I completed and submitted the required ethical application forms to the respective orgnasiations for review. An Ethical Approval Form (EA1) was submitted for my Systematic Literature Review, and a further form (Ethical Approval Form EA2) was submitted for aspects of my research that would involve human participation and the use of personal data, such as semi-structured interviews. The ethical application forms had to be submitted with a detailed project plan providing a timeline for each aspect of my proposed research activity, plus copies of any documentation that would be used to support my research (e.g., Participant Information Sheets (Appendix 20, p.361 and Appendix 21, p.363), Participant Consent Forms (Appendix 22, p.365 and Appendix 23, p.366), Interview Topic Guides (Appendix 24, p.367 and Appendix 25, p.372), Observation Guide (Appendix 26, p.378) and Record Sheet (Appendix 27, p.380)).

All necessary measures and precautions were taken to safeguard patient and participant data in accordance with AMB-X's information governance and data protection policy. Raw data extracts containing patient identifiable information were only accessible to members of the research department who had routine access to the patient databases as part of their job role. Raw data were stored confidentially, in lockable confines and within electronic files; secured on password protected encrypted computers. Prior to being released, data were anonymised in accordance with the Data Protection Act and the Caldicott principles, by members of AMB-X's research department. Participants' personal information (e.g. name and contact details) were kept separately from study data and were restricted to the researcher and research team members. In the bid to maintain AMB-X's organisational anonymity, locality identifiable information and associated references have been given a pseudonym where appropriate, and/or identifiable information has been redacted (e.g. from the references of cited publications such as Care Quality Commission reports).

Interviews and observations were undertaken with overt and informed consent; meaning paramedics who volunteered had a clear understanding of the study aims and their right to withdraw at any stage. This was achieved by providing those interested

with a participant information sheet in advance, allowing the information to be processed without duress (Appendix 20, p.348 and Appendix 21, p.363).

I was aware that enquiries undertaken during interviews and observations may cause participants to revisit potentially distressing experiences or disclose issues of a concerning nature. I endeavoured to ensure the risk of causing distress was minimal. A formal process of reporting was in place had any issues of concern become apparent during the study.

3.4 Context

AMB-X is one of ten ambulance services in England. It serves six counties, which for the purpose of organisational anonymity will be referred to as County1, County2, County3 et cetera. AMB-X provides urgent and emergency care to a population of 4.8 million, located across an area of 15,600km2.

3.4.1 *Emergency care delivered by AMB-X*

At the time of this study, AMB-X received approximately 2,000 emergency calls per day. Each call received would be triaged by a non-clinically qualified Emergency Medical Dispatcher, located remotely within the emergency operational control room. Triage was conducted using a computerised Ambulance Medical Priority Dispatch System (AMPDS). AMPDS categorises each emergency call as either life-threatening (i.e. a 'category A', Red 1 or Red 2 call), or non-life-threatening (i.e. a Green call). A fast Response Vehicle (FRV) and/or a double crewed ambulance (DCA) would be dispatched to attend Red 1 and 2 calls, and Green 1 and Green 2 calls. Further telephone assessment and advice was provided by paramedics and nurses within the Clinical Assessment Team (CAT), for all other non-emergency calls (i.e. Green 3 and 4 calls (Figure 3.2, p.89)).

Figure 3.2: An overview of the ambulance 999-call triage and response process
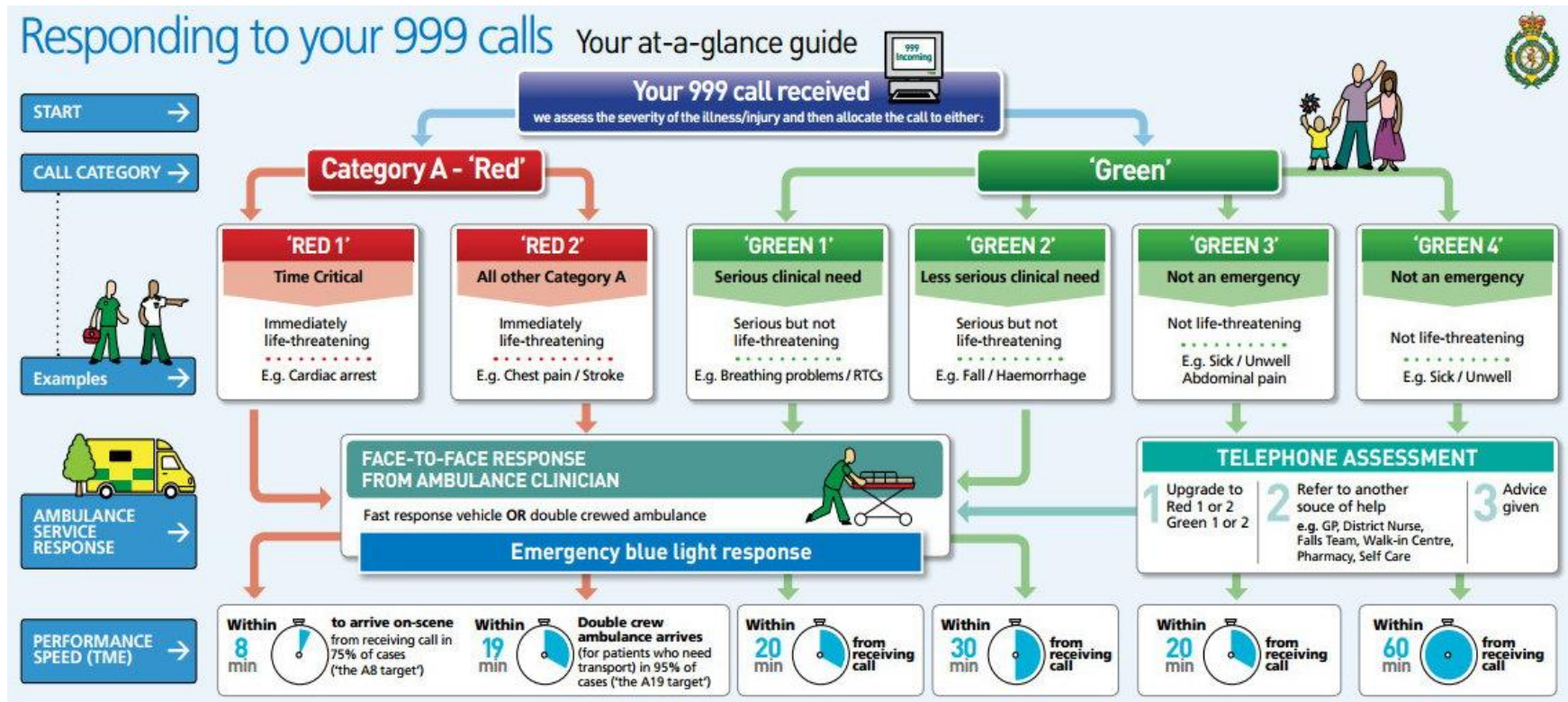
(AMB-X NHS Trust, 2014b)

A DCA is usually crewed by one Emergency Care Assistant (ECA) who is trained in basic first aid, cardiopulmonary resuscitation and emergency driving, plus a higher trained clinician, such as an EMT or paramedic. Paramedics have acquired professional status and are registered with the Health and Care Professions Council (HCPC). Paramedics also respond unaccompanied to incidents on an FRV.

The EMT or Paramedic, on the DCA, will take overall responsibility (above that of an ECA) for assessing the patient's clinical condition and providing any necessary treatment. If additional treatment, assessment or on-going care is necessary then the attending clinician will either decide to refer the patient to another community-based HCP (e.g. patient's GP), or to convey the patient to ED or other specialist treatment centre. Paramedics working solo on an FRV, will request a DCA to attend to convey the patient to hospital when necessary.

In April 2014, AMB-X began implementing the Paramedic Pathfinder Programme. The programme included training staff how to make decisions using the Paramedic Pathfinder tools and the NEWS *'to determine the potential to use ED alternatives'* (Mills et al., 2014, p.4). During training and within the Paramedic Pathfinder Handbook, clinicians are instructed to convey patients with a NEWS greater than four to the ED, in accordance with local protocols, whereas scores of four or below were *'deemed as low clinical risk and likely to benefit from a community based process'* (Mills et al., 2014, p.9). To measure the effect on decisions to convey or not convey, an interrupted time series method of analysis was adopted. This required quantitative data to be collected, before and after the intervention was introduced.

3.5 Quantitative data and analysis: an interrupted time series approach

3.5.1 Data collection

Data relating to Ambulance Quality Indicators (AQI) are submitted monthly by AMB-X to NHS England. NHS England uses the data to support governance, commissioning and to evaluate health service priorities. AQI data contain operational data (e.g. numbers of emergency calls received) plus clinical data (e.g. return of spontaneous circulation

following treatment for a cardiac arrest). For this study, the data sets were sourced from NHS England[3] and included the following:

- Numbers of emergency calls that were attended to face-to-face by an ambulance clinician (i.e. 'See & Treat' calls). Data set includes 999 and NHS 111 calls but excludes calls from other HCPs (e.g. GPs).

- Numbers of life-threatening category A calls resulting in an ambulance arriving at the scene of the incident. Includes 999 and NHS 111 calls that have been triaged as either Red 1 or Red 2 responses.

- Numbers and proportions of patients not conveyed to type 1 or 2 ED, but who were discharged after treatment at scene, or conveyed for treatment delivered by an alternative healthcare provider at a Type 3 or Type 4 facility (e.g. UCC, MIU or WiC). This data set provides the measure of patients being treated closer to home and includes 999-calls only.

- Numbers of patients treated, discharged and left at scene. Data set includes 999-calls only. Outcome relates to patients treated by the ambulance practitioner, and those referred to GP only. Excludes patients conveyed to alternative Type 3 or Type 4 service providers.

- Numbers and proportions of patients treated and left at scene, who recontact AMB-X within 24-hours. Data set includes 999-calls only.

The advantage of using AQI data sets is that the data were in the public domain[3] and the collection method was independent of the intervention. The data were collected objectively and validated by others not connected with this study. Data were collected using the same methods, before and after NEWS was introduced. A further advantage is the data captured *all* the emergency calls attended to across the region and subsequent decision outcomes. This equates to approximately 50,000 patients attended per month and more than a million patients per year. Unlike data samples,

---

[3] See Ambulance System Indicators Time Series available at
https://www.england.nhs.uk/statistics/statistical-work-areas/ambulance-quality-indicators/

with an element of sampling error, these data sets will provide a true measure of effect. There were however other discriminators included in the Paramedic Pathfinder algorithm, unrelated to the NEWS, that recommended patients should be conveyed to ED (e.g. headache as primary presentation). I could therefore not infer that any significant effects were solely because of the NEWS. Any inferences drawn needed to be validated using qualitative data.

A further problem with the analysis related to the NEWS being implemented gradually over a 12-month period (April 2014 to March 2015). Gradual diffusion of effects can sometimes be difficult to identify (Shadish et al., 2002). The decision was therefore made to include data for a protracted period before and after implementation to ensure adequate time for skills and knowledge to have become diffused and embedded. The data collected was therefore longitudinal (rather than cross-sectional) covering a total period of 68-months; 34-months pre-NEWS (capturing June 2011 to March 2014), and 34-months post-NEWS (capturing April 2014 to January 2017). The implementation of the NEWS commenced in April 2014, defining the timepoint on which comparisons of effect would be analysed.

3.5.2   Interrupted time series (ITS) method

The comparison of effect of the NEWS on decision outcomes were objectively measured using ITS methods. Time series analysis is the observed study of a measurable variable (e.g., rainfall, temperature, stock prices) across time (e.g., hourly, daily, weekly, monthly, quarterly, annually). I chose an ITS design as it enables researchers to analyse effects in situations where the researcher is unable to enforce strict experimental controls (i.e. real-world situations). It would entail collect data at consistent intervals, before and after the NEWS was introduced. The researcher must know the specific timepoint an intervention was introduced, as the objective of time series analysis is to detect whether the intervention (i.e., NEWS) has had an effect post-intervention significantly greater than the underlying secular trend pre-intervention. I described the Autoregressive Integrated Moving Average (ARIMA)

time series analysis method which I adopted in more detail below (Section 3.5.7, p.96, Section 3.5.8, p. 97 and 3.5.9, p.106).

A research design first proposed by Campbell (1963), Shadish et al. (2002, p.171) proclaim ITS designs to be *'one of the most effective and powerful of all quasi-experimental designs'*; as ITS design *'allows for the statistical investigation of potential biaises in the estimate of effect of the intervention'* (Ramsay et al., 2003p.614). Potential biases include secular trends where outcomes may increase or decrease naturally over time; or cyclical patterns (e.g., variations between traffic density or emergency calls on weekday compared to weekend) and seasonal effects; or duration of the intervention, which may mean the effect is only transient or has not yet had sufficient time to have an effect; or random fluctuations; or autocorrelation, which is the extent to which data collected close together in time are correlated. The method adopted in this study, according to the hierarchy of evidence, would be designated level III-3, that is the evidence would be obtained from an interrupted time series without a parallel control group (Table 3.2, below).

Table 3.2: Designated Levels of Evidence

I	Evidence obtained from a systematic review of all relevant randomised controlled trials.
II	Evidence obtained from at least one properly designed randomised controlled trial.
III-1	Evidence obtained from well-designed pseudo-randomised control trials (alternate allocation or some other method).
III-2	Evidence obtained from comparative studies with concurrent controls and allocation not randomised (cohort studies), case-control studies, or interrupted time series with a control group.
III-3	Evidence obtained from comparative studies with historical control, two or more single arm studies, or interrupted time series without a parallel control group.
IV	Evidence obtained from case series, either post-test or pre-test and post-test.

(As cited in Appendix B, p.56 in National Health and Medical Research Council, 1999)

3.5.3 Outcomes measured

The primary outcome measured were the numbers and proportion of patients not conveyed to ED.

The secondary outcome measured were the numbers and proportion of patients left at scene, who recontacted AMB-X within 24-hours.

The null hypotheses (H_0) being the numbers and proportion of patients not conveyed to ED and numbers and proportion of patients that recontacted would not be significantly affected by the implementation of the NEWS.

The alternative hypothesis (H_1) being the numbers and proportions of patients not conveyed to ED and numbers and proportions of patients that recontacted would be significantly affected by the implementation of the NEWS.

A confidence interval of 95% was applied.

3.5.4 Confounders

Ramsay et al. (2003) found 66% of ITS studies reviewed, failed to consider how events outside the researchers' control may have influenced the effects observed. Such confounders need to be considered when developing inferences. Therefore, the numbers of See & Treat calls were analysed to provide a baseline measure and insight of any changes to the overarching operational demand. Significant increases in demand may lead to changes in organisational policies and procedures that will impact on pre-existing models of care. Even if the numbers of attendances remained constant, the acuity of calls may have varied during in the time-period. Therefore, I also analysed the numbers of calls attended that were triaged as life-threatening responses (Category A). An increase in acuity may impact on numbers and proportions able to be treated closer to home (i.e. the primary outcome measure). The numbers of patients treated, discharged and left at scene were also analysed to provide a baseline measure for the secondary outcome measure.

3.5.5   Outliers

All data sets were assessed for outliers that deviated from other observations sufficiently *'to arouse suspicions that it was generated by a different mechanism'* (Hawkins, 1980, p.1). Detection was based on a t-statistic critical value of ±3.63. The critical value was based on the number of observations in this study and was derived from the formula developed by Ljung (1993), as specified within guidance developed by SAS Institute (2012, p.2608) and the X-12-ARIMA Seasonal Adjustment program (U.S. Bureau of the Census, 2010). Outliers detected for included:

Calendar effects related to Easter, numbers of trading-days[4] and leap-year;

Additive outliers (AO) which are unusually large or small values that affect one single observation;

Innovational outliers (IO) which have an initial impact with lingering effects over subsequent observations;

Transient changes (TC) are outliers whose impact decays exponentially to zero; and

Level shifts (LS) which can result from an organisational policy change, and are characterised by a shift in all subsequent observations to a new level, starting at a time-point and have a long-term or permanent effect (IBM, 2013b, IBM, 2016).

Calendar effects would be addressed by seasonally adjusting the data, which is discussed in more detail below. Outliers which had only a short-term effect (i.e. AO and TC) were removed and replaced by estimated values calculated using the remaining data. Level shifts remained untouched, as these provided an indication of a significant shift in the outcome being measured, which may or may not be related to the introduction of the NEWS. If not related to the NEWS, it suggests something else had occurred that warranted further investigation.

---

[4] Trading day referring to differences in working days and weekends contained in a monthly period

3.5.6 Linear regression

Linear regression measures relationships between continuous variables, from which predictions can be made. This is achieved through modelling and accounting for errors; i.e. each observed outcome (y_i) = (model) + error. Using the data set, a 'model' is derived from developing a 'mean' line that runs through all the data points (x_i) as closely as possible. This represents a general trend for the model, defined by the slope (or gradient (b_1)) of the line and point at which the line intercepts (b_0) the y-axis (Field, 2009). The line that best fits the data is determined by the sum of squared errors (ε_i) between the observed data points and the mean (Field, 2009). This method is referred to as ordinary least squares (OLS) regression. The equation for which is: $y_i = (b_0 + b_1 x_i) + \varepsilon_i$.

3.5.7 Autoregressive Integrated Moving Average (ARIMA)

Rather than using OLS regression, I used the autoregressive integrated moving average (ARIMA) method, as recommended by Cochrane (EPOC, 2017). This permitted primary and secondary outcomes and confounder variables to be regressed more accurately and effectively. To explain, time series data naturally fluctuates but there may be elements of predictability within the data, associated with existing underlying cyclical patterns or secular trends. Failure to remove these could result in an overestimation or underestimation of effect (McDowall et al., 1980, Ramsay et al., 2003, Hyndman and Athanasopoulus, 2014, Cochrane Effective Practice and Organisation of Care, 2017). Predictable non-seasonal and seasonal patterns and trends, such as increases in emergency 999-calls during the winter months as a consequence of influenza like illnesses, can be identified and adjusted for using ARIMA models (Box and Jenkins, 1970).

ARIMA models are defined using a standard notation of (p, d, q) (P, D, Q), where 'p' relates to autoregressive (AR) structures, 'd' relates to differencing or the integration (I) of data, and 'q' relates to moving average (MA) structures within the model. The capitalised P, D, Q terms relate to similar adjustments made in relation to seasonal effects. The equation for ARIMA analysis is not dissimilar to OLS regression: $y_t = b_0 + b_1$

$+ e_t$. Where y_t = the tth observation of the time series; b_0 = pre-intervention series level; b_1 = post-intervention series level; and e_t = estimated error associated with y_t. The null hypothesis (where the intervention had no significant effect on outcomes) is: $H_{0:}\ b_0 - b_1 = 0$. The key difference between the two methods is, OLS assumes adjacent error terms are uncorrelated (i.e. covariance ($e_t e_{t-1}$) = 0), which in time series is often incorrect. When error terms are correlated, the t-statistic used to test the null hypothesis may inflate statistical significance of effect (McDowall et al., 1980). Thus, unlike linear regression, ARIMA modelling predicts outcomes by accounting for trends, seasonality and adjacent error terms, collectively referred to as 'noise' (N_t), and reduces their impact on the intervention (I_t) by filtering; so $y_t = N_t + I_t$ and $N_t + I_t$ are random shocks (a_t) and N_t is filtered first as illustrated in Figure 3.3 below.

Figure 3.3: ARIMA modelling - d, p, q parameters act like filters

INPUT: Random shocks (a_t)	→	(d) *Differencing*	→	(p) *Autoregression*	→	(q) *Moving Average*	→	OUTPUT: Observation (Y_t)
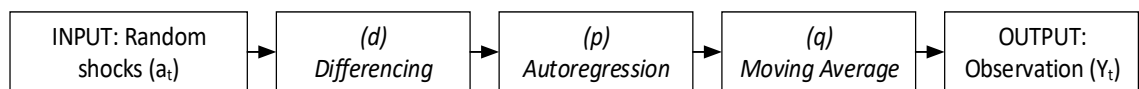
(McDowall et al., 1980, p.17)

This process allows the impact of the intervention to be measured more accurately (McDowall et al., 1980). For modelling purposes, random shocks should have a zero mean, i.e. mean (a_t) = 0; a constant variance, i.e. variance (a_t) = σ^2; and be independent, i.e. covariance ($a_t a_{t+k}$) = 0 (McDowall et al., 1980, p.15).

3.5.8   Modelling

ARIMA modelling is an iterative process, where several models with different parameters are assessed to identify the model with best fit. It is a method often used to forecast what is likely to occur, based on what has occurred previously.

Integration (d) – The first step in the process when forecasting, is to identify if the series is stationary or not; that is, identify if there is an existing underlying trend. If the series is found to be non-stationary then the series would need to be integrated, or differenced. Differencing involves subtracting the first observation from the second, the second from the third and so on, to reduce exponential increases or decreases and

to make the process constant. Differencing involves putting each random shock (a_t) into a filter where it is integrated with all previous random shocks. The integration (i) process may look as follows.

$$y_0 = y_0$$
$$y_1 = y_0 + a_1$$
$$y_2 = y_0 + a_1 + a_2$$

(McDowall et al., 1980, pp.20-22)

This example suggests a nonstationary (drifting) behaviour, because of the additive effect of each random shock. After differencing, the process looks like this:

$$y_1 - y_0 = y_0 + a_1 - y_0$$
$$= a_1$$
$$y_2 - y_1 = y_0 + a_1 + a_2 - y_0 - a_1$$
$$= a_2$$

(McDowall et al., 1980, pp.20-22)

The preceding shock has been removed and all that remains is the current shock. This model structure would be written as ARIMA (0,1,0). An ARIMA (0,0,0) model indicates the data has not been differenced, whereas an ARIMA (0,2,0) would indicate the preceding two shocks have been removed from the model because a lasting or lagging effect existed.

The need to 'difference' is identified using the autocorrelation function (ACF). ACF is the correlation coefficient (a measure of strength of relationship between two variables) estimated between specified timepoints in the series, referred to as lags; e.g. ACF (1) is the correlation coefficient estimated between Lag-0 and Lag-1, and ACF (2) is the correlation coefficient between time series Lag 0 and Lag 2 (see below). $ACF_{(k)}$ relates to the entire time series.

Lag-0 $\quad y_1 \qquad y_2 \qquad y_3 \ldots \quad y_N$

Lag-1 $\qquad\quad\; y_1 \qquad y_2 \ldots \quad y_{N-1} \qquad y_N$

Lag-2 $\qquad\qquad\qquad\quad y_1 \ldots \quad y_{N-2} \qquad y_{N-1} \quad y_N$

(McDowall et al., 1980, pp.24-27)

A nonstationary, or drifting model is depicted by ACF which starts high and takes a long time to decay. Estimated ACF which lie between ±2 standard errors, with a .95 confidence interval, are not statistically different from zero, meaning the residuals are nothing other than white noise (McDowall et al., 1980). Any model consisting of a nonstationary ACF should be differenced in the first instance. However, in this study integration was not necessary as non-stationarity of the series was captured by regressor (dummy) variables in the modelling and analysis processes which provided a prediction of how the series would change over time. Three regressors were included. These were 'Pre-Post', 'Interact' and 'Time-period', as per the method recommended by Cochrane (EPOC, 2017).[5]

The 'Pre-Post' variable provided the overarching level of effect; i.e. a measure of changes in intercept of the y-axis post-NEWS compared to the pre-intervention trend. The 'Time-period' variable provided the estimated slope (or gradient) of the regression line pre-intervention. The 'Interact' variable provided an estimated difference of change in trend post-NEWS, compared to trend pre-NEWS. 'Time-period' plus 'Interact', provided the estimate of the regression line post-intervention (Figure 3.4, p.100).

---

[5] Detailed instructions and resources for analysing time series can be sourced here
http://epoc.cochrane.org/resources/epoc-resources-review-authors

Figure 3.4: Illustration of the effects estimated by time series regression analysis
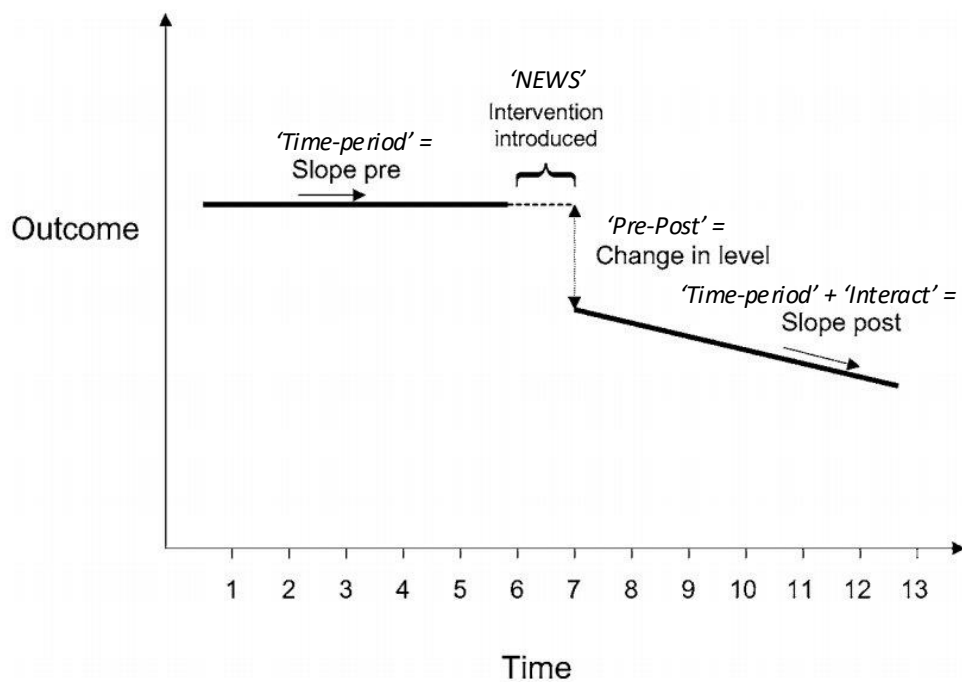
(Adapted from Ramsay et al., 2003, p.617)

In addition, I created a range of dummy variables to sub-define the 'Pre-Post' regressor, as recommended in the guidance provided by Cochrane Effective Practice and Organisation of Care (2017). The example, provided in the guidance, included dummy variables that would measure the effect of an intervention at four different time-points, those being 3, 6, 12 and 24-months post-intervention. I created dummy variables that would allow me to evaluate the data every other month (i.e. bimonthly). This was for several reasons. The first reason being that NEWS was introduced in an uncontrollable (real-world) setting. Therefore, there was a risk of other external factors influencing changes to working practices. Analysing the data on a bimonthly basis, rather than quarterly, half-yearly or yearly basis, would enable me to more accurately identify when changes were occurring, and to explore other events (e.g. by reviewing Trust board reports, hospital pressures, or identifying the introduction of new care pathways) that may have influenced outliers or longer-term changes at that time-point. The second reason was the training of the NEWS was being delivered over a protracted period and so the effects of the changes being introduced may have been

delayed. If a change did occur, then the method of evaluating the data bimonthly would enable me to identify where the tipping-point of change occurred in relation to the training. Thirdly, I knew from the pilot I had conducted before undertaking this study that paramedics would use the tool when first trained, but without feedback and reminders the utilisation of the tool and the recording of the score on the PRF decreased as the trial progressed (see Essam et al., 2015). Again, bimonthly evaluations would facilitate more effective identification of transient effects.

Serial dependency – Following data integration, the next step is to identify any serial dependency caused by moving average structures (i.e. signatures from residual errors), and/or autoregressive processes (i.e. lasting effects of preceding shocks (McDowall et al., 1980)). ACF plots are used again to determine the order of the MA terms and partial ACF (PACF) plots are used to determine the order of AR terms; PACF being the correlation between an observation in the time series with another specified prior observation with intervening observations removed.

As illustrated in Figure 3.5 (p.102), a moving average adjustment is identified by a non-zero significant spike in the ACF, which then cuts off to zero with exponential decay in the PACF (McDowall et al., 1980, Pelgrin, 2011). If the significant spike is identified at ACF lag-1 and cuts of to zero thereafter then this would indicate an ARIMA (0,0,1) term is required to achieve independence. An ACF which cuts off at lag-2 would indicate ARIMA (0,0,2) and so on. Moving average models are constrained by what is referred to as the 'bounds of invertibility'. This means the moving average coefficient must lie between -1 and +1 (McDowall et al., 1980). If not, this signifies the series contains a random shock with residuals that have a long-lasting effect; it is the moving average equivalent of non-stationarity. Similarly, autoregressive adjustments are identified by a significant PACF spike (p-lag) which cuts of to zero and a decaying or oscillating positively and negatively around the ACF zero-mean. Any series with ACF-lags that remains significant for six or more lags will need to be differenced (IBM, 2013b).

Figure 3.5: Examples of ACF and PACF plots and necessary adjustments to the model

	ACF	PACF
INTEGRATED ACF decays exponentially to zero (0,1,0)		
AUTOREGRESSIVE One or more PACF spikes. Number of spikes indicates the order of the autoregression. ACF gradually tails off or oscillates positive and negative. (1,0,0)		
MOVING AVERAGE One or more ACF spikes. The number of spikes indicates the moving average. PACF gradually tails off. (0,0,1)		
MIXED AUTOREGRESSIVE MOVING AVERAGE ACF & PACF show exponential decay (1,0,1)		

(Developed from IBM, 2013b, pp.29-32)

As mentioned, the NHS experiences seasonally associated peaks and troughs (i.e. seasonal non-stationarity). The need to adjust for cyclical annual drifts and seasonal fluctuations are indicated by a spike at ACF (12) and confirmed by PACF (12). As an example, the seasonal effects of tuberculosis are illustrated in Figure 3.6, p. 103. Figure 3.7, p.104, shows the same series following seasonal adjustments being made to the model (i.e. a (0,0,0) (1,2,0) model (Chowdhury et al., 2013)). The iterative process I have described is illustrated in Figure 3.8 (p. 105).

Figure 3.6: Example of seasonality - Illustration of total monthly numbers of cases of tuberculosis, and autocorrelation and partial autocorrelation plots indicating and confirming a seasonal component in the data
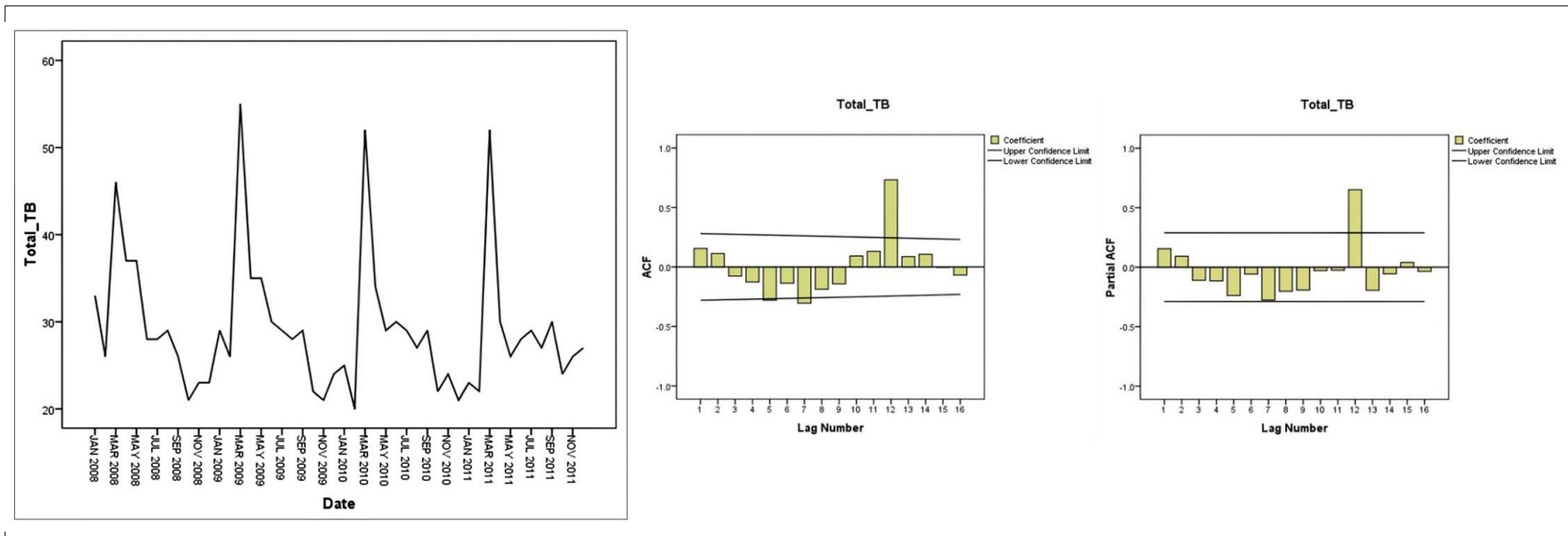
(Chowdhury et al., 2013: p.96)

Figure 3.7: Example of seasonal adjustment - ACF and PACF plots with seasonal autoregressive term and seasonal differencing
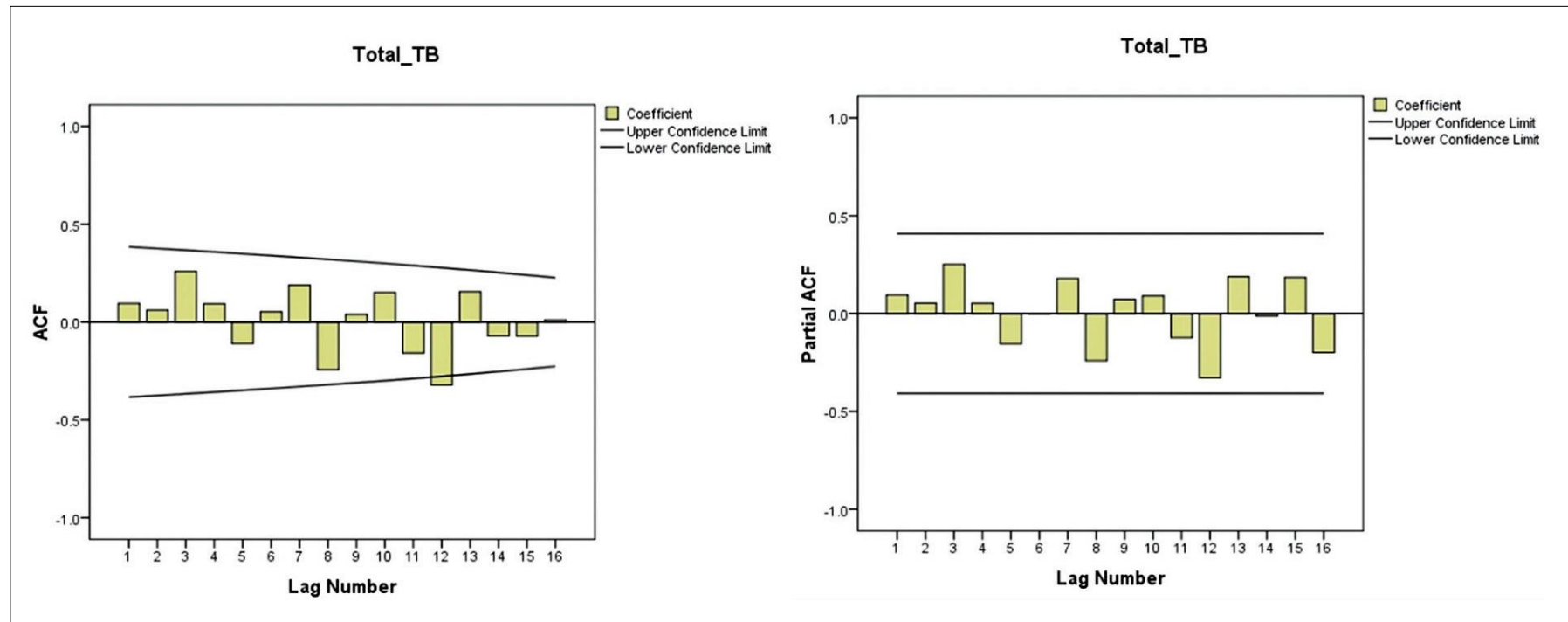
(Chowdhury et al., 2013, p.97)

Figure 3.8: The iterative process of ARIMA modelling

ARIMA Modelling Process

STEP 1: Plot the Data

Identify unusual observations.
Understand patterns

STEP 2: Transform Data
(If necessary)

Use a Box-Cox transformation to stabilise the variance.

OPTION A:
Select model order yourself

OPTION B:
Use automated algorithm

STEP 3: Difference the Data
(If necessary)

Difference the data until it appears stationary.
Use unit-root tests if unsure.

Use auto.arima() function to find the best ARIMA model for your time series

STEP 4: Plot the ACF/PACF

Plot the ACF/PACF of the differenced data.
Try to determine possible candidate models

STEP 5: Try Models

Try chosen model(s).
Use AICc to search for a better model

STEP 6: Check Residuals

Check the residuals of your chosen model by plotting the ACF of the residuals, and doing a portmanteau (Ljung-Box) test of the residuals

Do the residuals look like white noise?

NO

YES

STEP 7: Analyse

Use the optimal model for analysis

(Hyndman and Athanasopoulus, 2014, p.235)

3.5.9   Analysis

If necessary, there are several tests that can be conducted to check whether a time series is stationary. They include the Augmented Dickey-Fuller (ADF) test (Said and Dickey, 1984) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (Kwiatkowski et al., 1992). The null hypothesis for the ADF tests is the data were non-stationary, therefore a *p*-value <0.05 would suggest integration was unnecessary (Hyndman and Athanasopoulus, 2014, pp.220-221). Conversely, the null hypothesis for the KPSS test is the series is stationary. A *p*-value <0.05 indicates differencing is required (Hyndman and Athanasopoulus, 2014, pp.220-221). Based on the assumption that the series is stationary, the KPSS test will only select one or more differences when there is sufficient evidence to overturn this assumption (Hyndman, 2014). The KPSS test therefore often selects fewer differences than the ADF test and is considered to give the better forecast (Hyndman, 2014). As mentioned, non-stationarity within the data were captured in the modelling process with the dummy variables and therefore such tests were somewhat irrelevant for this analysis.

Further diagnostic measures were however utilised to assess the 'goodness of fit' for each model developed. 'Goodness of fit' measures are important, as a model is merely a 'simple approximation' of reality based on the information being analysed (Burnham and Anderson, 2002). This premise underlies the information-theoretic approach, which intends to identify the optimal approximated model that is *'appropriately simple, based on concepts of parsimony'* (Burnham and Anderson, 2002, pp.22-23) from which inferences can be developed.

Parsimony relates to the need of the investigator to make models as simple as possible, *"…with the smallest possible number of parameters for adequate representation of the data"* (Box and Jenkins, 1970, p.17, as cited by Burnham and Anderson, 2002, p.31). This may mean compromising between bias and variance. For instance, a model with too few variables is likely to be biased, meaning the model will fail to identify true effects because of the difference between the estimated values (approximations) and

true values (reality). Whereas, a model with lots of variables will have low precision, as spurious effects are more likely to be identified (Burnham and Anderson, 2002).

The Box and Jenkins (1970) modelling approach required parameter estimates of any autoregressive and moving average terms within the model to be statistically significant, if not then another model should be identified (see section 2.7, in Model Building by McDowall et al., 1980). However, the information approach theorists consider statistical significance less important than overall model fit, as the better fitting the model the less information will be lost, the more accurate the prediction. So, variables that improve model fit should be included regardless of whether they are significant or not (Burnham and Anderson, 2002, Burnham and Anderson, 2004, Hyndman and Athanasopoulus, 2014).

I adopted the information-theorist approach. Therefore, optimal models in this study were selected based on the model with the smallest goodness of fit measures. Two measures most commonly used are Akaike's Information Criterion, or AIC (Akaike, 1973) and Schwarz Bayesian Information Criterion, or BIC (Schwarz, 1978). Both criteria support parsimony in model building, as more complex models (those with more variables) are penalised and deemed to be a poorer fit than those less complex. For example, an ARIMA (2,1,2) model is likely to be a poorer fitting model with larger AIC and BIC than an ARIMA (1,1,1) model, because of the additional autoregressive and moving average terms. BIC will penalise complex models more harshly than AIC, but the diagnostic 'ideal' of either test is fundamentally the same; that being to achieve an AIC or BIC which is as small as possible. Neither AIC nor BIC should be used on small samples, in such circumstances the AIC corrected (AICc) for small samples should be used. Burnham and Anderson (2002) suggest using AICc regardless of sample size, as it will converge to AIC as sample size increases. I therefore reported AICc and BIC in my results, although optimal models were selected using the AICc.

In addition, predictive accuracy of each model was assessed by analysing the mean absolute percentage error (MAPE) and R-square (R^2). MAPE determines accuracy by calculating the 'error' between the actual value and predicted value at each time-point,

summarised as percentage; the smaller the value, the fewer the errors, the better the fit. R^2 also determines as a percentage, the 'correlation' between the fitted model to the actual data, but in this instance the higher the value, the greater the correlation between predicted and actual value.

Whilst not an issue in this study, MAPE should not be used with data containing units with small totals (e.g. zero or near zero monthly totals). This is because the accuracy of the predicted model is calculated using the actual totals; i.e. 'Actual' minus 'Forecast', divided by the 'Actual', multiplied by 100 (Stellwagen, 2017). R^2 should also be used with caution, as high values may be the result of 'over-fitting' the model. The model subsequently becomes too tailored and specific to the sample and less reflective of the overall population (i.e. biased).

The Ljung-Box test (Ljung and Box, 1978) was used to assess autocorrelations. The model should yield uncorrelated residuals (i.e. white noise) and residuals with a zero mean (Hyndman and Athanasopoulus, 2014). A non-significant p-value (> 0.05) is the desired outcome from the test. When significant (i.e. p-value < 0.05), this suggests serial dependency remains in the series and further adjustments may be necessary (McDowall et al., 1980). Once serial dependency had been minimised, the optimal ARIMA model was defined and the data were analysed using the method described by Hyndman and Athanasopoulus (2014, pp.264-5).

To conduct the modelling and analysis, I had considered using SPSS (IBM, 2013a); the software Statistical Package for the Social Sciences that is used by researchers worldwide. Instead, I taught myself how to use R (R Core Team, 2013), which is a programming language and environment with an integrated suite of software, developed to support data manipulation, analysis and graphical display (R Core Team, 2013). The following R software packages were used to complete my analysis: tseries (Trapletti and Hornik, 2017), tidyverse (Wickham, 2017), haven (Wickham, 2017), seasonal (Sax, 2017), RColorBrewer (Neuwirth, 2014), forecast (Hyndman, 2017), tsoutliers (Lopez-de-Lacalle, 2017).

R is more time-consuming and complex than SPSS, as the researcher must write computer script for each piece of analysis, but it enabled me to develop and evaluate my models more dynamically. My learning was primarily achieved using the guidance provided by Hyndman and Athanasopoulus (2014) in their book 'Forecasting: Principles and Practice' and associated on-line support (https://otexts.com/fpp2/), plus Hyndman's own website (https://robjhyndman.com/); and 'Cross Validated' which is a question and answers forum on the internet (part of stats.stackexchange.com) for people interested in statistics and data analysis. My Professors assisted and supervised my learning, but when I experienced a particular problem with my analysis, I sought additional assistance from the University's Mathematics and Statistical Help (MASH) team. The difficulty experienced related to my utilisation of of dummy variables and my erroneous integration during the ARIMA modelling, which in effect meant I was double differencing the data and hence why I specified in section 3.5.8 above that integration was not necessary for this study.

The results from the interrupted time series analysis are presented in Chapter 4, subsections 4.1-4.8, pp.122-149.

3.6 Qualitative data and analysis: semi-structured interviews and non-participant observations

For my qualitative work stream, I adopted a between-strategy method of data collection. This meant more than one method of data collection was adopted, i.e. an 'OBS-QUAN with OBS-QUAL with INT-QUAL' between-strategy method, which is a very powerful strategy for audit/improvement type studies (see Teddlie and Tashakkori, 2009, pp.237-247). Qualitative data were obtained from semi-structured interviews with clinical staff employed by AMB-X, and non-participant observations of paramedic-patient consultations. I selected a between-strategy design as I believed this would provide me with a greater understanding of how participants were influenced by contextual factors, and this deeper understanding would enabled me to develop inferences during the integration process (see Chapter 7, Table 7.1, p. 214 and Table 7.2, p.215). As Teddlie and Tashakkori (2009, p.289) state, *'A golden rule of making*

inferences in human research is know thy participants! Having a solid understanding of the cultures of the participants and the research context is a valuable asset in the process of making inferences.'

3.6.1 Participants and recruitment

A purposive sample of clinical staff trained to provide emergency care to patients were invited to participate. Participant information sheets were made available trust-wide via AMB-X's intranet (Appendix 20, p.361 and Appendix 21, p.363). The information sheet included the purpose and benefits of the study, and what participation would involve. Assurance was given that participation was voluntary, and information obtained would be anonymised and handled confidentially. Guidance was provided of what to do if they had any questions or concerns, and where to seek further information about the NEWS.

Signed consent was obtained from each participant prior to being interviewed and/or observed. This was intended to formally confirm they had read and understood the information I had provided; and they understood the data that would be collected, how it would be collected, how it would be stored and subsequently used; and that they could withdraw from the study at any time without giving any reason (Appendix 22, p.365 and Appendix 23, p.366).

Non-clinical personnel were excluded, because participants needed to possess clinical knowledge and be delivering emergency care to patients. ECAs were also excluded, as any clinical decisions made were the responsibility of the higher qualified clinician. No active patient participation was required.

Anonymised participant attributes were documented and stored using Microsoft Excel 2016. Attributes recorded included a personal identifier, gender, career route (i.e. Institute of Health Care Development (IHCD) or nursing/paramedic university degree),

years of service, current job role, highest level of qualification[6], locality of work-base (by sector), and crew status (i.e. FRV or DCA).

3.6.2   Semi-structured Interviews

Two topic guides were developed to gain insight from paramedics and Paramedic Pathfinder Leaders about the implementation of the NEWS and their opinions of its usefulness and effectiveness (Appendix 24, p.367 and Appendix 25, p.372).

3.6.3   Interview data collected

Each interview began with an 'ice breaker' question, intended to relax the participant and enable me to get to know more about them and their job role. This was followed by a few questions investigating whether they had undertaken any self-study related to the NEWS; that is, whether they had visited the Royal College of Physicians website using the link provided in the participant information sheet or had read any research papers of their own volition. These questions were followed by further questions that sought insight into the implementation of the NEWS (e.g. the training delivered) and their perception of the usefulness and usability of the NEWS, the effect the NEWS had had on decision-making, and the perceived longevity of the NEWS in the prehospital setting.

Interviews took between 30-60 minutes on average. Discussions were audio recorded and transcribed, before being thematically coded and analysed using NVivo 10 software (QSR International Pty Ltd., 2012).

3.6.4   Analysis and synthesis of interview data

A deductive-inductive coding and analysis approach was adopted.

<u>Deductive approach:</u> A coding framework was used to deductively identify relevant quotes and to support initial categorisation (or coding) into four overarching parent nodes. One node related to organisational attributes that may influence the adoption

---

[6] Highest level of qualification achieved to date based on the UK Regulated Qualification Framework (RQF): RQF ≤ 4 is AS/A level or GCSE qualification. RFQ 5 a foundation degree. RQF6 a bachelor's degree. RFQ 7 a master's degree. RFQ 8 a doctorate.

of the NEWS (e.g. socio-cultural factors and educational provisions). The other three related directly to my theoretical propositions (Figure 3.9, p.113). The coding framework used an 'if-this-then-that' information processing approach and was adopted to achieve consistency and support replicability.

Inductive approach: The quotes within the 'parent nodes' were reviewed and sub-categorised into 'child nodes'. This was an iterative process, providing conceptual clarity and allowing patterns to emerge (Bazeley and Jackson, 2013). The emergent patterns were narratively synthesised. This was achieved by developing bullet-point sentences or statements that summarised patterns found. Each bullet-point was supported by at least one quotation as evidence, sometimes two if contrary opinions or insights were found. Longer narratives were subsequently constructed using these bullet-points and a sample of pertinent quotes. All quotations used were attributed an anonymised identifier that corresponded to the respective participant. This was to allow quotes to be cross-referenced with participant attributes.

I remained vigilant throughout of the risk of confirmation bias. Rather than proving or disproving propositions, my intention was always to gain greater insight and understanding of the effectiveness and usefulness of the NEWS in the clinical assessment and decision-making process, and of any factors facilitating or inhibiting use. To identify whether my own subjectivity may have biasedly affected the analysis, a summary of my analysis and interpretations were shared with a sample of participants, to review and provide feedback.

The results from the interview data analysis and synthesis are presented in Chapter 5.

Figure 3.9: Qualitative coding framework

Parent Node 1

The effect of NEWS on decisions to convey or treat closer to home

[Consider: What effect has NEWS had on conveyance?]

Include: Quotes relating to NEWS 'and'...

- Decisions made to convey;
- Decisions made to leave at home;
- Decisions made to refer;
- Perceived increase or decrease in conveyance rates.

IF

Quotes relate to factors that have influenced or over-ridden decisions or use of NEWS (e.g., decisions made by patients or other HCP)

THEN

OR

Quotes relate to adoption (or lack of) and descriptions of how it is being applied consider 'compliance and accuracy' (e.g., convey just to cover your back)

THEN

Parent Node 2

The usefulness of NEWS in context

[Consider: How does NEWS help or hinder?]

Include: Quotes relating to NEWS 'and'...

- It assisting/helping with decisions made OR not.
- Its practicality (e.g., easy or difficult to use) OR not.
- It being worthwhile OR not (e.g., it was obvious the patient needed ED)
- In certain situations (e.g., grey areas); or stakeholders (e.g., patient decisions or clinical handovers) ; or conditions (e.g., COPD); or assisting certain clinicians (e.g. with less experience)
- How it is useful (e.g., as a benchmark, to monitor change etc.)

IF

Quotes relate to adoption (or lack of) and descriptions of how it is being applied consider 'compliance and accuracy' (e.g., convey just to cover your back)

THEN

Parent Node 3

Compliance and accurate use of NEWS

[Consider: How is NEWS being assessed?]

Include: Quotes relating to NEWS 'and'...

- Its adoption (e.g., frequency of use, sustainability)
- The physical assessment and calculation of NEWS
- Documenting NEWS
- Accuracy of scores
- Application of NEWS in relation to guidance and policy
- Appropriateness of decision outcomes (e.g., increase or decrease in Serious Incidents)

3.6.5 Non-participant observations

Paramedics and their interactions with the patient and others were overtly observed in context. My focus was primarily to observe how the NEWS was being used and the associated tasks were conducted; tasks such as obtaining and recording physiological measures and communicating the NEWS during handover. I also inquired how the paramedic had formed their decision, during a five-minute debrief hosted after each incident.

Observations excluded were those where patients had refused clinical assessment, or those patient groups where the NEWS was not permitted for use (i.e. patients less than 16 years of age and incidents relating to pregnancy).

My presence was explained to patients as being part of a clinical audit. Patients' questions were answered accordingly, before permission was sought to continue observing.

3.6.6 Observational data collected

An observational guide and record sheet were used to prompt and support data capture (Appendix 26, p.378 and Appendix 27, p.380). Data captured included information related to the time and date of the incident; physiological assessments of the patient and treatment provided; communication and interactions between the paramedic and others, including the patient, carers and other HCP; plus, contextual and environmental factors, such as weather, hospital delays, crew well-being, patients' and socio-environmental status. No patient identifiable information was recorded.

The participating paramedic and I also held an oral debrief after the handover/discharge of patient care. During the debrief I asked the paramedic to explain the decisions they had made regarding patient outcome (i.e. conveyed to ED or not conveyed). Key aspects influencing decisions were notated.

At no point did I question or prompt the paramedics regarding the physiological assessments associated with the NEWS, nor directly prompt the utility of the NEWS itself.

All notations were hand-scribed in real-time and written-up in detail within 24-hours of the observation.

An anonymised copy of each PRF, completed by the attending paramedic(s), was sourced retrospectively. The PRF contained a summary of the patient's clinical condition, details of the physical assessment and any treatment provided. PRFs are audited and validated by AMB-X before key information relating to AQI and other performance measures are extracted.

3.6.7 Analysis of observational field notes and patient report forms

Univariate descriptive analysis was conducted, using Microsoft Excel, on data abstracted from the PRF and from my observational field notes. Data analysed included patient demographic information (e.g. age and sex) and well-being (e.g. clinical complaint, physiological measures) and observed utility of the NEWS (e.g. frequency of use of the NEWS tool itself, frequency and accuracy of score recorded on the PRF, and/or the oral communication of the NEWS during clinical handover of care).

Notations transcribed during the observational debrief were also analysed, to identify factors described by the paramedic as influencing or justifying their decision to convey or treat closer to home. Data were coded and analysed using NVivo 10 (QSR International Pty Ltd., 2012). The results are presented in Chapter 6.

3.7 Pilot study

According to Yin (2014) the final preparation before data collection is for the researchers to conduct a pilot study. A pilot study is a smaller study conducted before the main study begins. The purpose of the pilot study is to enable researchers to test the study's feasibility and to evaluate their research protocol, data collection tools,

recruitment strategies and study sample (Hassan et al., 2006). It also provides an opportunity for the researcher to *'learn on the job'* (Robson, 2011, p.141).

As mentioned in Chapter 1 (see section 1.4, p.38) and earlier in this chapter (see section 3.3, p.86), I conducted a quantitative pilot study using a modified EWS (MEWS). My objective was to evaluate the effects on decisions made to convey patients to hospital or treating them closer to home.

The pilot study was conducted between January and September 2012; prior to formally commencing my PhD studies. As part of the pilot, a self-selected sample (n=19) of ambulance paramedics were trained to use a MEWS to support their decision-making. Paramedics were asked to record on the PRF the final MEWS calculated. This score related to the last physiological measures obtained either before conveying to ED or leaving the patient at scene. This score was deemed most representative of the patients' physiological status on which the final clinical decision was based.

I used an interrupted time-series design and autoregressive integrated moving average (ARIMA) analytical methods, to evaluate differences in number of patients conveyed, to hospital, numbers not conveyed, and numbers revisited, 17-weeks pre-intervention (PRE-MEWS: January-April 2012) compared to 17-weeks post-intervention (POST-MEWS: June-September 2012).

During this pilot study timeframe, 4,140 patients were attended to by the participating paramedics (Pre-MEWS: n=1,978, 48% and Post-MEWS: n=2,162, 52%). Taking existing trends into account, the numbers of patients conveyed, and numbers being treated at, or closer to home were unaffected by the intervention; Conveyed - Pre-MEWS: mean=68.9, SD=11.44, Post-MEWS: mean=80.2, SD=16.59 versus Not Conveyed - Pre-MEWS: mean=47.4, SD=10.14, Post-MEWS: mean=47.0, SD=8.73. Numbers revisited within 7 days did however decrease significantly (Pre-MEWS: mean=1.7, SD=1.36, Post-MEWS: mean=1.1, SD=1.30, Post-MEWS intercept coefficient=3.417 [95% CI: 0.268 to 6.566], Pre-vs-Post-slope interact coefficient =-0.260, [95% CI: -0.392 to -0.129]). Whilst, the documentation of physiological measures improved (Pre-MEWS:

n=1,413, 71.44% vs Post-MEWS: n=1,696, 78.45%, OR=0.687, [95% CI: 0.596 to 0.792]) the recording of the MEWS was low (n=686, 32%). Of the scores that could be assessed (n=550), I found many had been calculated and/or documented inaccurately (n=265, 48.18%), most were under-scored (n=207, 37.64%). No adverse events were however reported.

The reduction in number of patients being revisited, in conjunction with a lack of statistical difference in numbers being conveyed or treated closer to home, could infer decisions made using MEWS were more appropriate. However, the fact that MEWS was infrequently documented made it difficult to confirm with confidence that MEWS was actually being used.

One reason why MEWS had no significant effect on conveyance outcomes, and reason why scores were frequently not calculated or calculated incorrectly, may have been the opportunity for on-going training, clinical support and feedback was limited. This was because there were limited resources (clinical personnel and time) allocated to the pilot study to audit and monitor e-PRFs and to assess the appropriateness of decisions being made. Paramedic Pathfinder Leaders were made aware of the limitations of the pilot study, so these limitations could be addressed before the NEWS was formally implemented at the case study site.

Lack of qualitative insight from participating paramedics restricted my ability to fully evaluate the effectiveness and usefulness of MEWS to support paramedics' decision-making, and the interpretation of the quantitative results. It was therefore important for my PhD study to include a qualitative work-stream and to ascertain whether adoption and utilisation was being constrained by cultural or contextual affects.

I subsequently undertook a qualitative pilot study in 2014, just before the NEWS was introduced by the ambulance service being studied. The qualitative pilot study included semi-structured interviews and non-participant observations (as discussed earlier in this chapter, see section 3.6), plus focus group discussions and a questionnaire study. The focus group study and the questionnaire study were

subsequently excluded from the final case study programme. Focus groups were excluded because of the difficulties experienced in arranging suitable venues, transport and associated costs, and scheduling a time that was mutually agreeable and convenient for all participants. Questionnaires were excluded because of low response rate.

All those who participated in the pilot interviews and pilot observations were provided with information about the NEWS beforehand. The information included a link to the RCPs' website, which hosted training related to the NEWS and a copy of the NEWS tool.

The topic guides I used in the pilot interview were changed before commencing the main study. Whilst both guides were similar, the pilot guide accounted for the fact participants had not yet been formally trained. The procedure and tools used for the observations conducted during the pilot study, were found to be satisfactory and were used in the main study.

3.8   Supplementary information

Certain organisational documents were cross-referenced to supplement and support quantitative and qualitative analysis. Documents that were cross-referenced included NHS England's AQI guidance and a range of AMB-X policies, reports and other documents; e.g. Paramedic Pathfinder Leaders' job descriptions specifying their roles and responsibilities, the Paramedic Pathfinder Handbook (AMB-X NHS Trust, 2014a), the 'On scene conveyance and referral procedure' (AMB-X NHS Trust, 2015a, AMB-X NHS Trust, 2016), plus performance and board reports. These were used to provide me with greater insight and understanding of the measures and outcomes being evaluated and explored.

3.9   Pattern-matching

The empirically-based inferences developed from the quantitative data analysis, participant interviews and non-participant observations were compared to my theoretical propositions to determine whether my findings corroborated one

proposition more accurately than the other (Figure 3.10, below). Such a method is referred to as pattern-matching (Yin, 2014)

Figure 3.10: Pattern-matching process
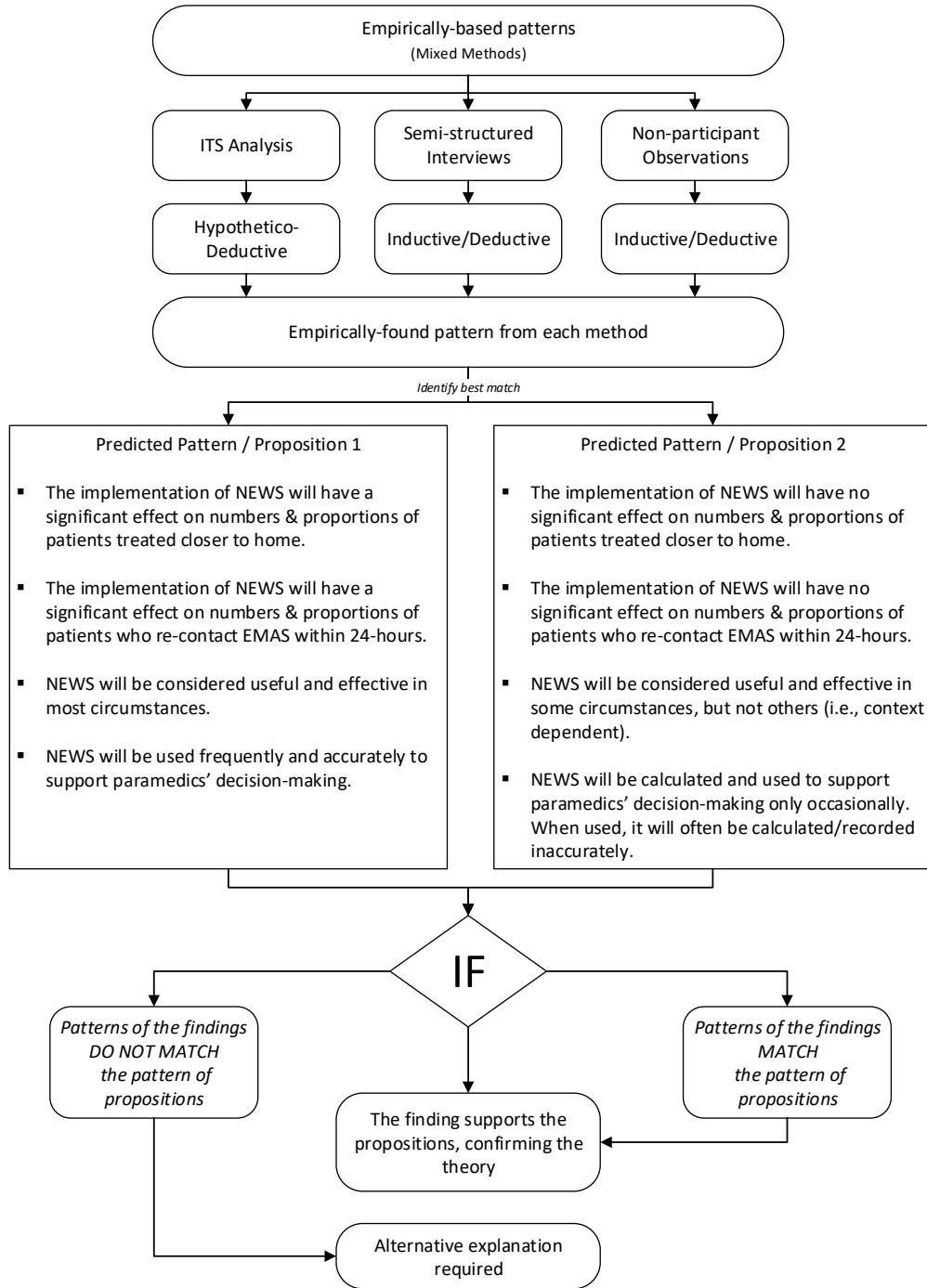
(Adapted from Almutairi et al., 2014, p.241)

Pattern-matching is a similar process to the convergence triangulation method proposed by Creswell and Plano Clark (2006), the key difference is convergence triangulation is used to confirm or corroborate quantitative with qualitative results, whereas pattern-matching is used to corroborate the evidence with the researcher's own theoretical propositions. Where pre-existing theories are not verified, then further evidence should be sought, or alternative explanations should be proposed (Almutairi et al., 2014). Such methods enhance rigor, and strengthen internal validity of case studies (Yin, 2014).

3.10 Summary

In this chapter, I discussed ethical issues and explained how I would provide practical 'real-world' insight and understanding of the effectiveness and usefulness of the NEWS, in supporting paramedics' decision-making. Having considered the various philosophical approaches, I chose to adopt a pragmatic mixed method approach.

Quantitative methods were deemed necessary to objectively measure whether the changes being implemented had any effect on patient non-conveyance and recontact rates. In addition to these two measures, I discuss three other measures that would be analysed to support the analysis of potential confounding effects. These related to emergency 999-call demand, the acuity of the calls and the numbers of patients being treated and discharged at scene. The data gathered would relate to all patients attended to by AMB-X during the specified study timeframe and would be analysed using an interrupted time series method. Rather than using a standard linear regression method to analyse the data, I described how I would use an autoregressive integrated moving average statistical modelling technique. This technique provides a means of adjusting for natural fluctuations, underlying cyclical patterns and secular trends that otherwise may lead to erroneous estimations.

Qualitative methods were necessary to gain subjective insight directly from those using the NEWS of its perceived effectiveness and usefulness to support clinical decision-making, and to gain insight first-hand of how the NEWS was being used in context. I

described how a self-selected purposive sample of clinical staff employed by AMB-X would be invited to participate. Semi-structured interviews, non-participant observations, focus group discussions and a questionnaire were piloted before the NEWS was introduced, but only interviews and observations were conducted post-NEWS. Focus groups were found to be unfeasible, and the validity of the questionnaire was weak owing to low level of participation. Interview and observation topic guides were piloted before being used in the main study. These were used to support a consistent approach to data capture.

To mitigate risks of bias, I presented the coding framework that would be used to support qualitative analysis of interview transcripts. Univariate descriptive analysis of observational data would be conducted using data from my field notes, in conjunction with data extracted from the PRFs. I also explained that my analysis, and the development of inferences, would be supplemented by other documents sourced from NHS England and AMB-X.

Lastly, I described how the results from each of the three work-streams would be integrated; that is, I would compare the evidence to pre-existing theories proposed and identify the best match. Collectively, the methods proposed in this chapter, should strengthen the construct validity of my case study.

In the next chapter I present the results from the interrupted time series analysis.

4 Interrupted time series analysis: evaluating the effect of the NEWS on patients being treated closer to home

In this chapter, I evaluate ambulance data using an interrupted time series design (ITS). As mentioned previously, the data collected and analysed were in the public domain - see Chapter 3, section 3.5.1 and footnote 3, on p.91 for hyperlink to data source. The aim of the chapter is to seek answers to the first two research questions posed. The questions to be addressed were, 'What effect did the NEWS have on the numbers and proportions of patients not conveyed to ED, and the numbers and proportions of patients (discharged at scene) who recontacted AMB-X within 24-hours?' The comparison of effect of the NEWS on decision outcomes were objectively measured using an autoregressive integrated moving average analysis method. This method was described in detail in Chapter 3, section 3.5.

I begin by providing a quantitative overview of relevant operational demands and call outcomes for the time-period. More detailed analysis of each variable is presented thereafter, starting with the non-conveyance rates and then recontact rates (i.e. the primary and secondary outcome measures). These are followed by the results relating to the analysis of the numbers of 999-calls attended, patients discharged and left at scene and lastly, category A calls.

4.1 Overview of emergency operational demands and key outcomes

Between June 2011 and January 2017, AMB-X received 3.4m 999-calls from the public, of which 3.3m[7] (98%) were attended by ambulance (i.e. See & Treat, Figure 4.1, p.123 & Figure 4.2, p.124). Of the calls attended, 1.5m (46%) were category A life-threatening calls[7] and 1.2m (31%) were not conveyed to ED, but were instead treated closer to home; either at the scene, or conveyed by ambulance to the local UCC, MIU or WiC.[8]

---

[7] Sum includes NHS 111 emergency referrals. The number of referrals and proportion of NHS 111 calls resulting in an ambulance being dispatched can be found in Appendix 28, p.319 and Appendix 29, p.320.
[8] Sum includes 999-calls only.

Just under a million were treated and discharged at scene,[9] which may include the patient being referred to their own GP. Of those who were treated and discharged at scene, 54k[10] recontacted AMB-X within 24-hours of the original 999-call.

Figure 4.1: An illustration of emergency call management flow at AMB-X
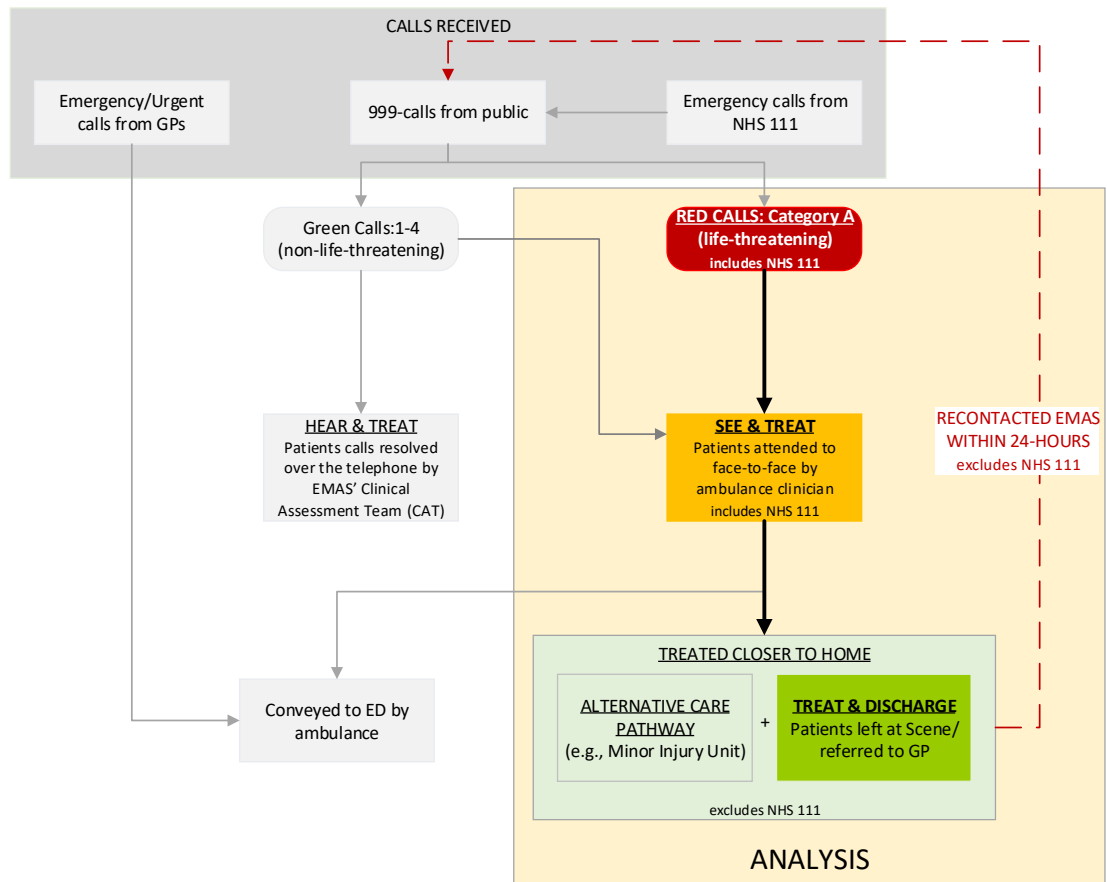
The coloured section in Figure 4.1 above illustrates the focus of analysis in this chapter.

---

[9] Sum includes 999-calls only and patients treated at scene by attending paramedic and those referred to their GP only. Excludes patients who were referred/conveyed for treatment MIU, UCC or WiC or similar.

[10] Sum includes 999-calls only.

Figure 4.2: Same-scale overview of numbers of emergency calls and category A calls attended, decision outcomes to treat patients closer to home and the numbers of patients left at scene who recontacted AMB-X within 24-hours

Emergency ambulance demand and decision outcomes
(June 2011 - January 2017)
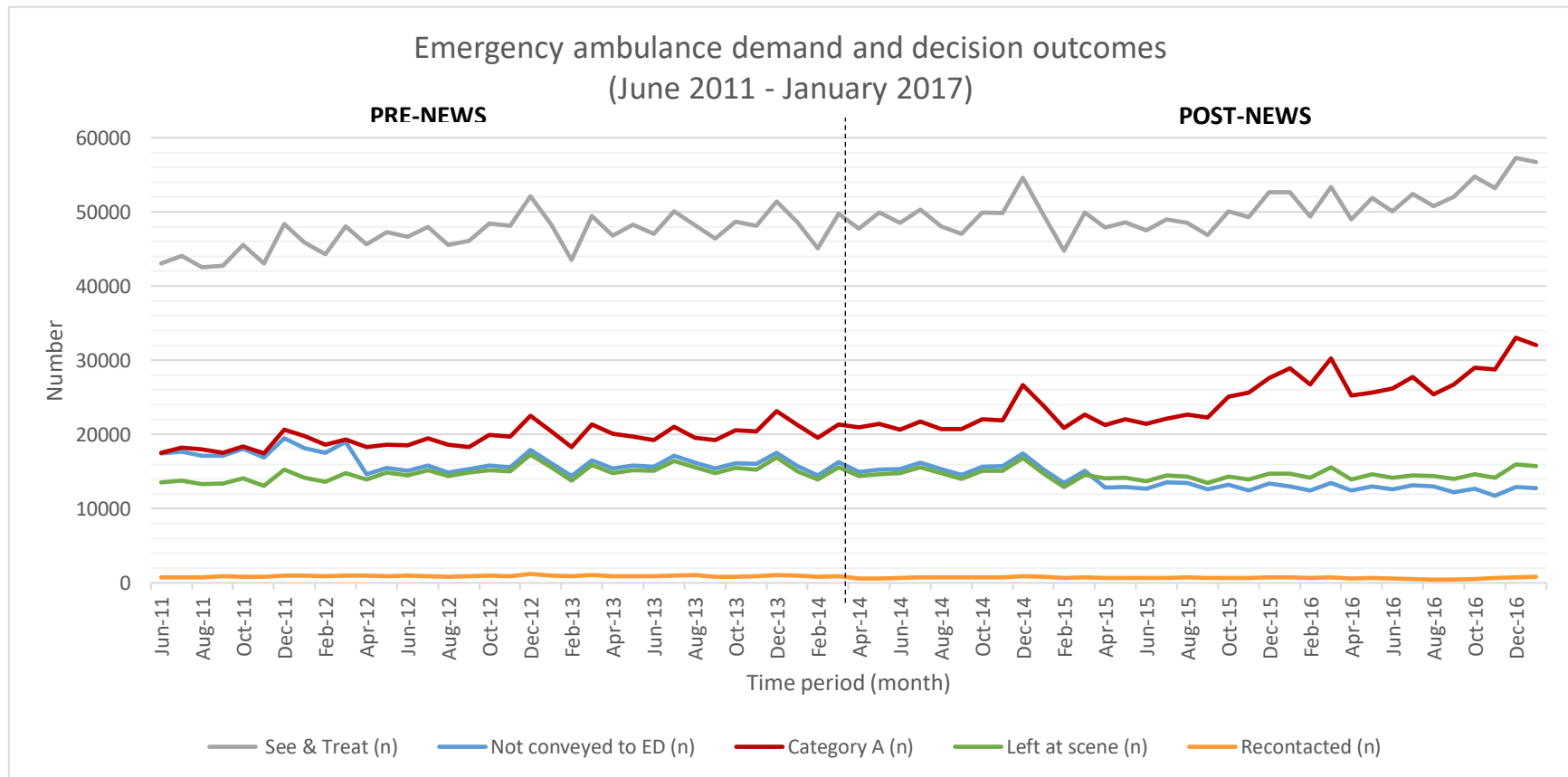
4.2 Primary outcome measure: Patients not conveyed to ED who were treated closer to home[11]

4.2.1 Descriptive overview

Overall, there was a decrease in the numbers and proportions of patients being treated closer to home; Pre-NEWS n=557,874, 34.98% and Post-NEWS n=467,066, 27.25% (Table 4.1 below).

Table 4.1: Descriptive breakdown of patients not conveyed to ED each month

Time Period	Measure	Mean	Range		Standard
			From	To	Deviation
PRE-NEWS	Number of patients	16,408	14,387	19,489	1,277
	Percentage of patients	35.06	32.01	40.47	3.22
POST-NEWS	Number of patients	13,737	11,740	17,473	1,379
	Percentage of patients	27.35	22.07	32.18	3.10

Both the numbers and proportions decreased sharply in April 2012, they then plateaued before declining from December 2014 to the end of the series (Figure 4.3 & Figure 4.4, p.126). There were some seasonal effects, more so in numbers not conveyed than proportions. Seasonal effects are depicted by the repetitive increasing and decreasing spikes each December and January, from 2011 through to 2015.

---

[11] Data includes 999-calls only.

Figure 4.3: Time series of numbers of patients not conveyed to ED
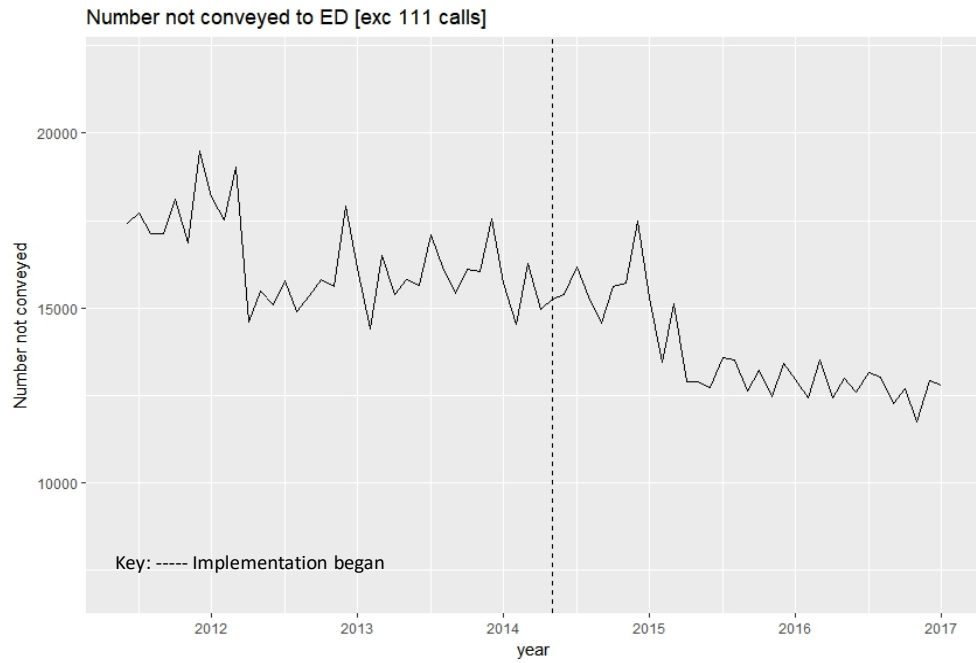
Figure 4.4: Time series of proportions of patients not conveyed to ED
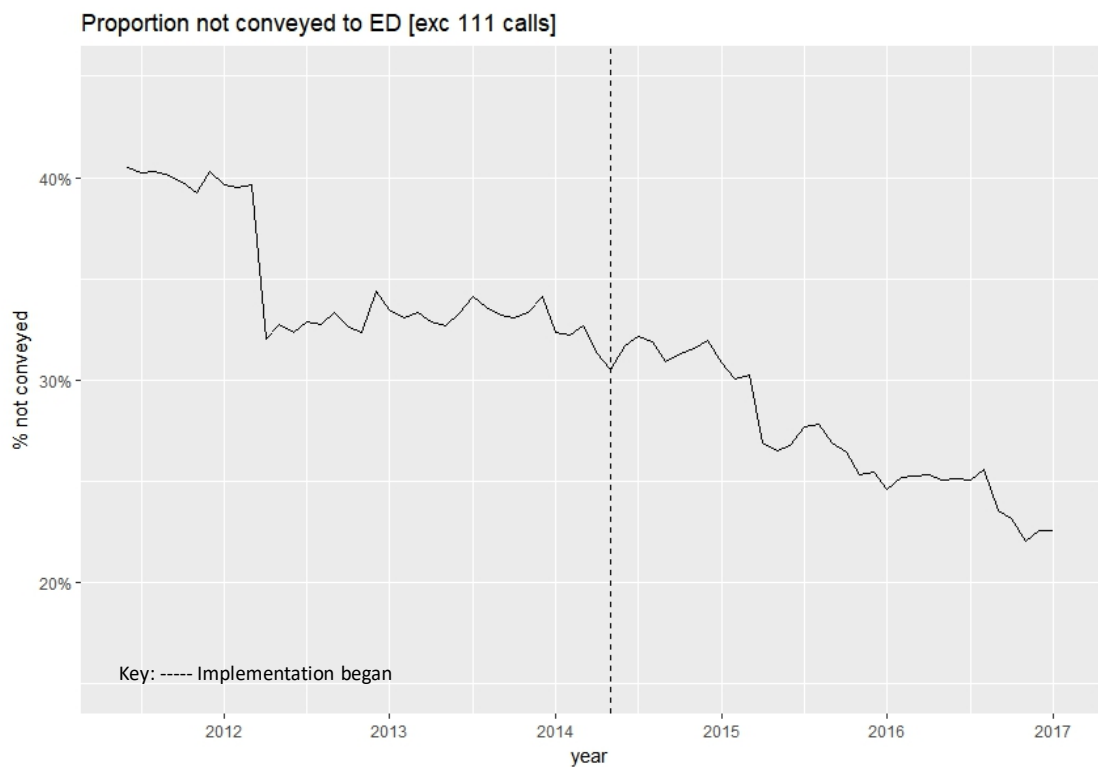
4.2.2 Modelling: Assessing outliers and improving goodness of fit

When assessing for outliers, a significant downward shift in April 2012 was identified in both series (Table 4.2 below). There was a further downward shift in April 2015 in the proportion of patients not conveyed. Calendar effects (leap-year and Easter) were found to have little effect, although results confirm both series contained seasonal errors. Seasonal errors can be addressed by adding seasonal autoregressive (SAR) adjustments to the model. Once these predictor variables were included in the modelling, a seasonal ARIMA (SARIMA) (1,0,0) (1,0,0) model was found to be the optimal model to analyse both time series (Table 4.3 below).

Table 4.2: Outlier estimates for unadjusted time series of numbers and proportions of patients not conveyed to ED

Time series	Outlier	Coefficient	Std. Error	t-statistic
Numbers not conveyed	SAR1	0.886	0.042	21.352
	Trading day	-15.337	12.783	-1.200
	Leap-year	776.475	264.536	2.935
	Easter	-125.684	142.995	-0.879
	April 2012	-3,324.553	587.865	-5.655
Proportions not conveyed	AR1	0.962	0.029	33.284
	SAR1	0.630	0.093	6.753
	Intercept	0.370	0.031	12.039
	Trading day	0.0001	0.0002	-0.500
	Leap-year	0.004	0.003	1.433
	Easter	-0.003	0.002	-1.389
	April 2012	-0.071	0.006	-11.222
	April 2015	-0.026	0.005	-5.020

Table 4.3: Serial dependency and goodness of fit for time series analysis of numbers of patients not conveyed to ED

Time series	Model	Ljung-Box test			Goodness of Fit			
		x^2	df	*p*-value	AICc	BIC	MAPE	R^2
Number not conveyed	(1,0,0) (1,0,0)	16.859	18	0.533	1105.9	1119.57	3.306	0.875
Proportion not conveyed	(1,0,0) (1,0,0)	7.803	18	0.981	-404.49	-390.82	2.155	0.953

4.2.3   Interrupted time series analysis

Level: There was no significant change in the level of numbers nor proportions of patients being treated closer to home pre versus post-NEWS (see PREPOST in Table 4.4, p.129 & Table 4.5, p.130).

Trend: Analysis shows the numbers and proportions of patients being treated closer to home were declining before NEWS was introduced by c. 73 (0.26%) patients per month. Afterwards, numbers and proportions continued to decrease, with the declining (post-slope) trend increasing to c. 107 (0.27%) patients per month; that being an insignificant difference of c. 34 (0.01%) less patients per month being treated closer to home than before NEWS was introduced (see TIMEPERIOD and INTERACT in Table 4.4, p.129 & Table 4.5, p.130).

The 2-month level of effect in Table 4.4 (p.129) and Table 4.5 (p.130) shows c. 308 (0.24%) more patients than predicted were treated closer to home, whereas 34-months after NEWS began to be introduced there were c. 768 (0.01%) less patients than predicted. These changes were not significant.

Table 4.4: Parameter estimates for numbers of patients not conveyed to ED

SARIMA (1,0,0) (1,0,0)					Confidence Intervals	
Parameter	Coefficient	Std. Error	t ratio	*p*-value	Lower	Upper
AR1	0.716	0.089	8.039	<0.001	0.541	0.891
SAR1	0.795	0.069	11.462	<0.001	0.659	0.931
Intercept	17952.070	1192.620	15.053	<0.001	15614.583	20289.567
TIME-PERIOD	-73.039	36.249	-2.015	0.044	-144.086	-1.992
INTERACT	-33.622	56.122	-0.599	0.549	-143.620	76.375
PREPOST	1517.949	2001.332	0.759	0.448	-2404.590	5440.489
Month 02	307.543	503.842	0.610	0.541	-679.969	1295.0557
Month 04	240.299	533.684	0.450	0.653	-805.703	1286.300
Month 06	173.054	583.933	0.296	0.767	-971.434	1317.542
Month 08	105.809	649.872	0.163	0.871	-1167.917	1379.535
Month 10	38.564	727.246	0.053	0.958	-1386.812	1463.940
Month 12	-28.651	812.767	-0.035	0.971	-1621.733	1564.372
Month 14	-95.925	904.205	-0.106	0.916	-1868.135	1676.285
Month 16	-163.170	999.867	-0.163	0.870	-2122.873	1796.533
Month 18	-230.415	1098.670	-0.210	0.834	-2383.768	1922.938
Month 20	-297.660	1199.842	-0.248	0.804	-2649.306	2053.986
Month 22	-364.904	1302.824	-0.280	0.780	-2918.393	2188.585
Month 24	-432.149	1407.230	-0.307	0.759	-3190.269	2325.970
Month 26	-499.394	1512.754	-0.330	0.741	-3464.337	2465.549
Month 28	-566.639	1619.180	-0.350	0.726	-3740.171	2606.894
Month 30	-635.760	1726.190	-0.368	0.713	-4019.031	2747.510
Month 32	-702.630	1833.646	-0.383	0.702	-4296.510	2891.250
Month 34	-768.373	1942.411	-0.396	0.692	-4575.429	3038.683

Timeline Ruler																
02	04	06	08	10	12	14	16	18	20	22	24	26	28	30	32	34
May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan
2014				2015						2016						2017

Table 4.5: Parameter estimates for proportions of patients not conveyed to ED

SARIMA (1,0,0) (1,0,0)						
Parameter	Coefficient	Std. Error	t ratio	*p*-value	Confidence Intervals	
					Lower	Upper
AR1	0.7947	0.0776	10.240	<0.001	0.6426	0.9468
SAR1	0.3313	0.1624	2.040	0.041	0.0131	0.6500
Intercept	0.4027	0.0174	23.107	<0.001	0.3690	0.4368
TIME-PERIOD	-0.0026	0.0007	-3.481	<0.001	-0.0040	-0.0011
INTERACT	-0.0001	0.0012	-0.067	0.946	-0.0024	0.0022
PREPOST	0.0053	0.0421	0.126	0.900	-0.0773	0.0879
Month 02	0.0024	0.0109	0.223	0.824	-0.0190	0.0239
Month 04	0.0023	0.0116	0.197	0.844	-0.0200	0.0249
Month 06	0.0021	0.0126	0.168	0.866	-0.0226	0.0268
Month 08	0.0020	0.0140	0.140	0.888	-0.0254	0.0293
Month 10	0.0018	0.0156	0.116	0.908	-0.0287	0.0323
Month 12	0.0016	0.0174	0.095	0.925	-0.0324	0.0357
Month 14	0.0015	0.0193	0.077	0.939	-0.0363	0.0392
Month 16	0.0013	0.0213	0.062	0.950	-0.0403	0.0430
Month 18	0.0012	0.0233	0.050	0.960	-0.0445	0.0469
Month 20	0.0010	0.0255	0.040	0.968	-0.0489	0.0509
Month 22	0.0008	0.0276	0.031	0.975	-0.0533	0.0550
Month 24	0.0006	0.0297	0.023	0.981	-0.0578	0.0591
Month 26	0.0005	0.0320	0.017	0.987	-0.0623	0.0633
Month 28	0.0004	0.0343	0.011	0.991	-0.0668	0.0676
Month 30	0.0002	0.0366	0.006	0.995	-0.0715	0.0719
Month 32	0.0001	0.0389	0.001	0.999	-0.0761	0.0762
Month 34	-0.0001	0.0412	-0.002	0.998	-0.0808	0.0806

Timeline Ruler																
02	04	06	08	10	12	14	16	18	20	22	24	26	28	30	32	34
May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan
2014				2015						2016						2017

4.3 Secondary outcome measure: Patients treated and discharged at scene who recontacted within 24-hours[12]

4.3.1 Descriptive overview

The numbers and proportions of patients treated and discharged at scene, who recontacted AMB-X within 24-hours decreased during the time-period; Pre-NEWS n=31,013, 6.16% and Post-NEWS n=23,076, 4.66% (Table 4.6 below).

Table 4.6: Descriptive breakdown of patients left at scene who recontact within 24-hours each month

Time Period	Measure	Mean	Range		Standard
			From	To	Deviation
PRE-NEWS	Number of patients	912	714	1,206	101
	Percentage of patients	6.15	5.20	6.98	0.47
POST-NEWS	Number of patients	679	456	916	100
	Percentage of patients	4.65	3.23	5.48	0.58

Both numbers and proportions increased at the beginning of the series (Figure 4.5 & Figure 4.6, p.132). Levels then plateaued, before decreasing in the first quarter of 2014 to a lower level than previously. Midway through 2016, the levels decrease further still, before increasing again that autumn. Seasonality was again more evident in the series relating to numbers than proportions.

---

[12] Data includes 999-calls only.

Figure 4.5: Time series of numbers of patients left at scene who recontacted within 24-hours.
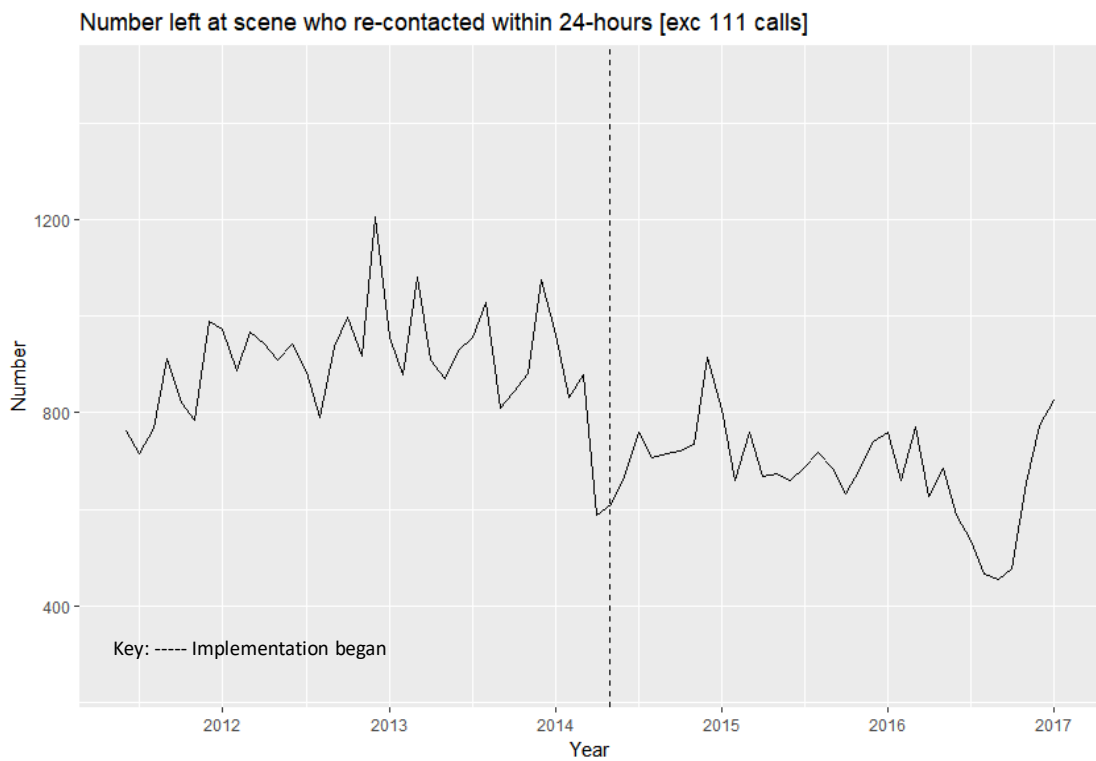
Figure 4.6: Time series of proportions of patients left at scene who recontacted within 24-hours
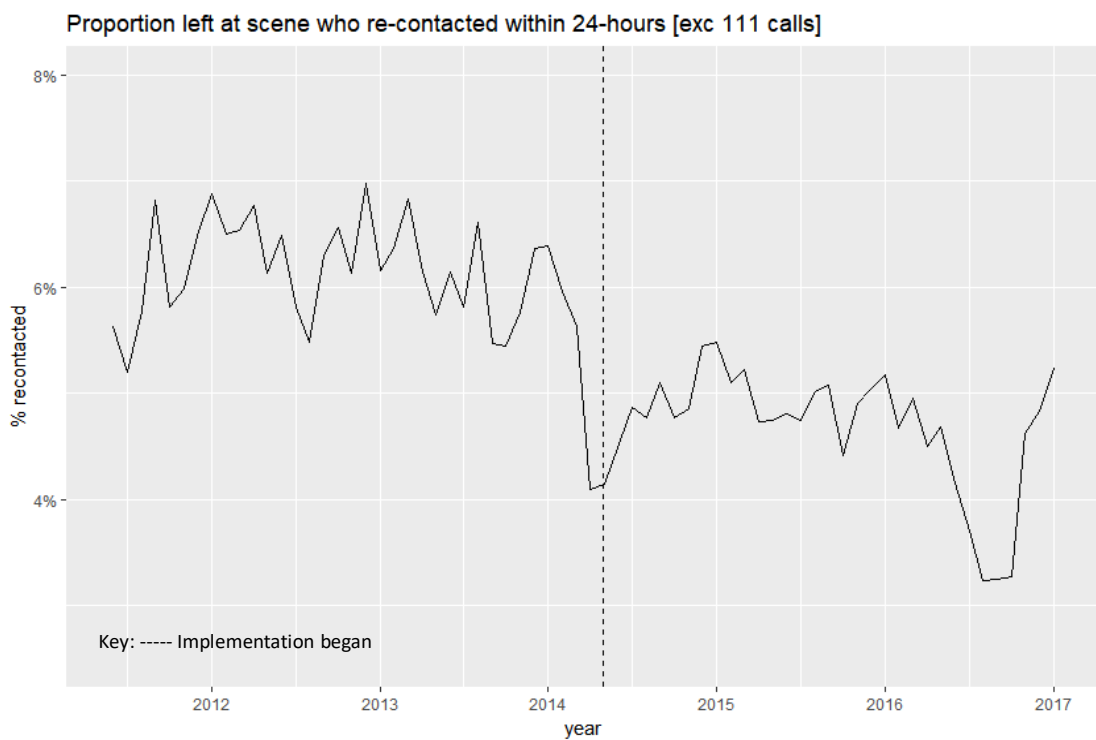
4.3.2 Modelling: Assessing outliers and improving goodness of fit

When assessing for outliers, a seasonal autoregressive adjustment to the series was found to have a significant effect (Table 4.7 below). A SARIMA (1,0,0) (1,0,0) model was subsequently found to be most optimal to analyse the data relating to numbers of patients, whereas an ARIMA (1,0,0) (0,0,0) model was found to be a better fit for analysing the proportions of patients (Table 4.8 below).

Table 4.7: Outlier estimates for unadjusted time series of numbers and proportions of patients left at scene who recontacted within 24-hours.

Time series	Outlier	Coefficient	Std. Error	t-statistic
Number recontacted	MA1	-0.333	0.158	-2.108
	SAR1	0.504	0.108	4.649
	Trading day	-1.917	2.921	-0.656
	Leap-year	14.798	57.925	0.255
	Easter	19.635	31.728	0.619
Proportion recontacted	Trading day	-0.0001	0.0002	-0.500
	Leap-year	-0.0024	0.0032	-0.750
	Easter	0.0001	0.0019	0.053

Table 4.8: Serial dependency and goodness of fit for time series analysis of numbers of patients who recontacted within 24-hours

Time series	Model	Ljung-Box test			Goodness of Fit			
		x^2	df	p-value	AICc	BIC	MAPE	R^2
Numbers recontacted	(1,0,0) (1,0,0)	14.825	18	0.674	803.54	817.21	8.00	0.744
Proportions recontacted	(1,0,0) (0,0,0)	17.03	19	0.5878	-534.62	-522.68	7.079	0.779

4.3.3 Interrupted time series analysis

Level: There was no significant change in the level of numbers nor proportions of patients who recontacted, pre versus post-NEWS (Table 4.9, p.134 & Table 4.10, p.135).

Trend: Whilst numbers and proportions were increasing by c. 2 (0.001%) patients per month pre-NEWS, post-NEWS figures showed a declining trend with a decrease of c. 3 (0.12%) patients per month; an insignificant difference pre-vs-post of c. 5 (0.012%) less patients re-contacting AMB-X per month (Table 4.9, p.134 & Table 4.10, p.135).

Table 4.9: Parameter estimates for numbers of patients left at scene who recontacted within 24-hours

SARIMA (1,0,0) (1,0,0)						
Parameter	Coefficient	Std. Error	t ratio	*p*-value	Confidence Intervals	
					Lower	Upper
AR1	0.488	0.111	4.382	<0.001	0.269	0.706
SAR1	0.476	0.115	4.161	<0.001	0.252	0.701
Intercept	856.175	58.041	14.751	<0.001	742.417	969.933
TIME-PERIOD	2.299	2.487	0.924	0.355	-2.576	7.174
INTERACT	-5.215	3.872	-1.347	0.178	-12.805	2.375
PREPOST	-19.756	143.646	-0.138	0.891	-301.298	261.786
Month 02	-207.498	54.292	-3.822	<0.001	-313.908	-101.088
Month 04	-217.929	55.719	-3.911	<0.001	-327.137	-108.721
Month 06	-228.360	58.152	-3.927	<0.001	-342.335	-114.385
Month 08	-238.792	61.469	-3.885	<0.001	-359.270	-118.314
Month 10	-249.223	65.539	-3.803	<0.001	-377.646	-120.769
Month 12	-259.653	70.228	-3.697	<0.001	-397.299	-122.008
Month 14	-270.087	75.423	-3.581	<0.001	-417.910	-122.257
Month 16	-280.514	81.026	-3.462	<0.001	-439.322	-121.705
Month 18	-290.944	86.958	-3.346	<0.001	-461.380	-120.509
Month 20	-301.375	93.157	-3.235	0.001	-483.959	-118.791
Month 22	-311.806	99.572	-3.131	0.001	-506.963	-116.659
Month 24	-322.238	106.162	-3.03	0.002	-530.316	-114.160
Month 26	-332.670	112.903	-2.947	0.003	-533.956	-111.385
Month 28	-343.104	119.763	-2.865	0.004	-577.836	-108.372
Month 30	-353.538	126.726	-2.790	0.005	-601.916	-105.161
Month 32	-363.974	133.774	-2.720	0.007	-626.165	-101.782
Month 34	-374.410	140.895	-2.657	0.008	-650.560	-98.261

Timeline Ruler																
02	04	06	08	10	12	14	16	18	20	22	24	26	28	30	32	34
May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan
2014				2015						2016						2017

Table 4.10: Parameter estimates for proportions of patients left at scene who recontacted within 24-hours

ARIMA (1,0,0) (0,0,0)						
Parameter	Coefficient	Std. Error	t ratio	*p*-value	Confidence Intervals	
					Lower	Upper
AR1	0.53694	0.1103	4.869	<0.001	0.3208	0.7510
Intercept	0.06132	0.0030	20.389	<0.001	0.0554	0.0672
TIME-PERIOD	0.00001	0.0002	0.054	0.957	-0.0004	0.0004
INTERACT	-0.00012	-0.0001	-0.503	0.615	-0.0006	0.0003
PREPOST	-0.00894	0.0084	-1.065	0.287	-0.0254	0.0075
Month 02	-0.0134	0.0036	-3.666	<0.001	-0.0205	-0.0062
Month 04	-0.0136	0.0037	-3.674	<0.001	-0.0209	-0.0063
Month 06	-0.0139	0.0038	-3.633	<0.001	-0.0213	-0.0064
Month 08	-0.0141	0.0040	-3.553	<0.001	-0.0219	-0.0063
Month 10	-0.0144	0.0042	-3.445	<0.001	-0.0225	-0.0063
Month 12	-0.0146	0.0044	-3.319	<0.001	-0.0232	-0.0060
Month 14	-0.0148	0.0047	-3.184	0.001	-0.0240	-0.0057
Month 16	-0.0151	0.0049	-3.048	0.002	-0.0248	-0.0054
Month 18	-0.0153	0.0053	-2.914	0.004	-0.0256	-0.0050
Month 20	-0.0156	0.0056	-2.786	0.005	-0.0265	-0.0046
Month 22	-0.0158	0.0059	-2.665	0.008	-0.0275	-0.0042
Month 24	-0.0161	0.0063	-2.552	0.011	-0.0284	-0.0037
Month 26	-0.0163	0.0067	-2.447	0.014	-0.0294	-0.0032
Month 28	-0.0166	0.0070	-2.350	0.019	-0.0304	-0.0030
Month 30	-0.0168	0.0074	-2.260	0.024	-0.0314	-0.0022
Month 32	-0.0171	0.0078	-2.177	0.029	-0.0324	-0.0017
Month 34	-0.0173	0.0082	-2.100	0.036	-0.0334	-0.0012

Timeline Ruler																
02	04	06	08	10	12	14	16	18	20	22	24	26	28	30	32	34
May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan
2014				2015						2016						2017

Two-months post-NEWS there were c. 207 (1.34%) fewer patients who recontacted AMB-X than predicted (Table 4.9, p.134 & Table 4.10, p.135). This had increased to c. 374 (1.73%) fewer patients by the end of the study period. All bimonthly measures of level of effects were found to be significantly lower than predicted, although these results should be interpreted with caution. This is because the first Paramedic Pathfinder training did not begin until June 2014, with only 17 (1%) staff in total having been trained by the end of July (Figure 4.7 below). Figure 4.5 and Figure 4.6 (p.132), both illustrate the decline in numbers and proportions which occurred just prior to the timeline indicating when the Paramedic Pathfinder Programme formally commenced. This would suggest something other than the introduction of NEWS (or Paramedic Pathfinder) precipitated the significant change in recontact rates, although the introduction of the NEWS may have assisted in sustaining the effect.

Figure 4.7: Numbers and percentage of AMB-X staff trained to use the NEWS
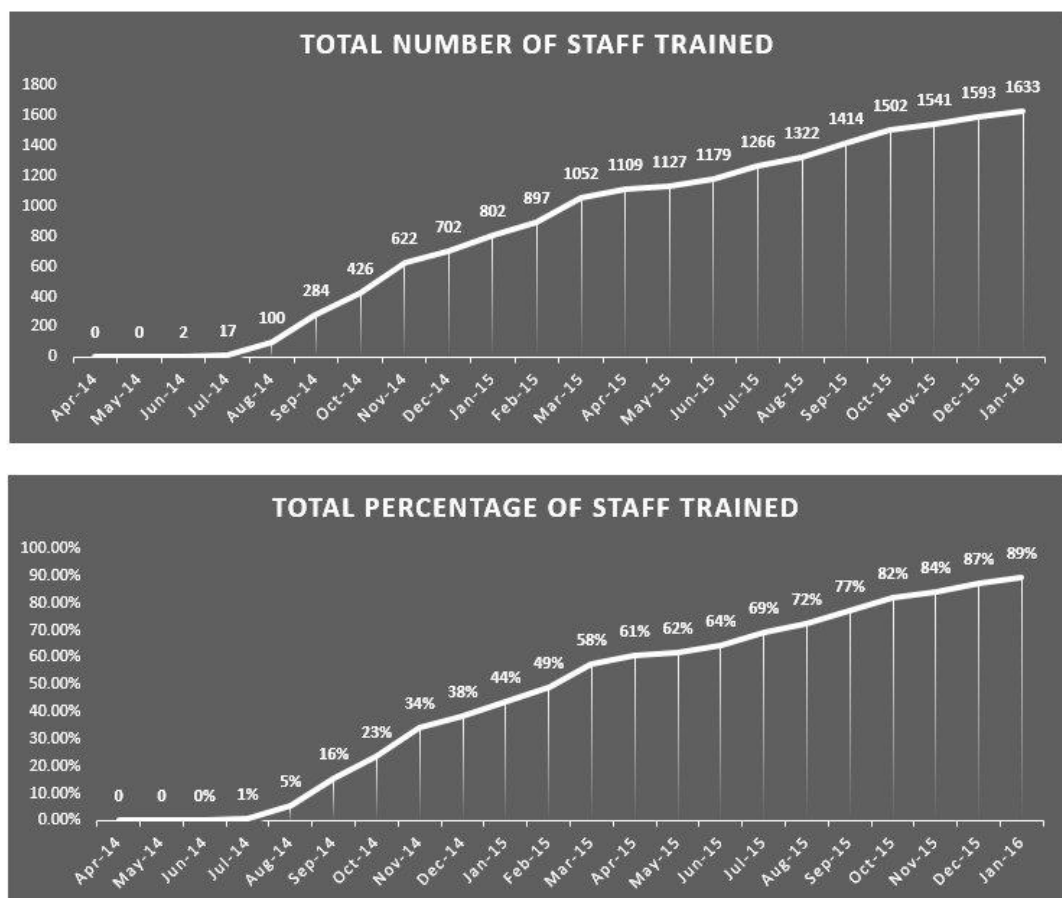
4.4 See & Treat calls[13]

4.4.1 Descriptive overview

The numbers of patients attended to by ambulance clinicians were found to increase during the timeframe; Pre-NEWS n=1,594,924 and Post-NEWS n=1,713,875 (Table 4.11 below). From June 2011 until January 2013 there was a steady increase. Numbers then plateaued from January 2013 until autumn 2015. In 2016, numbers began increasing once again (Figure 4.8 below).

Table 4.11: Descriptive breakdown of numbers of See & Treat calls each month

Time Period	Mean	Range		Standard
		From	To	Deviation
PRE-NEWS	46,910	42,535	52,086	2,447
POST-NEWS	50,408	44,745	57,274	2,816

Figure 4.8: Time series of numbers of See & Treat calls

See & Treat: Number of 999 calls attended by a paramedic [inc 111 calls]

---
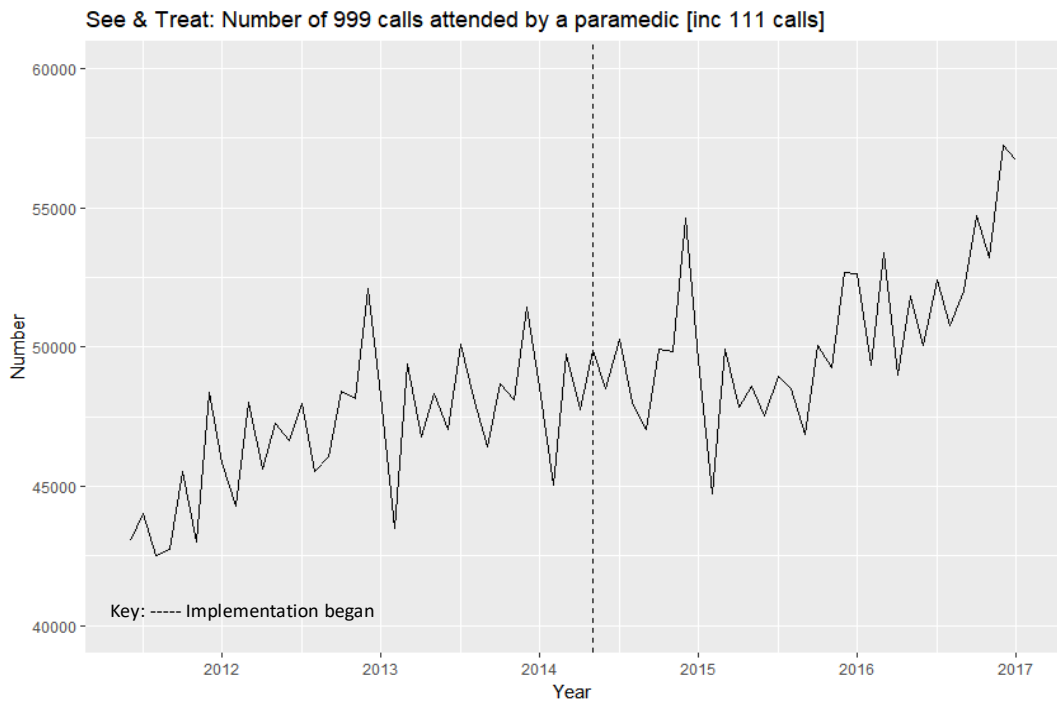
[13] Data includes 999 and NHS 111 calls (see Appendix 22, p.319 and Appendix 23, p.320).

4.4.2 Modelling: Assessing outliers and improving goodness of fit

Both seasonal and non-seasonal autoregressive adjustments to the time series were shown to have a significant effect on serial dependency errors within the time series, otherwise no outliers were detected (Table 4.12 below). A SARIMA (2,0,0) (1,0,0) was subsequently identified as optimal for analysis (Table 4.13 below).

Table 4.12: Outlier estimates for unadjusted time series of numbers of See & Treat calls

	Coefficient	Std. Error	t-statistic
AR1	0.944	0.052	18.218
SAR1	-0.500	0.121	-4.139
Trading day	-16.223	23.701	-0.684
Leap-year	1,578.929	563.647	2.801
Easter	686.698	303.691	2.261

Table 4.13: Serial dependency and goodness of fit for time series analysis of numbers of See & Treat calls

ARIMA (2,0,0) (1,0,0)						
Ljung-Box test			Goodness of Fit			
x^2	df	p-value	AICc	BIC	MAPE	R^2
13.074	17	0.731	1195.69	1211.00	2.046	0.838

4.4.3 Interrupted time series analysis

Level: I found the actual numbers attended post-NEWS did not differ significantly to those predicted (Table 4.14, p.139).

Trend: Pre-NEWS, the numbers of See & Treat calls were increasing by c. 150 calls per month, whereas post-NEWS they were increasing by c. 162 calls per month; an insignificant difference of c. 12 more calls per month (Table 4.14, p.139).

The numbers of See & Treat calls were lower than predicted at the beginning of the time series post-NEWS, increasing to above predicted levels at 22-months post-NEWS. By the end of the study, AMB-X was receiving c. 158 more calls than predicted. The changes were not found to be significant.

Table 4.14: Parameter estimates for See & Treat calls

SARIMA (2,0,0) (1,0,0)						
Parameter	Coefficient	Std. Error	t ratio	*p*-value	Confidence Intervals	
					Lower	Upper
AR1	0.514	0.130	3.970	<0.001	0.260	0.768
AR1	0.170	0.129	1.314	0.189	-0.084	0.423
SAR1	0.810	0.064	12.731	<0.001	0.686	0.936
Intercept	43581.434	2089.492	20.857	<0.001	39486.104	47676.764
TIME-PERIOD	150.413	61.424	2.449	0.014	30.024	270.802
INTERACT	11.7302	93.745	0.125	0.900	-172.007	195.468
PREPOST	-639.309	3364.590	-0.190	0.849	-7233.784	5955.166
Month 02	-217.021	926.885	-0.234	0.815	-2033.683	1599.640
Month 04	-193.561	972.539	-0.200	0.842	-2099.703	1712.581
Month 06	-170.100	1050.167	-0.162	0.871	-2228.389	1888.188
Month 08	-146.640	1153.332	-0.127	0.899	-2407.130	2113.850
Month 10	-123.180	1275.857	-0.097	0.923	-2623.814	2377.455
Month 12	-99.719	1412.706	-0.070	0.944	-2868.572	2669.134
Month 14	-76.259	1560.121	-0.049	0.961	-3134.039	2981.522
Month 16	-52.798	1715.376	-0.031	0.975	-3414.872	3309.276
Month 18	-29.338	1876.529	-0.016	0.988	-3707.267	3648.591
Month 20	-5.877	2042.187	-0.003	0.998	-4008.491	3966.736
Month 22	17.583	2211.327	0.008	0.994	-4316.537	4351.703
Month 24	41.043	2383.212	0.017	0.986	-4629.967	4712.054
Month 26	64.504	2557.306	0.025	0.980	-4947.724	5076.732
Month 28	87.964	2733.181	0.032	0.974	-5268.972	5444.900
Month 30	111.425	2910.483	0.038	0.969	-5593.018	5815.867
Month 32	134.885	3088.974	0.044	0.965	-5919.393	6189.163
Month 34	158.346	3268.502	0.048	0.961	-6247.800	6564.491

Timeline Ruler																
02	04	06	08	10	12	14	16	18	20	22	24	26	28	30	32	34
May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan
2014				2015						2016						2017

4.5   Patients treated and discharged at scene[14]

4.5.1   Descriptive overview

The numbers of patients being treated and discharged at scene decreased; Pre-NEWS n=503,733 and Post-NEWS n=495,512 (Table 4.15 below). Numbers increased initially, then plateaued in 2013 (Figure 4.9 below). This was followed by a slight decrease in 2014 and a further decrease in January 2015. In 2016, numbers appear to be slowly increasing again.

Table 4.15: Descriptive breakdown of numbers of patients left at scene each month

Time Period	Mean	Range		Standard
		From	To	Deviation
PRE-NEWS	14,816	13,117	17,279	990
POST-NEWS	14,574	12,915	16,835	746

Figure 4.9: Time series of numbers of patients left at scene

_____
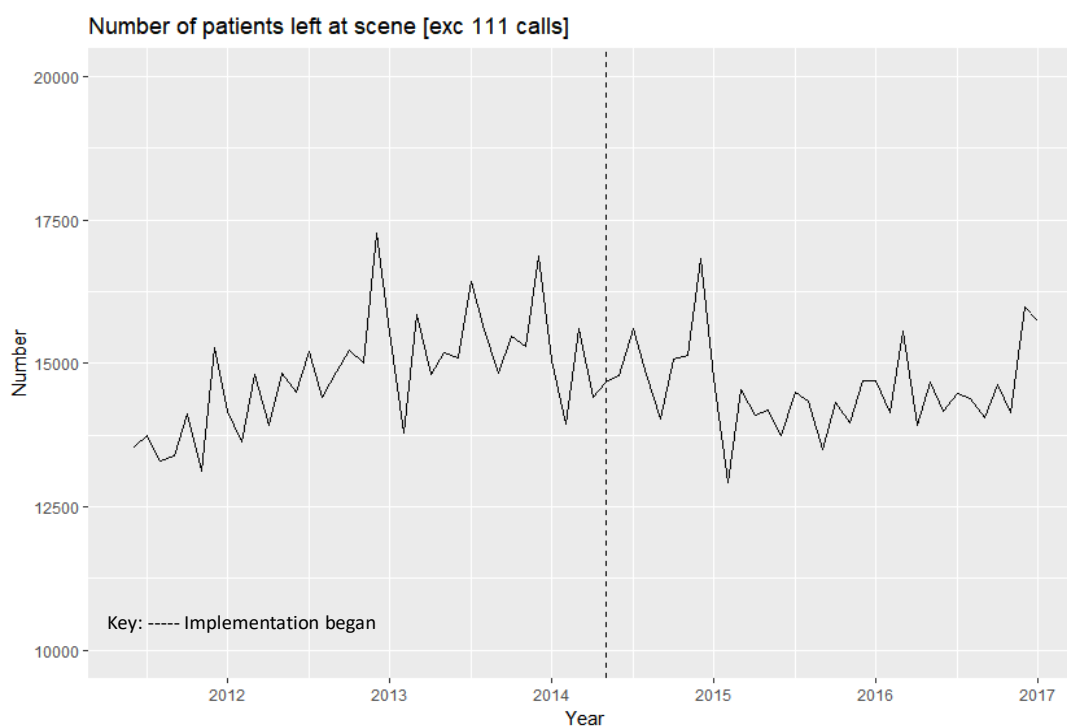
[14] Data includes 999-calls only

4.5.2   Modelling: Assessing outliers and improving goodness of fit

Other than autoregressive and seasonal autoregressive errors, no other outliers were detected (Table 4.16 below). A SARIMA (1,0,0) (1,0,0) model was identified as optimal for analysis (Table 4.17 below).

Table 4.16: Outlier estimates for unadjusted time series of numbers of patients left at scene

	Coefficient	Std. Error	t-statistic
AR1	0.755	0.082	9.248
SAR1	0.840	0.056	14.922
Intercept	14,445.740	912.210	15.836
Trading day	-15.653	14.401	-1.087
Leap-year	702.834	303.750	2.314
Easter	212.318	145.185	1.462

Table 4.17: Serial dependency and goodness of fit for time series analysis of numbers of patients left at scene

SARIMA (1,0,0) (1,0,0)						
Ljung-Box test			Goodness of Fit			
x^2	df	p-value	AICc	BIC	MAPE	R^2
13.724	18	0.7469	1070.54	1084.21	2.769	0.646

4.5.3   Interrupted time series analysis

Level: The numbers of patients left at scene post-NEWS did not differ significantly to that predicted (Table 4.18, p.142).

Trend: Pre-NEWS numbers were increasing by c. 58 patients per month (Table 4.18, p.142). Whereas post-NEWS, numbers were decreasing at a rate of c. 2 patients per month; a significant difference of c. 60 less patients per month being treated and discharged at scene than pre-NEWS.

Bimonthly evaluations show post-NEWS the numbers of patients treated and discharged at scene were decreasing significantly (Table 4.18, p.142). Two-months post-NEWS there were c. 883 less patients, and by study end the level had reached c. 2,800 less patients.

Table 4.18: Parameter estimates for numbers of patients left at scene

SARIMA (1,0,0) (1,0,0)						
Parameter	Coefficient	Std. Error	t ratio	*p*-value	Confidence Intervals	
					Lower	Upper
AR1	0.535	0.115	4.674	<0.001	0.311	0.759
SAR1	0.766	0.073	10.552	<0.001	0.624	0.909
Intercept	13607.520	553.447	24.587	<0.001	12522.783	14692.256
TIME-PERIOD	57.898	18.419	3.143	0.002	21.798	93.998
INTERACT	-59.917	28.155	-2.128	0.033	-115.100	-4.735
PREPOST	1273.884	1024.190	1.244	0.214	-733.490	3281.259
Month 02	-883.140	340.560	-2.593	0.010	-1550.626	-215.655
Month 04	-1002.982	352.696	-2.844	0.004	-1694.254	-311.710
Month 06	-1122.951	372.999	-3.011	0.003	-1854.017	-391.886
Month 08	-1242.785	400.277	-3.105	0.002	-2027.312	-458.257
Month 10	-1362.618	433.191	-3.146	0.002	-2211.657	-513.579
Month 12	-1482.452	470.562	-3.150	0.002	-2404.737	-560.167
Month 14	-1602.285	511.413	-3.133	0.002	-2604.637	-599.933
Month 16	-1722.118	554.977	-3.103	0.002	-2809.852	-634.384
Month 18	-1841.951	600663	-3.067	0.002	-3019.229	-664.673
Month 20	-1961.784	648.023	-3.027	0.002	-3231.885	-691.682
Month 22	-2081.478	696.756	-2.987	0.003	-3447.094	-715.862
Month 24	-2201.313	746.524	-2.949	0.003	-3664.472	-738.153
Month 26	-2321.147	797.162	-2.912	0.004	-3883.556	-758.738
Month 28	-2440.981	848.516	-2.877	0.004	-4104.042	-777.921
Month 30	-2560.816	900.462	-2.844	0.004	-4325.689	-795.942
Month 32	-2680.650	952.905	-2.813	0.005	-4548.310	-812.990
Month 34	-2800.484	1005.767	-2.784	0.005	-4771.751	-829.217

Timeline Ruler																
02	04	06	08	10	12	14	16	18	20	22	24	26	28	30	32	34
May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan
2014				2015						2016						2017

The significant declining trend in numbers being treated and discharged at scene, without a significant change in rate of patients being treated closer to home, would suggest more patients were being conveyed to alternative care facilities (e.g. UCC, MIU, WiC).

Figure 4.9 (p.140) shows a corresponding (non-significant) downward shift in numbers of patients being left at scene that occurred around April 2015. This shift is similar to those in Figure 4.3 and Figure 4.4 (p.126). The decline could therefore be related to the increase in category A calls, which I discuss next.

4.6   Category A (life-threatening) calls[15]

4.6.1   Descriptive overview

There was an increase in the numbers of category A calls received by AMB-X during the timeframe; Pre-NEWS n=664,994 and Post-NEWS n=840,392 (Table 4.19 below & Figure 4.10 below).

Table 4.19: Descriptive breakdown of numbers of category A calls per month

Time Period	Mean	Range		Standard Deviation
		From	To	
PRE-NEWS	19,559	17,461	23,182	1,396
POST-NEWS	24,717	20,662	33,047	3,493

Figure 4.10: Time series of numbers of category A calls

Number of Category A calls attended [inc 111 calls]

---
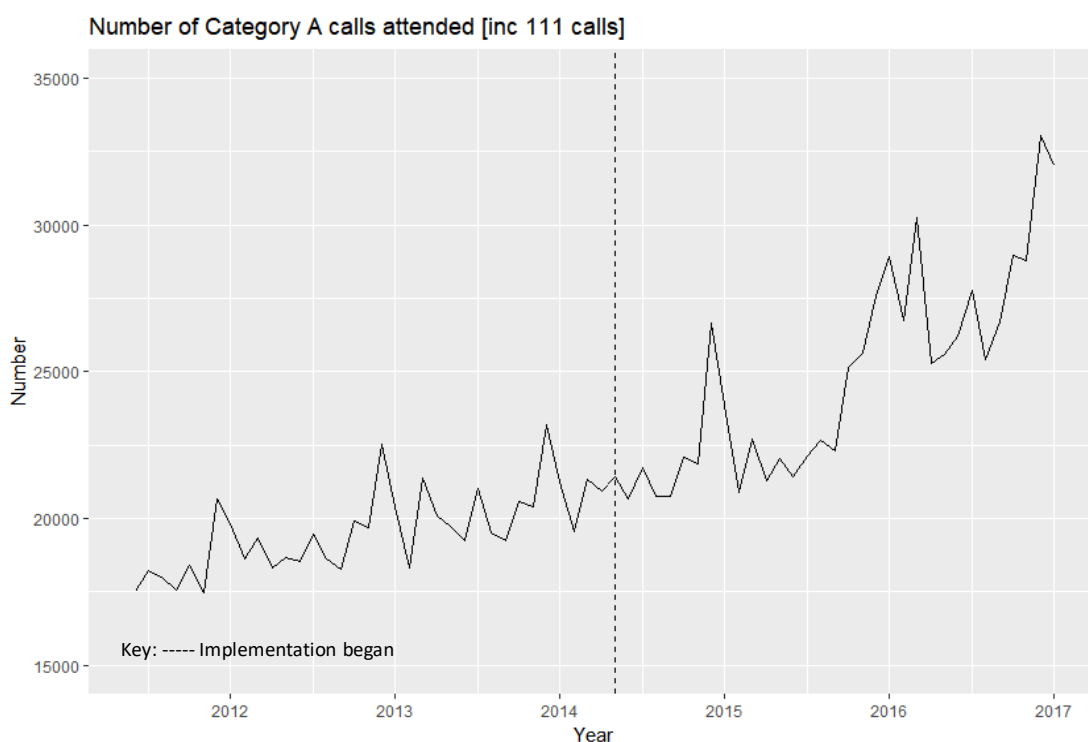
[15] Data includes 999 and NHS 111 calls (see Appendix 22, p.319 and Appendix 23, p.320)

4.6.2   Modelling: Assessing outliers and improving goodness of fit

Other than autoregressive and seasonal serial dependencies, no outliers were detected (Table 4.20 below). A SARIMA (1,0,0) (0,0,1) model was identified as optimal for analysis (Table 4.21 below).

Table 4.20: Outlier estimates for unadjusted time series of numbers of category A Calls

	Coefficient	Std. Error	t-statistic
MA1	-0.465	0.133	-3.494
SMA1	-0.544	0.182	-2.992
Trading day	-13.911	29.201	-0.476
Leap-year	1,325.269	648.354	2.044
Easter	975.476	375.303	2.599

Table 4.21: Serial dependency and goodness of fit for time series analysis of numbers of category A calls

SARIMA (1,0,0) (0,0,1)						
Ljung-Box test			Goodness of Fit			
x^2	df	p-value	AICc	BIC	MAPE	R^2
30.718	18	0.031	1179.93	1193.6	3.778	0.890

4.6.3   Interrupted time series analysis

Level: There was a significant increase in the numbers of category A calls after NEWS had been introduced compared to before (Table 4.22, p.145).

Trend: Pre-NEWS, numbers of life-threatening calls were increasing by c. 84 calls per month (Table 4.22, p.145). Calls continued to increase post-NEWS at a rate of c. 283 calls per month; a significant difference of c. 199 more life-threatening calls being attended each month.

Sixteen-months after the NEWS had been introduced category A calls had increased significantly above the level predicted (Table 4.22, p.145). Numbers continued to increase and remained significant up until the end of the study; level of effect at 34-months post-NEWS was c. 6,064 more calls than predicted.

Table 4.22: Parameter estimates for numbers of category A calls

SARIMA Model (1,0,0) (0,0,1)						
Parameter	Coefficient	Std. Error	t ratio	*p*-value	Confidence Intervals	
					Lower	Upper
AR1	0.362	0.113	3.201	0.001	0.141	0.584
SMA1	0.531	0.125	4.252	<0.001	0.286	0.776
Intercept	17910.540	774.978	23.111	<0.001	16391.612	19429.469
TIME-PERIOD	84.247	35.532	2.371	0.018	14.607	153.888
INTERACT	199.167	56.306	3.537	<0.001	88.809	309.525
PREPOST	-7478.969	2097.400	-3.566	<0.001	-11589.792	-3368.145
Month 02	-308.957	779.239	-0.396	0.692	-1836.237	1218.324
Month 04	89.377	798.438	-0.112	0.911	-1475.532	1654.286
Month 06	487.711	832.559	0.586	0.558	-1144.075	2119.498
Month 08	886.045	879.870	1.007	0.314	-838.469	2610.559
Month 10	1284.379	938.376	1.369	0.171	-554.804	3123.562
Month 12	1682.713	1006.127	1.672	0.094	-289.259	3654.686
Month 14	2081.047	1081.385	1.924	0.054	-38.428	4200.523
Month 16	2479.381	1162.697	2.132	0.033	200.538	4758.225
Month 18	2877.715	1248.877	2.304	0.021	429.962	5325.469
Month 20	3276.049	1338.989	2.447	0.014	651.679	5900.420
Month 22	3674.383	1432.289	2.565	0.010	867.148	6481.619
Month 24	4072.717	1528.192	2.665	0.008	1077.515	7067.919
Month 26	4471.051	1626.236	2.750	0.006	1283.687	7658.415
Month 28	4869.385	1726.064	2.821	0.005	1486.362	8252.408
Month 30	5267.719	1827.378	2.883	0.004	1686.124	8849.315
Month 32	5666.053	1929.939	2.936	0.003	1883.442	9448.665
Month 34	6064.387	2033.570	2.982	0.003	2078.663	10050.111

Timeline Ruler																
02	04	06	08	10	12	14	16	18	20	22	24	26	28	30	32	34
May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan
2014				2015						2016						2017

4.7 Inferences

Table 4.23 below provides an illustrative summary of any change in direction of level of effect and trend for each variable measured.

Table 4.23: Summary of interrupted time series analysis

Variable measured	Level of Effect	Change in Trend
Numbers not conveyed	↔	↔
Proportions not conveyed	↔	↔
Numbers recontacted	↔	↔
Proportions recontacted	↔	↔
See & Treat Calls	↔	↔
Left at Scene	↔	↓
Category A call	↑	↑

KEY:
Significantly increased   ↑
Significantly decreased   ↓
No significant difference   ↔

4.7.1 Baseline: Numbers of 999-calls attended increased as predicted

I found the numbers of emergency calls attended by ambulance were increasing each month pre-NEWS and continued to increase as predicted post-NEWS.

4.7.2 Increased use of alternative care pathways but no significant change in non-conveyance rates

Whilst the acuity of calls attended increased significantly, I found no significant difference in the numbers or proportions of patients being treated closer to home. There was however a declining trend in the numbers of patients being treated and discharged at scene, which indicates more patients who called 999 were being treated via alternative care pathways.

4.7.3 No significant change in recontact rates

There was also evidence of a declining trend in the numbers and proportions of patients re-contacting within 24-hours, although the decline commenced before the implementation of the NEWS began. Comparing recontact rates dichotomously, pre-NEWS compared to post-NEWS no significant differences were found.

146

4.7.4 Outliers: downward shifts in numbers and proportions not conveyed

The downward level shifts that occurred in April 2012 for both the numbers and proportions of patients being treated closer to home were possibly related to the new service model (i.e. the three-tier model) that was introduced at AMB-X in April 2012. To explore the potential impact of all the changes implemented at this time is beyond the scope of this study, because the changes were implemented a long-time before and are not related to NEWS, but certain aspects that may have had a long-term impact on paramedic decision-making are discussed in Chapter 9, section 9.3.3, p.263.

The downward level shift that occurred in April 2015 in proportions of patients being treated closer to home may be related to the increase of category A calls. The AMPDS codes were reviewed nationally during the timeframe of this study. The review was instigated following a national pilot that took place in October 2013 to March 2014 (Williams, 2015). Following the review, some AMPDS codes were revised. AMPDS codes that were changed and may have had an impact on the numbers of category A responses measured in this study are listed in Table 4.24 below.

Table 4.24: *AMPDS code changes*

code	Description	Standard		Date of change
		Old	New	
29B04a	Traffic/Transport Incident with haemorrhage	Green 1	Red 2	Mar 2014
12C3	Known diabetic fitting	Green 1	Red 2	Oct 2014
12C3E	Known diabetic fitting	Green 1	Red 2	Oct 2014

(Williams, 2015)

Whilst the dates in Table 4.24 above do not directly correspond with the date the downward shift occurred, these changes in conjunction with the increase in See & Treat calls in 2015 (Figure 4.8, p.137) may have provoked a 'tipping-point', resulting in this step change. AMB-X implemented other changes to their emergency call-handling

and ambulance dispatch procedure[16] in October 2016, and further changes to clinical codes[17] were implemented in 2017. These changes may have contributed to the increase found towards the end of the time series.

The April 2015 outlier may also be related to the increases in operational demand and the increase in CAT call management capacity. For example, Emergency Medical Dispatchers can refer certain calls to the CAT. This can occur if ambulance dispatch has been or is likely to be delayed.

> *"The CAT could use their clinical judgement and the TAS [telephone assessment software] to inform what they needed to do and change the level of priority calls. We saw CAT staff change coding and the priority of calls appropriately after re-assessing the risk to patients."*[18] *(Care Quality Commission, 2016, p.67)*

I therefore analysed and made inquiries regarding the numbers of Hear & Treat calls being managed by the CAT. I was informed that at the same time Paramedic Pathfinder began to be implemented, AMB-X expanded the CAT team and infrastructure to manage lower acuity calls over the phone (i.e. Hear & Treat calls), which meant proportionally more of the patients being attended by ambulance would be conveyed. This is substantiated by data. In 2015/16, the CAT handled 190,666 calls compared to 114,326 in 2014/15 (Gilbert, 2016), and Figure 4.11 (p.149), illustrates the increase occurred at the same time as the downward shift in the proportions of patients not conveyed. I therefore infer from this, that the outlier detected in April 2015 was more

---

[16] Ambulance Response Programme (ARP) Phase 1: Dispatch on Disposition (DOD) pilot was instigated by the Department of Health in accordance with recommendations provided by the National Director for Care at NHS England. The pilot evaluated the impact of allowing additional time for 999-calls to be triaged and ambulances to be dispatched. Pilot commenced in early 2015 in London Ambulance Service and South West Ambulance Service and was gradually rolled out to other trusts.
[17] Ambulance Response Programme (ARP) Phase 2: Instead of calls prioritised as Red 1, Red 2, Green 1, Green 2, Green 3 and Green 4, calls are now prioritised as Category 1: Immediately life-threatening calls with ambulance to arrive on scene within 7 minutes; Category 2: Emergency calls with 18 minutes response; Category 3: Urgent calls with 120 minutes response; and Category 4: Less urgent calls with advice provided over the phone or ambulance response in 180 minutes.
[18] Report relates to inspection visits on 16-20 November 2015 and 3 December 2015.

likely attributable to the quality improvement initiative associated to the CAT than to the introduction of the NEWS or changes to AMPDS codes.

Figure 4.11: Time series of numbers of Hear & Treat calls.
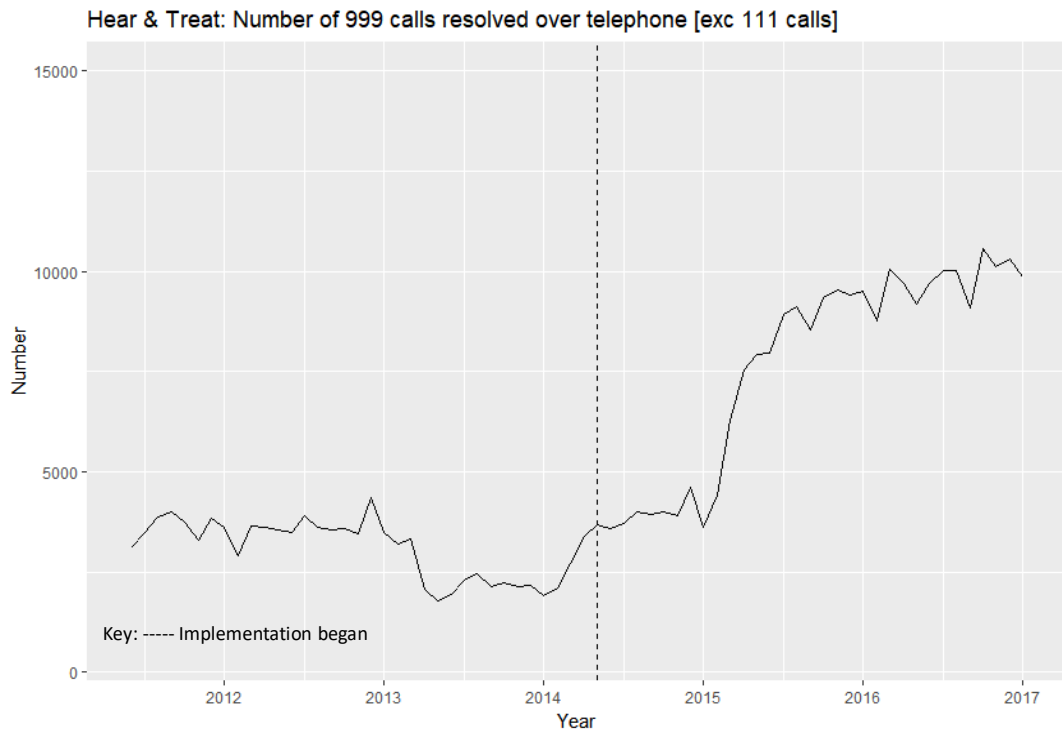
4.7.5 Increase in category A calls

The increase in category A calls was most likely to be attributable to a 27% increase in category A calls received from NHS 111, which occurred between April and December 2015 (Gilbert, 2016). The increase in category A calls from NHS 111 would not have had any effect on primary or secondary outcomes measured as these data sets include 999-calls only. The increase in category A calls is discussed in more detail in Chapter 9, section 9.3.2, p.262.

4.8 Summary

Overall the NEWS had no significant effect on non-conveyance or recontact rates. There were however significantly fewer patients being treated and discharged at scene, but rather than conveying those patients to ED, the results suggest that paramedics were conveying them for treatment to a UCC, MIU or WiC.

In the next chapter, the findings from the interview study provide insights from the paramedics' perspective about the effect the NEWS has had on their decision-making and decision outcomes.

5 Understanding how the NEWS affects and supports paramedics' decision-making: gaining insight from frontline paramedics and leaders

In this chapter I provide greater insight and understanding of the effect of the NEWS on paramedics' decision-making. My aim was to seek answers to the third and fourth research questions posed: 'How useful and effective did paramedics perceive the NEWS to be in supporting them in their decisions to convey or treat patients closer to home?'. And, 'how was the NEWS being used by paramedics in the emergency prehospital care setting?'.

This was achieved from hosting interviews with a purposive sample of clinical staff employed by the ambulance service in this case study, which included paramedics, clinical team leaders, and members of the Paramedic Pathfinder management team. The method adopted was discussed in detail previously in Chapter 3, section 3.6. But briefly, as a reminder, I developed and used two topic guides (Appendix 24, p.367 and Appendix 25, p.372) to gain insight from the clinicians and Paramedic Pathfinder Leaders about the implementation of the NEWS and their opinions of the usefulness and effectiveness of the NEWS. Interviews took on average between 30 to 60 minutes to complete. Discussion were audio recorded and transcribed, before being thematically analysed using NVivo 10 software (QSR International Pty Ltd., 2012).

I begin by providing an overview of the paramedics who were interviewed. I then provide further insight relating to the context of this case study; that is, the socio-organisational factors that may have helped or hindered the implementation and adoption of the NEWS at the time. This is followed by the perceived effects, according to paramedics, that the NEWS had on decision outcomes and its usefulness and application in context. Lastly, the inferences derived from the findings are summarised.

5.1 Participant sample

From 1,600 clinical staff, 16 (1%) HCPC registered paramedics were interviewed (Table 5.1, p.152).

Table 5.1: Summary of interview participants' attributes

Identifier	Gender	Career route[19]	Years	Current role	Aptitude[20]	Locality	Crew status	Interview method	Time (hr: mins)
P1	Male	IHCD	23	Paramedic Pathfinder Team	7	Trust-wide	Solo	Face-to-face	1:00
P2	Female	IHCD	17	Paramedic	7	Sector-1	DCA	Telephone	0:50
P3	Male	IHCD	16	Paramedic	≤ 4	Sector-1	Solo	Telephone	0:24
P4	Male	Degree	5	Paramedic Pathfinder Team	6	Trust-wide	Solo	Face-to-face	1:54
P5	Male	PARA	7	Paramedic Pathfinder Team	7	Trust-wide	Solo	Face-to-face	1:10
P6	Male	IHCD	7	Paramedic	≤ 4	Sector-2	Solo	Telephone	0:35
P7	Male	PARA	14	Clinical Team Leader	6	Sector-2	Solo	Telephone	1:02
P8	Male	IHCD	37	Paramedic	≤ 4	Sector-2	DCA	Telephone	0.38
P9	Male	Degree	13	Clinical Team Leader	6	Sector-2	Solo	Face-to-face	0:56
P10	Female	Degree	2	Paramedic	6	Sector-1	DCA	Telephone	0:37
P11	Male	IHCD	16	Clinical Team Leader	6	Sector-2	Solo	Telephone	1:13
P12	Male	IHCD	16	Paramedic	≤ 4	Sector-1	DCA	Telephone	1:10
P13	Female	IHCD	19	Paramedic Pathfinder Team	≤ 4	Trust-wide	Solo	Face-to-face	1:24
P14	Female	IHCD	10	Paramedic	6	Sector-1	Solo	Telephone	0:38
P15	Female	IHCD	14	Paramedic Pathfinder Team	≤ 4	Trust-wide	Solo	Face-to-face	0:45
P16	Male	IHCD	7	Paramedic	≤ 4	Sector-1	DCA	Telephone	0:44

[19] IHCD: Institute of Healthcare Development qualification. Degree refers to those whose careers began with the completion of a paramedic or nursing degree

[20] Highest level of qualification achieved to date based on the UK Regulated Qualification Framework (RQF): RQF ≤ 4 is AS/A level or GCSE qualification. RFQ 5 a foundation degree. RQF6 a bachelor's degree. RFQ 7 a master's degree. RFQ 8 a doctorate.

The sample interviewed contained a range of experience and knowledge, although no EMTs volunteered to participate. Most began their career by completing an Institute of Health Care Development (IHCD) accredited training course. During their first 6-weeks, basic life support, ambulance aid and emergency (blue light) driver training would be provided. This would be followed by a 12-months probationary period before qualifying as an EMT. An additional 12-weeks training in advanced life support needed to be completed before qualifying as a paramedic.

Three participants joined the ambulance service having previously qualified and worked as a nurse. Two had entered directly, having completed a paramedic degree.

The majority worked at the frontline of patient care (i.e. paramedics and paramedic Clinical Team Leaders (CTLs)), either solo on an FRV or on a DCA. A third of those interviewed were involved in the implementation of Paramedic Pathfinder and the NEWS (i.e. Paramedic Pathfinder Leaders).

There were a similar number of individuals from Sector-1 (five participants from County1 and two were from County2) and Sector-2 (eight participants from County3). There was no involvement from those working at the frontline in Sector-3 (i.e. County4, County5 or County6).

5.2 Research context

5.2.1 Paramedic Pathfinder management team

The Paramedic Pathfinder management team consisted of a Consultant Paramedic and several Paramedic Pathfinder Leaders. Each Lead was required to work with frontline paramedics and management teams across AMB-X, plus other NHS organisations and HCPs in their locality, including acute trusts, clinical commissioning groups and community-based service providers. They were accountable for the implementation of the NEWS and Paramedic Pathfinder into clinical practice, as well as increasing and improving associated care pathways. They were required to develop and formulate associated plans, strategies, policies and procedures necessary to facilitate successful implementation. They were expected to continuously evaluate operational activity and

outcomes, reflecting on existing referral pathways and redesigning pathways where necessary. In addition, they were personally required to develop and deliver an education programme to, *'overcome barriers and gain buy-in to the adoption of the Pathfinder scheme'* (AMB-X NHS Trust, 2015b, p.3).

> *"… it was my homework, my first ever week as Pathfinder Lead. [name] said, 'here are some statistics, do something with them that makes it [NEWS/Pathfinder] look good'… So, what I've done is a normal patient journey conveyed to an ED. A normal patient journey left at home with some alternate care pathway… we increase the time on scene to make a referral but actually, if we just had 5% of patients that went through this process then actually that would mean in figures … 4,000 shifts free a year back into [AMB-X]. You're not waiting on scene, you know, 'Kilo zero'[21] because that crew is probably freed up 20 minutes early." [P4]*

5.2.2   Education and training programme

Training commenced in July 2014. Lessons learned from the training methods adopted by other ambulance services, influenced how the training was delivered at AMB-X. Instead of Paramedic Pathfinder and the NEWS training being delivered solely as part of the annual Essential Education training, as in North East Ambulance Service (McClelland, 2015), or through cascade-style training, as adopted by North West Ambulance Service, AMB-X clinicians were expected to attend a classroom-based training session on their rest-day. There were no financial incentives, instead time could be reclaimed in lieu. The content taught included a PowerPoint presentation with rationale detailing why Paramedic Pathfinder and the NEWS were being introduced. A paper-based vignette exercise provided an opportunity for the tools to be practically applied. This was followed by a group discussion.

The methods adopted at the beginning of the implementation programme were later revised. This was in response to feedback from staff and from identified misunderstanding of when the tool should be used.

---

[21] Kilo zero is the radio term used by the Emergency Operational Control to communicate all available resources have been depleted

"…some people have got the impression that, 'I only need to follow it if I am leaving somebody at home.' They weren't routinely using it for every patient that was going in. That might have been something from the training or just perceptions. So, we've modified the training in that we have a real focus on every job you go to, you must record this." [P5]

Instead of taking a whole day as it did initially, training was streamlined and delivered in half-a-day. Instances where staff could not, or would not attend, Pathfinder Leaders would provide one-to-one training, the effectiveness of which was questioned.

"… they didn't want to come in on their own time. So, I said I would ride out with them for a shift. And it just didn't work. And then they got split up. And then I said, 'we really haven't covered it'. And they said, 'it's all right, we will sit and read the book'. I mean they were fairly conscientious chaps anyway, but it will be interesting to see how well they have picked up on it and how well they are using it, because I didn't feel that I had given them enough information." [P13]

Training and education were also supported by providing information updates on dedicated Paramedic Pathfinder noticeboards that were located on every ambulance station. Clinical newsletters, disseminated regularly to staff via internal and/or personal email, included a section designated to the NEWS and Paramedic Pathfinder. Learning was subsequently updated as part of the annual Essential Education programme.

Most believed the training and education provided did not need to be expanded, as the use of the tool was self-explanatory and easy to understand. Although some believed more information should have been provided relating to evidenced patient-benefits.

"There was no background to it, no, 'this is being used for X-amount of years. It has been proven to identify early deterioration and trends', blah, blah, blah. It was just, 'this is what we are doing and if you get the NEWS above this they have to go to hospital'." [P9]

The lack of this information had led some to perceive the implementation as being a risk averse measure for legal purposes, rather than to improve patient care.

"...it's been sold as a bum covering exercise in some respects if you know what I mean." [P10]

5.2.3 Commissioning and governance of alternative care pathways

As part of the implementation programme, the Paramedic Pathfinder management team were required to review and improve the governance related to alternative care pathways. This involved liaising with frontline staff and senior managers at AMB-X, and other service providers and respective commissioners. The initial review showed pathway provisions to be varied, inconsistent and sporadic across the region. The information held at AMB-X was itself disorganised.

> *"...part of the session is me asking them, 'I want your feedback on alternative care pathways that are working or not working' and then we can work with the Locality Quality Managers and the commissioners to fix them. One of the things the commissioners are saying to us at the minute is, you know, we want to know if it's not working, is the criteria too stringent..."* [P4]

> *"...she said, 'we have lots of these alternative care pathways, but nobody is using them. Can you tell me why that is because I can't get my head round it?' Well I said, 'Can I have a look? She reaches under her desk and she pulled out an A4 ring-binder, probably three-inches thick and she said, 'There you go'. I asked, 'Are they for the whole region?" She said, 'No, no, no - just [specific locality]'. And you open it up and there are one million different alternatives. And it's like, well I think I know straight away why people aren't doing it, because nobody can be bothered to sift through all this raft of information to find which services are applicable to me, at this time of day, with this patient, with this condition. And everyone was clearly written on the back of a fag-packet in terms of the criteria."* [P1]

At the time, the NEWS and Paramedic Pathfinder were considered incompatible with existing working practices. The locations where utilisation of alternate pathways did work effectively was not necessarily where there were lots of pathways, but more where pathways worked collaboratively with each other and patient acceptance criteria was not too specific, and the services were commissioned appropriately to facilitate this.

"We don't have a big number of pathways in [specific locality]. For when we've met up with the others, they are like 'well we've got blah blah blah' and I'm like 'well we've only got 4 or 5' but ours seem to take the majority of things." [P4]

"...each one is only interested in their little piece of the pie and don't give two hoots what happens 500-yards over the border. That drives me insane does that. And it is only when people start to look at it, in that more joined up approach, albeit as I say [name of service provider]. I'm sure they have a financial incentive for them to do it, but hell it works." [P1]

The Paramedic Pathfinder Leaders' objective was to…

"...get rid of all of that claptrap of pages and pages of, they will take this, but they won't take that…. some of the urgent care centres have got very strict inclusion exclusion criteria and what we need to do is revisit them and say, you know, 'the crews are following Pathfinder, and everybody that is potentially negative should be heading to you." [P13]

5.2.4 Socio-cultural influences

Some frontline staff thought the implementation of the NEWS would be easy because…

"We are a service that works on algorithms and mnemonics…" [P6]

Whereas, others believed the socio-culture would make implementation and adoption more difficult.

"We are ambulance staff. We just look on the dark side of everything. Yeah, people just don't like being told what to do, do they? Sometimes, they're frightened that it is de-skilling them, and what have you. And to be honest, ambulance staff do tend to look at the negative in anything. A lot of ambulance staff do anyway." [P3]

These opinions may be representative of the socio-culture in which the individuals worked, as there was greater level of engagement from those working in Sector-2 (e.g. P6) compared to Sector-1 (e.g. P3).

"In [County1] particularly, they were really militant about having to come for the training. They didn't want to do it, and they didn't see why they should have to do it… I never had any problem with anybody in [County3]. They all came and did it." [P13]

There was even greater resistance in Sector-3 (hence no-one from that sector participated in this study). The resistance was attributed to a breakdown in relations between frontline staff and the management teams.

> *"… I think there were two or three HCPC hearings. And there was one paramedic that was off the road for a year, while they were under investigation. It was handled very badly by the trust. And, I think that really angered people….to them management, as a group, are the baddies…. speaking to a couple of the Paramedic Team Leaders it's not a nice place to be at the minute. There's a lot of trouble up there… they had I think it was 14 Paramedic Team Leaders, and five have just walked out. They had four Clinical Team Mentors. A couple have just walked out and quit… I think for [locality in Sector-3], I've got four people booked in. That's it, out of the whole of [the locality]." [P4]*

After some consideration, Paramedic Pathfinder Leaders removed their rank-markings to help integrate them and facilitate greater engagement from frontline staff. Paramedic Pathfinder Leaders also experienced a lack of support from some of the operational management teams. This was attributed to managers having their own work-based agendas. It had been acknowledged that more time, effort and money needed to be invested by AMB-X and other key stakeholders for the desired changes to be realised.

> *"Organisationally there's been a lack of buy-in and understanding from the operations side. But we can see the reason for that because they breed a culture of short-termism. So, if I'm a Team Leader, if I'm a Locality Manager it's a case of, 'Yes, Pathfinder might be helpful in the long-term, but in the short-term it's gonna be a problem'. Because if we are accessing an alternative, that will take longer on scene." [P5]*

5.3 Convey or not convey: the perceived effect of the NEWS on decision outcomes

5.3.1 Conveyance rate had reduced

From operational quantitative data, Paramedic Pathfinder Leaders had perceived there to have been a reduction in conveyance rates to ED. They had also personally assessed decisions made, by conducting audits on crews as they arrived at ED. Most decisions were found to have been made appropriately.

The audit sessions were hosted at various EDs across the region. During these sessions, the Pathfinder Leaders would review the information recorded by the paramedics on the PRF and ask them about their rationale for conveying to ED; in accordance with Paramedic Pathfinder and the NEWS. The Pathfinder Leaders did not necessarily see or speak to any patients.

> *"…we've been having support and review sessions down at the hospitals…*
> *It was good. The upper 90% of patients presented at ED were appropriate."*
> *[P5]*

On the occasions where decisions were found to have been made inappropriately, Paramedic Pathfinder Leaders would go through the incident with the crew and provide guidance for future reference. At the time, there had been no formal assessment on the appropriateness of decisions made to leave patients at home. But, as there had been no increase in serious untoward incidents being reported, or complaints associated with decisions made to leave at home, these decisions were considered to have been made safely.

> *"…we had an increase in call volume, non-conveyance rates improved*
> *without a spike in SIs, serious untoward incidents. The only thing we have*
> *changed is Pathfinder. So, you can't say that it is absolutely Pathfinder, but*
> *we've shown a positive trend." [P5]*

5.3.2   Conveyance rates had increased

Unlike Paramedic Pathfinder Leaders, frontline clinicians had perceived conveyance rates to have increased. The consensus being the increase was because of Paramedic Pathfinder and the associated policy, not the NEWS per se.

> *"I wouldn't attribute to NEWS that much to be that honest. NEWS is a very*
> *good reporting mechanism, but I don't think it's sensitive enough to drive*
> *transport figures up. I think Pathfinder is very much driven by protocol and*
> *really NEWS is just one very small part of Pathfinder." [P12]*

This was because the 'On scene conveyance and referral procedure' (AMB-X NHS Trust, 2016) was considered to impose certain restrictions, which left them at times with little option other than to convey.

"I think they're taking more people to hospital… because the 'Pathfinder says' and therefore the 'Pathfinder does', so therefore 'they do'. You know, a 21-year-old with central chest pain, before it was introduced, you might look at it and do an assessment and go, 'well, you've got a bit of muscular pain. Let's go and see your GP'. Now, Pathfinder, central chest pain, hospital. So, we take them to hospital… Pathfinder, I don't like it, it's too prescriptive." [P9]

5.4 The perceived usefulness of the NEWS when used in context

5.4.1 Physical practicalities

Overall, the NEWS was considered suitable for most patients and provided a representative measure of their physiological wellbeing. It was found to be easy to use and compatible with existing working practices.

"…it's only a small step more than what we do anyway. Because, we are doing a BP, you are doing a pulse rate, you are doing the respiratory rate and BMs and oxygen saturation. You are doing them straight away, you see. So, it's only a small step to complete this and to use this as a dialogue to the nursing staff." [P8]

However, the mathematical symbols (e.g. $\geq$ and $\leq$) had proven to be problematic for many. The training delivered and the Paramedic Pathfinder Handbook itself may have added to the confusion (Figure 5.1, p.161).

"We had a few teething problems, didn't we? At [AMB-X], at first, because they had got the wrong score. So, everybody in the [locality] were working to 5 (sic) or less, until it was refined." [P6]

Figure 5.1: Paramedic Pathfinder Handbook - conflict in protocol and mathematical symbols usage

(Mills et al., 2014, p.9 & p.11)

161

The individual thresholds pertaining to individual physiological parameters were also difficult for staff to remember. Personal issue pocket guides were therefore provided, along with aide memoire stickers in the rear of ambulances. The pocket guides were found helpful by some, others found them too big and unable to fit into their pockets or were just reluctant to use them. Many were subsequently lost, or at least kept elsewhere and not on their person. Thus, if the NEWS was used during the patient assessment it would be calculated from memory.

> "I could do an audit on staff today and ask them if they had their Pathfinder booklet with them and I would suggest 70% wouldn't have it." [P9]

> "I quite often look across at the NEWS table and tot up their score and say, 'oh yes, I was right, they do need to be going in.' And sometimes, I will put that score on my paperwork as well. That tends to be done after I've already made the decision, but it does help to back up the decision that the patient definitely needed to go in." [P14]

The aide memoire in the ambulance may prompt paramedics to document the NEWS on the PRF, and perhaps pre-alert ED before arrival. They would however be ineffective in supporting decisions to treat patients closer to home, as the decision to convey would have already been made.

> "…if I have to get that pocket book out and look at it, the patient might think I don't know what I'm talking about, or what I need to do… it is a pride thing really. You know, I ought to know what I'm doing without looking it up." [P14]

5.4.2 Individual factors

Paramedic Pathfinder Leaders acknowledged various strategies would be needed to encourage adoption because of the individual factors that existed.

> "… it was never going to be something you can get everybody to adopt in one fowl swoop. This is a long-term hearts and minds 'sell it' kind of thing. It needs be done through a variety of means. You know, three or four hours in the classroom isn't going to be the thing that does it. It will get your early adopters, but it won't get the laggards at the other end…" [P1]

From the individual feedback received from staff, it seemed the majority were in favour and willing to use the NEWS. One of the CTLs interviewed from Sector-2 believed most individuals were using the NEWS regularly. They claimed they used it personally to assess 99% of patients they attended. The only time they would not use it, was when the patient had declined a physical assessment. A few others interviewed were also in favour of the tool and had developed an understanding and a purpose of its use for themselves. Those individuals appeared to use it regularly. I found the opinions of these individuals, and their descriptions of how they applied the tool, to be consistent throughout their discussion. The majority however had mixed opinions and their use was more context dependent. This was illustrated by deviance in their discussion. For example, P11 describes how they prefer to use traditional methods rather than using the NEWS. Then later, claimed to use the NEWS all the time… or may be just sometimes.

> *"It doesn't affect my clinical practice at all. I'm still very traditional in the way I recognised somebody who is extremely poorly. Somebody who is poorly, who is going to get seriously unwell. I use my clinical experience and my clinical practice is governed by red flags. You know? That's what I was brought up on… my training has been around red flags."* [P11]

> *"I use the NEWS all the time. Whilst I've got a good depth of clinical knowledge, I still you use it to justify some of the decisions that I make."* [P11]

One participant had found the *"ones who have come out of university"* [P3] were more likely to use the NEWS and *"your older generation tend to use it less"* [P3]. Whereas, another had found those who had been to university were more resistant, so say proclaiming *"I didn't go to university for three years and then various courses since to follow an algorithm"* [P4]. Some believed the NEWS was useful for everyone regardless of experience, because of the variability of the job, whereas others thought those less experienced would not have the clinical expertise to interpret and apply the scores appropriately in some circumstances.

"I think for an unqualified person, so say like my crewmate, she's an ECA, I think for them, in some respects, for those special patient groups you get, their observations might cause them more alarm than it would a registered professional." [P10]

AMB-X acknowledged the importance of confidence and highlighted how Paramedic Pathfinder and the NEWS would provide additional confidence to treat patients closer to home, particularly those who are less experienced.

"[AMB-X] are keen to recognise the vast experience their clinicians have and wish to utilise this along with Paramedic Pathfinder to provide a better patient experience. We also recognise new staff may not have the luxury of experience but have underpinning knowledge; Paramedic Pathfinder will assist these staff members by increasing their confidence in the process of using an alternative pathway to ED. Thus, the Pathfinder tool will create a more consistent approach to the way we work no matter the skill level of the clinician using it." (AMB-X NHS Trust, 2014a, p.4)

And …

"…assuming the clinician has followed Paramedic Pathfinder, documented appropriately and used a suitable alternative, clinicians can be assured that they will be supported, and no punitive action will be undertaken" (AMB-X NHS Trust, 2016, p.6)

5.4.3   Usefulness of the NEWS to support decision-making

Despite the training, education and assurance provided, some frontline paramedics had difficulty in constructing a useful purpose for the NEWS. They could not see how it would fit into their routine or help with their clinical practice.

"I was sort of, one of them that thought, 'oh I'll maybe not use this, because I can't see how it's gonna help me.' You know? I'm quite happy doing what I do day-to-day." [P6]

Others still saw it as a threat to their clinical autonomy, describing it as *'paramedicking by numbers'* [P12] or considered it to be demeaning as "…*it's teaching me to suck eggs. It is what I do already"* [P5]. A few did describe using the information derived from the tool and using it in conjunction with their clinical knowledge and experience, so they could "…*really make an informed decision"* [P7]

The way it was used and applied to the decision-making process seemed dependent on the situation. The occasions when the NEWS was most useful was, *"…if there was a grey area…if they were borderline"* [P2] or when the paramedic was uncertain what to do and had no planned outcome in mind, then the NEWS would be *"…used as leverage"* [P6]. However, such circumstances were purported to occur infrequently.

> *"If you unsure, you are completely unsure, it's like 'well should we? Shouldn't we? Should they? Shouldn't they?'… and you are uncertain. It is few and far between, but when you really are, and you look at NEWS and you think actually, NEWS says on this occasion you should. And then, I'm going to err on the side of caution on this occasion. You know, if you are not really quite sure, it does give you that little bit of an edge. [P3]*

5.4.4 Usefulness of the NEWS to support clinical assessment

The NEWS assisted some paramedics to monitor the clinical stability of their patient.

> *"… I do a minimum of two sets of observations on a patient normally between 15 and 20 minutes apart, so I know in that short period of time whether or not they are deteriorating. If they are deteriorating, whether it's a rapid thing or a gradual thing. And that can sometimes determine whether I take them into Resus or whether or not I'm going to take them round to majors. Or if there improving, whether or not I could get a GP to come out, because they had little bit of a blip at that time." [P16]*

Sometimes the effectiveness and usefulness of the NEWS was questioned, more so when scores caused confusion and/or did not meet with paramedics' expectations.

> *"I don't know if sometimes it can be flawed. I had a patient who was having an obvious bleed. Her GCS was 4. I knew this lady was dying in front of me, but her observations were perfect. She scored a seven, so not perfect, because obviously she wouldn't have scored seven, but technically that wouldn't match somebody who was dying." [P2]*

5.4.5 External factors facilitating or inhibiting the usefulness and effectiveness of the NEWS

In certain circumstances, the NEWS was considered useful in prioritising and supporting communications. For example, when ambulance crews were experiencing handover delays at ED, the NEWS would be used to ascertain which patients should be

given clinical priority. Although the application of the NEWS to support communication varied, even by those working in the same locality; such as P8 and P11.

> *"…when I do talk to a GP the NEWS would be prominent".* [P8]

> *"I'm not aware of anybody using it when handing over to a GP"* [P11]

The usefulness of the NEWS to support communication seemed to be influenced by the familiarity and understanding of the NEWS held by another HCP.

> *"If I want to refer on to a GP or whatever I tell them the score. I give them all their observations and the NEWS. It might be zero or one. They don't question me, so I've assumed they know what I'm talking about."* [P2]

> *"To be honest, I think it's probably gone past the point where we are using NEWS in handover, because there is no correlation between our score and their score, it is almost seen as if it is pointless."* [P12]

When paramedics attempted to refer patients to their GP, some GPs would still insist the patient was transported to ED, regardless of the NEWS. Decision outcomes could also be influenced by patients' preferences and expectations, which can on occasions be influenced by those they have spoken to when seeking advice. Where a patient's decisions were contrary to the paramedic's advice, the NEWS had sometimes been used to try and persuade the patient to change their mind.

> *"A lot of it is mentality of both staff and patients - Well, if 111 said I need an ambulance, I must be poorly, so I should go to hospital"* [P7]

> *"We used it with a patient who wouldn't go, to explain to the family and to try and explain to him that the score was telling him that things were changing for him and his body wasn't coping with it."* [P13]

Decisions not to convey were also stymied by a lack of provisioning and commissioning of alternative care pathways. Where alternative care pathways did exist, their use was being hindered by difficulties in accessing services; such as getting a patient an appointment with their GP. Information governance also made pathway navigation difficult and time-consuming for frontline clinicians.

"It takes more effort not to. You know? It is going to take an hour or so to try and get an out-of-hours or find the right pathway. And, a lot of it is locally, particularly the pathways, there just isn't any. And, if they are there, then they are very hard to get hold of and they're often overloaded. And, unfortunately, we've got a system, or a group of staff that come and go, 'Oh well, if you can't get what you want first time around, you go with what you know'. And, they take them to A&E." [P7]

Much of the information obtained by the Paramedic Pathfinder Leaders, from service providers, relating to opening times and acceptance criteria, would be out-of-date within a short timeframe of the Paramedic Pathfinder guidance being distributed. Paramedics would therefore often convey patients to ED without trying an alternative, even when their patient could be treated appropriately closer to home. Paramedic Pathfinder Leaders had acknowledged these problems and were reviewing and working with other service providers and commissioners to address the barriers found.

"...commissioners need evidence to say, 'well actually this really works when you've got the next step in place'. So hence it would need commissioners to work with us hand-in-hand really." [P1]

5.4.6 Exceptional circumstances

When a patient is seriously unwell (colloquially referred to as 'big sick') or injured, and there was no doubt treatment at ED was required, the NEWS would not be used.

"Big sick patients, I wouldn't because there just wouldn't be the time. You know, it is usually a time critical job. They need to go somewhere quickly, whether that is the Cath lab or into Resus... I can see it being used more on the 'do they need to go in, or don't they?' type issues, as opposed to the 'yes, big sick' or 'no, there is really nothing wrong with them and they can stay at home' - it is that middle-ground bit really, that it seems to help with." [P15]

The NEWS was also considered ineffective and unhelpful by most when assessing patients with long-term conditions, such as Chronic Obstructive Pulmonary Disease (COPD), although a couple did describe how they would use the NEWS in conjunction with clinical knowledge in such circumstances.

"I would calculate the NEWS and I would look at why they have got a high NEWS. Is it based on domiciliary oxygen? Is it based on their respiration rate? Is it based on their temperature? Is it based on their SpO2? So, what is triggering the high NEWS? And then what is their normal baseline. So that is what you're looking at. If it's triggering a high NEWS based on O2 sats and respiration rate for instance, then what are they normally? If there normally 88, and they've normally got resp rate of 26 - then I'm not concerned. If it's triggered on temperature for instance, then that is a bit more concerning, because they shouldn't have a temperature above 39." [P9]*

Even when patients presented with a minor complaint, an alternative tool may be considered more useful.

"For minor injuries and illness, I don't do a full set of observations, because they don't require that amount of analysis. Critical analysis, if you like. Then I wouldn't apply a NEWS. But there are certain tools that you have to use within minor injuries and illness, like the Ottawa neck knee and ankle rule, and the Centor criteria, because they are tools specific to that presentation." [P11]

5.5   Compliant use of the NEWS

5.5.1   Adoption

The Paramedic Pathfinder Programme was a long-term project. The successful adoption of the NEWS trust-wide was expected to take five to 10-years. At the time of this study, the level of adoption was speculative. Some claimed to use it regularly, although not necessarily to assess every patient, *"… probably about six or seven"* [P12]. Others used it less often, *"… maybe two or three times a week"* [P10], or not at all.

"I used to, and probably six to eight months ago I stopped. And I don't know why I stopped" [P3]

"I tend to trust my gut instinct. I tend to trust the decision that I come to from my assessment and history taking, and the observations I've got. I like to have it [NEWS] there as backup" [P10]

Face-to-face training and education were an essential requirement to the implementation programme, but these were insufficient in changing embedded cultural routines. A range of other methods and prompts were adopted to encourage compliance and support accurate application. Whilst there was no single method that

could be used to replace all others, the support and review audit sessions, hosted by Pathfinder Leaders, were considered by many to have been particularly effective.

> *"What you tend to find is you will get a generic memo come up at the end [of a job], 'NEW scores must be done'. And everybody goes, 'yeah, whatever'. But, if you tackle people individually about their clinical practice, people get very defensive. That's how you can change clinical practice, by being able to tackle them individually." [P9]*

However, owing to time constraints, the Pathfinder Leaders were unable to host the review sessions frequently and extensively Trust-wide, which may explain why the NEWS had not become embedded in some areas.

> *"I don't think it's being pushed enough…. It's just not being pushed… there's been nothing. I think it has just been an [AMB-X] 'tick-the-box' and 'done that' kind of thing, a 'what you are supposed to do' exercise. And now they are just forgetting about it." [P3]*

There were other factors considered influential to successful adoption, such as the influence of peers and the leadership within the organisation. Where Paramedic Pathfinder Leaders were *"known, respected and loved, for want of a better phrase, then it has been embraced a lot faster"* [P1]. The greatest factor influencing the adoption of the NEWS would seem to have been the active use of the NEWS in the receiving ED.

> *"…in [County3] uptake was really quick. People that hadn't done the training still took up NEWS. That was influenced by the hospital, who questioned them every time they go in, 'What's your NEW score?' … And that had a big impact. So, other areas like [County1] or [County2], where they are using different tools, it's been a little bit more mixed. But some areas where the hospital are using it, but not actively promoting it, crews have gone, 'Oh yeah. Hospitals do that!'." [P5]*

The majority of those interviewed believed the NEWS had longevity in the prehospital setting, although some thought sustainability was less assured.

> *"I think it is either going to go one way, as in they are going to make a lot of modifications to it, and then it's gonna be used all of the time. Or, completely the other way and just get disregarded" [P10]*

5.5.2 Appropriateness of decisions

There were occasions described, where decisions were made to treat patients closer to home, despite patients presenting with a high NEWS. Conversely, there were occasions when patients were conveyed to ED with low or borderline scores, or scores were purposefully manipulated to achieve a desired outcome.

> *"… she was scoring a four. So, it was at that point that I decided to take her to ED, because I know that they can then refer patients round to the GP… in a way I kind of left it up to the hospital to decide whether she was suitable for the primary care around the corner, or whether they needed to keep her." [P10]*

> *"We have noticed certain individuals do tend to score people to ensure conveyance… there's a lot of fear with staff at the minute about, if you don't get it right then there's gonna be an investigation, and suspensions and your registration. You know? You are living in fear a lot of the time. Obviously, you want to do was best for the patient, but you also want some protection for yourself." [P7]*

Pathfinder Leaders and CTLs did however consider most of the decisions made to convey patients to hospital to have been made appropriately. The degree of accuracy did vary depending on who I spoke to but ranged from 80% to 98%; Paramedic Pathfinder Leaders indicated a higher level of accuracy than CTLs. Similarly, decisions to treat patients closer to home were also considered to have been made appropriately.

> *"…you can't prove something hasn't happened, but we don't seem to have had, well they [untoward incident reports] haven't come across my desk in the same frequency. Patients being left at home with worrying conditions, I mean we still get them but they're not coming across my desk in the volume that they were." [P1]*

5.5.3 Documenting the NEWS

Paramedic Pathfinder Leaders had found paramedics were not documenting the NEWS on the PRF, thus there was little evidence of it being used. The frontline clinicians claimed this was because there was nowhere on the PRF where the score should be documented. The layout of some forms restricted the paramedics' ability to document the necessary information; i.e. only space for one set of physiological measures. This

meant if a NEWS was calculated and documented, it was done just once, not twice. This would inhibit the identification of trends using the NEWS score, as indicated in the policy. At the time of interview, plans were in place to modify both paper and electronic PRFs. Some believed these changes were essential to encourage widescale adoption, but additional strategies would be required to ensure the scores calculated were an accurate representation of the patients' physiological status. Sometimes paramedics were found to have consciously avoided documenting a NEWS, because of the potential risk of being reprimanded when protocols were not followed. To encourage compliance, Paramedic Pathfinder Leaders were providing real-life 'lessons learned' examples, from serious incident investigations.

> *"...he wouldn't write down his score because it [Paramedic Pathfinder] said that vomiting blood needed to go to the emergency department... he didn't trust the management, because if it came to bite him on the bum they would say, 'Yes, but it's PP-positive. You should have gone'. And I said, 'but you've done the right thing, because the discriminator is talking about haematemesis. It is not talking about what was up with this patient.' But he wasn't keen, because he thought it would drop him in the poop basically. He would prefer to have his own clinical judgement and that only, rather than a National Early Warning Score." [P13]*

5.5.4 *The clinical assessment process and the application of the NEWS*

I found the NEWS was used and applied in a variety of ways. Sometimes, it was used only to confirm a decision made, or where there was an element of doubt. Some would formally calculate and document a score, whereas others would just conceptualise the score.

> *"I just did it in my head. I was working with an ECA. So, they just shouted out the baseline set of observations... it's easy to visualise." [P15]*

Some would use the NEWS in conjunction with their clinical knowledge and judgement, to assess their patient's response to any treatment provided. These tended to be paramedics who were more experienced and higher qualified.

"Have I got a tachycardia? I've got increased confusion. Do I have hypotension? And, what's the BM like?... then I look at my NEW score. I'd got a NEW score of six. I got a haematuria. So actually, this lady warrants conveyance. I could justify my conveyance... I've got my NEW score; I've ruled out my red flags and my issues around sepsis. I'd got a NEW score of six...when I did a secondary NEWS it had changed, because I had given her paracetamol. I had taken her cardigan off her... I had already made my mind up what I was going to do... The NEW score for me, was just to give me a benchmark as to the start of my treatment and my review after 30 minutes. That's what I use it a lot for." [P11]

"I will do the initial NEW score. I would do my follow-up assessment and treatment, and then redo the NEWS score. I will judge the patients need on the final NEW score... I will do a pre-NEWS and a post-NEWS. It gives you a marker, to see the change... I would be trying to understand the underlying condition, such as a UTI, which can cause various symptoms. If it's maybe five, we can understand that. They are a bit dehydrated, which is obviously going to cause an increase in heart rate and stuff like that. Well, we will get them drinking and see what we can do. Rehydrating someone is a longer process - it takes hours. But, as long as we can understand that, and the patient is able to drink and take on fluids and rehydrate themselves... and as long as they have got someone to support them during the referral." [P7]

Whilst having an understanding about underlying cause (e.g. UTI) can mean decisions are more informed, there was evidence that seeking a cause can lead to the NEWS being disregarded.

"...what they think is, 'it's a high NEWS score, so they are poorly'. But then, they forget about that, and then they will go searching for why it is high. For some reason, paramedics seem to want to have to diagnose.... What I try and show people is you don't have to make a formal diagnosis. You need to make a more differential diagnosis." [P9]

5.6   Summary

The effectiveness and usefulness of the NEWS was found to be subjective and context driven. For instance, some found the NEWS effectively supported their communication with other HCPs, whereas others found using it in this manner futile. Respectively, such interactions acted as facilitators or barriers to the adoption of the NEWS.

Those who used the NEWS to support their decision-making, used it in a variety of ways. Only occasionally would it be used to track clinical improvement or

deterioration, and when used for this purpose, it would be by those who were more clinically experienced. Mostly, it would be used in those rare, but ambiguous situations when the decision to convey or not was marginal. Then the NEWS would be used as leverage, adding weight to the decision-making process or to justify the decision made. Sometimes it would be used to try and convert decisions made by others. Most did not believe the NEWS had dramatically changed their own decision-making processes or had any effect on decision outcomes. Where compliance was assessed, Paramedic Pathfinder Leaders found documentation relating to the NEWS to be lacking, although they believed decisions were being made safely and appropriately.

Whilst the majority considered the NEWS tool to be easy and practicable to use, it would not necessarily be used to assess every patient, in fact some rarely used it. Goodness of fit between the tool and the task requirements was paramount for the NEWS to be used effectively. Many considered the NEWS to be inappropriate and unhelpful when assessing patients with complex conditions. In other circumstances, such as when assessing patients with trauma or specific ailments, alternative assessment tools may be selected in preference to the NEWS. This was because they were considered more useful and suitable for that context. Even if the NEWS were not used, the changes implemented seem to have been effective in prompting paramedics to be more mindful of the decisions they were making, ensuring their decisions could at least be justified.

The utilisation of the NEWS and paramedics' decision-making processes, singularly and in combination, were influenced by organisational guidelines and policies, and the relationships between frontline staff and management teams; relationships not just within AMB-X, but in the wider context. Adoption and use of the NEWS had been hindered in some localities by socio-cultural influences and a lack of shared understanding of its purpose. The NEWS was more readily adopted and embedded in the localities where other stakeholders and their clinical practices supported and worked in accordance with the NEWS. In this context, the NEWS would be documented and used to good effect to support the clinical handover of patient care. It was still

difficult to determine with certainty whether the paramedics were using the NEWS to support their decision-making in these circumstances, or whether it was just being documented in accordance with policy. Even when the NEWS was used, the effectiveness of the decisions to treat patients closer to home could be hindered by a lack of provision, or easy accessibility to alternative care pathways. If the changes implemented did have any effect on conveyance or non-conveyance rates, then most believed this was attributable to Paramedic Pathfinder and the associated policy, rather than the NEWS.

In the next chapter, I present the findings from my own observations of the NEWS being used in context.

6 Observing how paramedics used the NEWS in context

In this chapter, I provide insight of how the NEWS was being used in context, the insight was derived from my non-participant observations of paramedics as they attended to their patients. My aim was to seek further understanding to answer the fourth research question posed, which was 'How was the NEWS being used by paramedics in the emergency prehospital care setting?'

The method adopted was discussed in detail previously in Chapter 3, section 3.6. But briefly, as a reminder, paramedics and their interactions with the patient and others were overtly observed in context. My focus was primarily to observe how the NEWS was being used and the associated tasks were conducted. I also inquired how the paramedic had formed a decision, during a five-minute debrief hosted after each incident. An observational guide and record sheet were used to prompt and support data capture (Appendix 26, p.378 and Appendix 27, p.380).

The chapter begins with a description of the paramedics observed and the incidents that were included and excluded. I then provide a descriptive overview of the context in which the observations were conducted, taking into consideration wider external factors that may have influenced paramedics' clinical practice and/or decisions made on the day. I then present the findings from my analysis, which includes the level of compliant and accurate use of the NEWS and associated tasks; such as the assessment and documentation of the physiological measures required to calculate a NEWS, and the justifications given by paramedics about the decisions they made.

6.1 Cross-section observation sample

6.1.1 Paramedics

I observed eight HCPC registered paramedics, as they attended to patients in the prehospital emergency setting. This provide a 0.5% sample of clinicians employed by AMB-X (Table 6.1, p.176).

Table 6.1: *Summary of observation participants' attributes and incidents observed*

ID	Gender	Professional experience			Aptitude[22]	Locality	Crew status	Total incidents observed	Included[23]	PRF Missing	Reference to NEWS[24]	Usage rate	Score accuracy	
		Career Route	Years	Role										
								n	n	n	n	%	n	%
P3	M	IHCD	16	Paramedic	≤ 4	Sector-1	Solo	4	4	-	0	0	-	-
P4	M	Degree	5	Paramedic Pathfinder Team	6	Trust-wide	Solo	2	2	-	2	100	2	100
P6	M	IHCD	7	Paramedic	≤ 4	Sector-2	Solo	3	3	-	2	67	1	50
P9	M	Degree	13	Clinical Team Lead	6	Sector-2	Solo	3	2	-	0	0	-	-
P10	F	Degree	2	Paramedic	6	Sector-1	DCA	2	1	1	0	0	-	N/A
P11	M	IHCD	16	Clinical Team Lead	6	Sector-2	Solo	8	4	-	0	0	-	N/A
P14	F	IHCD	10	Paramedic	6	Sector-1	Solo	8	6	1	0	0	-	N/A
P17	F	IHCD	7	Paramedic	6	Sector-1	DCA	3	3	-	2	67	0	0%
Total								33	25	2	6	24	3	50%

---

[22] Highest level of qualification achieved to date based on the UK Regulated Qualification Framework (RQF): RQF ≤ 4 is AS/A level or GCSE qualification. RFQ 5 a foundation degree. RQF6 a bachelor's degree. RFQ 7 a master's degree. RFQ 8 a doctorate.

[23] Incidents relating to pregnancy, patients 15 years or less & those where patient refused assessment were excluded

[24] Number of incidents where the NEWS was documented by attending clinicians on PRF, or the use of the NEWS was observed (e.g. verbally, during the clinical handover of patient care).

Seven of those observed had also participated in the interview study. The exception was P17 who left her employment with AMB-X before her interview was conducted. Observing and interviewing the same participants was a method intended to lessen participant and observer biases; it would provide me with the means of comparing clinicians' statements, obtained during interviews, to my observation notes, and vice versa.

I had aimed to observe 9-12 clinicians. The ideal sample being three or four paramedics from each of the three sectors (i.e. Sector-1, Sector-2 and Sector-3). The paramedic sample was in fact constrained by clinicians' proclivity to volunteer. I achieved my target numbers in Sector-1 and Sector-2, where there was a higher propensity for paramedics to volunteer, but not in the Sector-3 where organisational factors appeared to have inhibited participation. This was highlighted previously during the interviews.

6.1.2 Patient sample

A total of 33 patients were attended. Twenty-five observations were included. A summary of each observation included can be found in Appendix 30 (pp.385-400). One observation was excluded because the patient was experiencing a mental health episode and refused to be clinically assessed. Another was excluded because the patient was in labour and the NEWS is not used in such circumstances. A further six were excluded because the patient was aged less than 16 years. I do however discuss the assessment of one child, as another scoring tool (the Centor tool) was used, documented and retrospectively referred to by the attending paramedic after the patient was discharged. The observation is discussed merely for comparative purposes.

Of the observations included, there were more male patients attended to than female patients (n=14, 56% vs n=11, 44% respectively), which is comparable to the patient samples included in the studies I reviewed by Ebrahimian et al. (2014b) and McClelland (2015). The majority were aged 65 years or over (mean: 63.16, ± 22.23, range: 17-97 years), which is slightly older than those in the two previously cited studies. Most of

the patients were experiencing a medical related complaint rather than traumatic or minor injury (Figure 6.1 & Figure 6.2, below).

Figure 6.1: Patients' age range

Figure 6.1: Patients' Ages

Figure 6.2: Clinical complaint
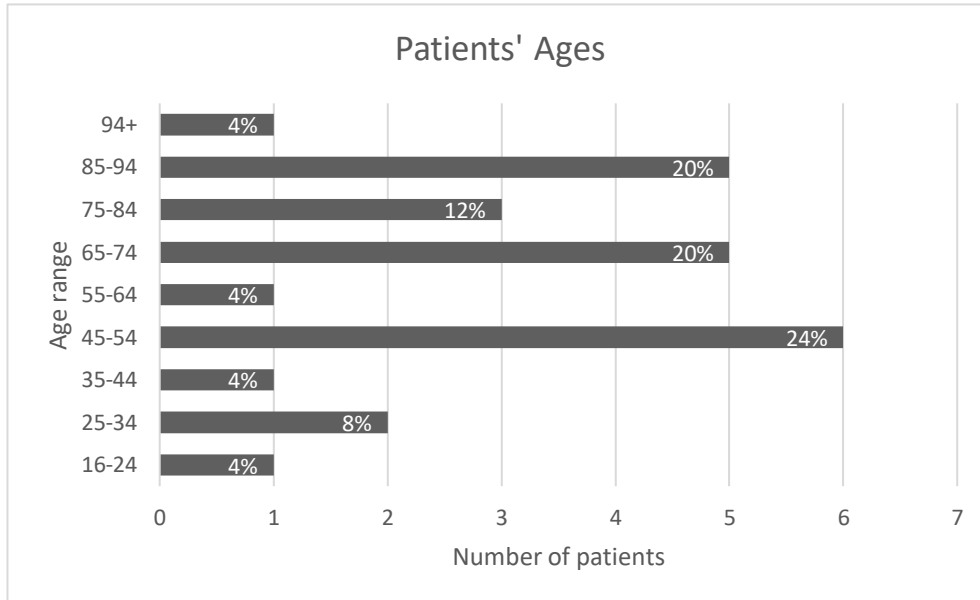
Figure 6.2: Clinical Complaint
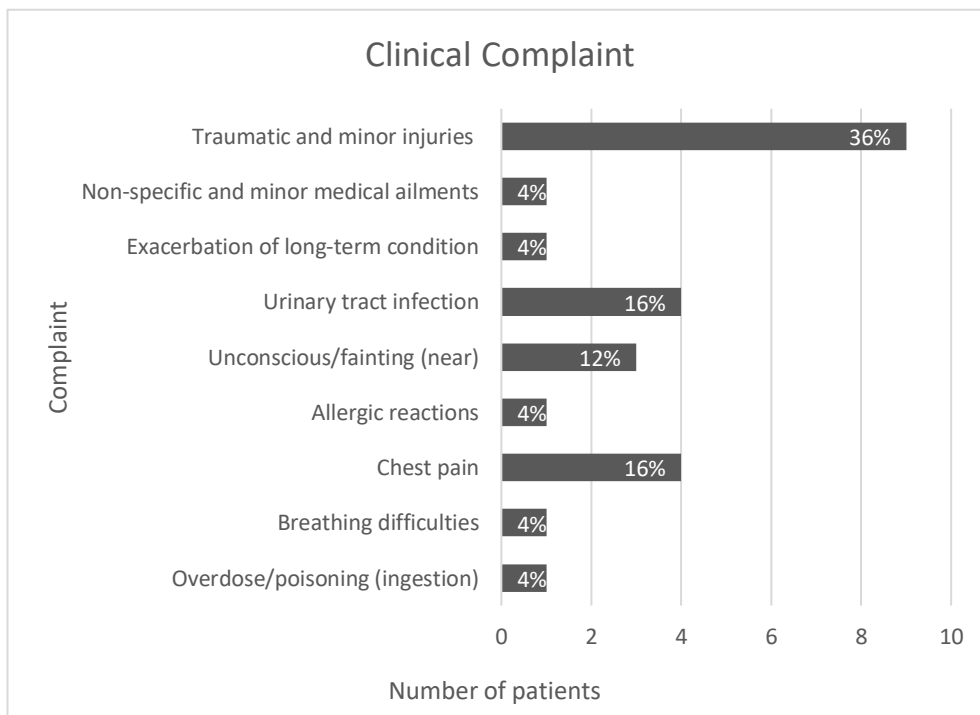
6.2 Contextual factors: Potential confounding variables and effect modifiers

A summary of contextual factors notated relating to each observation shift can be found in Appendix 31 (p.401).

6.2.1 Shifts observed

Observations took place between July 2015 and April 2016, although no shifts were observed between October and February. This decision was made for safety purposes, because of the travel distance, early shift-start and shift-end times, reduced day-light hours and potential hazards posed by the winter weather.

A total of eighty-two hours of clinical practice were observed across a variety of shift-patterns (i.e. 6, 8, 8.5, 10 and 12-hour shifts) covering the time-frame 06:00 to midnight.[25] Night shifts could not be observed, purely because of the impracticality and danger of travelling distance home, at shift-end, without sleep.[26] At least one shift was observed on each day of the week, the exception being a Saturday; owing to my availability and participants' Saturday shift patterns never coinciding.

6.2.2 Weather conditions

Weather conditions on days when shifts were observed were unexceptional.

6.2.3 Localities

I acknowledged that this was a small observation study, therefore, to enhance validity and generalisability I arranged observations to ensure a wide variety of localities were covered; including rural, semi-rural, urban, large-urban and coastal areas. At least one shift was observed in each of the three sectors; the observation of P4 was conducted in Sector-3.

---

[25] Travel time from home to ambulance station ranged between 1-hour to 3-hours. My working day therefore ranged from 8-hours to 18-hours.
[26] Night shifts are rostered to end between 05:30 am and 08:00 am, most finish at 07:00 am.

6.2.4 Response unit

Most paramedics observed were working on their own, on a car known as an FRV. Any decision made by an FRV paramedic, to convey the patient to the ED or another Type 3 or 4 facility (i.e. UCC, MIU or WiC), would require back-up from a DCA to transport. There was one exception, P6 conveyed patient 8 himself, by FRV, to hospital (see Appendix 30, Observation ID P6/8, p.389). The influence of 'back-up requests' on paramedic decision-making needed to be considered, because emergency resources can often be depleted during periods of high emergency 999-call demand. It was possible that depleted resources may have influenced the paramedic working solo to consider utilising alternative care pathways, purely because of a lack of DCA availability. However, operational demands across the shifts observed were either lower than usual, or as expected.

Two paramedics observed were working on a DCA with an ECA. The main disadvantage of observing paramedics working on a DCA can be that many of the decisions made to convey patients to hospital have already been made by another paramedic working on the FRV. This however occurred just once (Appendix 30: P17/25, p.400). On this occasion, I asked P17 to reflect on the FRV paramedic's decision to convey. P17 confirmed they would have made the same decision had they been in attendance first. Observing on a DCA did however provide an opportunity to observe if or how the NEWS was used during the clinical handover of care at ED.

I also observed one paramedic working on the ECP assessment unit. Observing clinical practice on the ECP assessment unit would increase the opportunity of witnessing the NEWS being used to assess patients with minor injuries and illness.

The ECP assessment unit was first introduced in 2014. The aim of the unit was to reduce unnecessary 999-calls and/or visits to hospital. The unit provides treatment and advice on minor injuries and illnesses. It is a purpose-built vehicle enabling patients to be treated in an environment very similar to a cubicle found in a hospital ED. The unit contains a reclining and pivoting seat with lighting both above and below to enable the assessment and suturing of minor wounds. There is a small wash basin with hand

hygiene products to facilitate compliant infection prevention and control practices. An automated external defibrillator is included, plus all other standard equipment found on an ambulance. The service is provided throughout the summer months, seven days a week at three locations in Sector-2. The vehicle attends each site at pre-planned times. Patients can attend without an appointment.

6.2.5   Traffic conditions

Traffic conditions were found to be no worse than would normally be experienced, and therefore unlikely to have deterred decisions to convey patients either to ED or to Type 3 or 4 facilities.

6.2.6   Medical equipment

Vehicles and equipment were checked at the beginning of each shift. Thereafter, I did not observe any shortfall in medical supplies or drugs, nor any malfunction with equipment when attending to patients; e.g. broken tympanic thermometers preventing the measurement of temperature, or pulse oximeters inhibiting the measurement of patient's heart rate. Any medical supplies and/or drugs used were restocked when the paramedic returned to station.

6.2.7   Patient-flow at ED

There was one shift where there was a risk of handover and ambulance turnaround-delays at hospital. Patient-flow in hospitals were being hindered because of a 48-hour strike by junior doctors. Whilst the ED was fully staffed, there could be difficulties and delays discharging patients from the hospital wards, which could result in bed-blocks. Bed-blocking prevents patients being admitted from ED to a ward, and subsequently, ambulances can end up queuing outside ED with patients still on-board.

Whilst the strike was causing problems at the hospital, it did not impact on the decisions made by P14 who was being observed. In fact, the publicity in the media, forewarning the wider public about the strike, may have resulted in a decrease in 999-call volume. The emergency demand was found to be particularly low for this large urban area that day.

6.2.8   Organisational factors

Whilst on station, I witnessed P14 and colleagues discussing Paramedic Pathfinder and the NEWS. P14 said she has recently received (by email) the latest version of the 'On scene conveyance and referral procedure' but had not yet read beyond the first few pages and so was not sure how it should be used. This shift was in March 2016, two-years after the NEWS began to be implemented. It seemed from her comments that the length of the document had perturbed her and discouraged the document from being read. P14 admitted she had not used Paramedic Pathfinder at all. She made no reference to the utilisation of the NEWS. P14 subsequently provided me with a copy of the procedure and having read it I found the use of Paramedic Pathfinder in conjunction with the NEWS was mandatory, except for inter-facility transfers.

> *'Paramedic Pathfinder must be used to support and confirm all conveyance, referral and self-care decisions… The Paramedic Pathfinder outcome must be documented each time a patient is assessed, including those patients transported to ED, this demonstrates the clinician has used Paramedic Pathfinder to support, confirm and guide their clinical decision-making.' (AMB-X NHS Trust, 2015a, sections 6.3 on p.6 and 9.1 on p.7)*

I also enquired during the discussion whether there were more pathways available since NEWS and Paramedic Pathfinder had been introduced. I was informed that this was not so. Despite frontline staff being given assurance during their training that the CAT would support them gaining access to alternative pathways, I had been informed the support had not materialised. I subsequently contacted a member of the CAT to gain insight from an alternative perspective. It seemed what the frontline staff had told me was factual. That is, the CAT's time was being used more to *'fire-fight 999-call demand'* than it was to support the frontline crews to find and access care closer to home. I also found evidence that the increasing 999-call demands were having a more direct impact on individuals working at the frontline. Some of those observed were sufficiently discontent with their job that they were actively seeking employment elsewhere. Two had finished their previous shifts several hours late, resulting in a 14 or 15-hour working day. Both claimed this was becoming the norm.

Psychological stress in the ambulance service was becoming an increasing concern. During this study's timeframe, stress-related sickness-absence at AMB-X had doubled. According to one ambulance trade union representative, the increase in stress-related sickness absence by ambulance personnel was a consequence of the long-hours worked, and the lack of downtime between incidents to reflect and process what had occurred (BBC News, 2014). The atmosphere on station the day I observed P4, in Sector-3, was particularly sombre, as a colleague had committed suicide just seven hours beforehand; on a station in the locality. There were 29 (13%) frontline staff on sickness-absence leave in his locality that day. Twelve of whom were on long-term sickness absence and six were absent because of stress. Consequently, Sector-3 had lost fourteen resources; four DCAs and ten FRVs.

Added to these stressors, this station and others across the Trust were being prepared for 'Quality Task Force' inspections the following week, which were part of the Trust's preparations for the imminent CQC inspection. A further factor that had unsettled staff at this time was the resignation of the Chief Executive. Regardless of all that which was occurring organisationally, I found those being observed acted and behaved with the utmost professionalism when attending to their patients. Any tiredness, stress or discontentment that was verbalised to me, was perceptually concealed from patients, carers and on-lookers.

6.2.9 Information from Emergency Operational Control

Information is conveyed to the paramedic before arriving at the scene of an emergency. Sometimes the information is conveyed verbally over the radio, by the Emergency Medical Dispatcher. Mostly, the information is sent electronically via mobile data transfer and displayed on computer screen in the ambulance cab. The information contains the AMPDS derived clinical complaint (typology and code), obtained during telephone triage. Details include type of emergency response (e.g. Red 1 or 2); address to be attended; patient details (e.g. age and sex); and brief notes related to the problem.

Paramedics may consider the information provided while on route to the incident, but this is mostly to determine scene accessibility, and what equipment they may need to take with them when they arrive at scene. Often, the information about the patient's condition is treated with scepticism.

> *"Experience has made me a little cynical. Those jobs which sound serious often turn out to be nothing and vice versa, I just wait to see what is going on when I arrive." [P9]*

6.2.10 Previous attendances

There is always the potential that previous knowledge of the patient can influence decisions. There was one patient who had been attended to by P14 previously (P14/18, Appendix 30, p.395). P14 discussed with the nurse on scene the visible deterioration in the patient's condition since her last attendance, seven days ago. They commented that the patient was more confused, and less coherent than normal.

> *"She is not her normal self and she is slurring her words..." [P14/18]*

Not only had P14 attended this patient previously, but there was evidence that other AMB-X clinicians had also attended in the previous few days; there were two PRFs on the sideboard which P14 reviewed but did not comment on. Using the previous knowledge of this patient, P14 made the decision to convey.

Having retrospectively assessed the patient's physiological measures and clinical complaint, it would appear the patient was presenting with signs and symptoms associated with sepsis. I did not however witness sepsis being mentioned or discussed by any clinician attending to the patient. There was also no evidence of NEWS being used.

6.3   Utilising the NEWS: Compliance and accuracy of the task

6.3.1   Physiological measurements

AMB-X (2015a, section 7.4 p.7) specifies, *'two sets of vital signs should be recorded to enable the generation and identification of trends with the NEWS score'.* From the 25 observations, I found 16 of the PRFs were completed as required (Figure 6.3, p.185).

Figure 6.3: Compliance – Documenting two sets of physiological measures
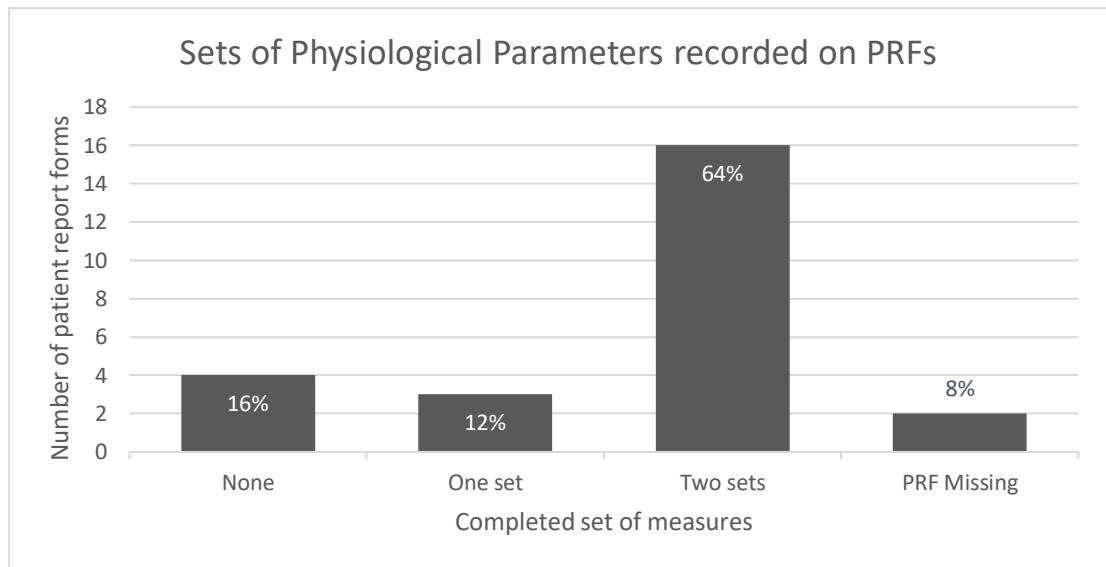
Two PRFs however could not be traced, and therefore could not be assessed; missing PRFs related to observations P10/12 and P14/22 (see Appendix 30, p.391 & p.398 respectively).

The three PRFs that had only one set of measures recorded related to observations P6/8, P9/11 and P14/17 (see Appendix 30 p.389, p.391 & p.394 respectively). Patient 8 who was attended to by P6 had sustained a traumatic injury to their elbow. Medically the patient appeared well. A NEWS had been accurately calculated and recorded on the PRF as zero. P6 was working solo on an FRV and conveyed the patient to hospital themselves, therefore there was no opportunity to re-assess the patient while on route. I cannot account for the missing set of measures for observations P14/17 and P9/11. Whilst patients 17 and 11 were initially attended to by paramedics working solo on FRV (i.e. by P14 and P9), a DCA had been requested to convey the patients to hospital, during which time attempts should have been made to obtain a second set of measures, *'to support and confirm'* the clinical care and decision made by the attending paramedic (AMB-X NHS Trust, 2015a, section 6.3. p.6).

Four PRFs had no complete set of observations recorded. These PRFs related to patients who attended the ECP assessment unit, who were assessed by P11 (Appendix 30: P11/13 – P11/16, pp.392-393). Whilst I did not witness P11 utilising the NEWS, I

did observe him using the Centor criteria to assess a child. The Centor criteria is a scoring system used to assess patients experiencing acute sore throat to identify the likelihood of group A streptococcal infection (Centor et al., 1981, Pelucchi et al., 2012). Scores are attributed or subtracted based on patients age, exudate or swelling on tonsils, tenderness or swelling of cervical lymph nodes; temperature and presence or absence of a cough. Whilst the patient assessed during my observation was less than 16 years of age, and therefore did not meet the inclusion criteria for the NEWS, the Centor scoring criteria can be used to assess patients aged three years and above. P11 had notated individual parameter scores for the Centor on the PRF with one exception, no score had been attributed for the patient's age. Furthermore, no total Centor score had been recorded. When I enquired retrospectively,[27] P11 claimed the Centor criteria was more useful in this circumstance, as it supported a more accurate assessment of the patient's condition compared to the NEWS.

> *"… if that child had been 25, I'd use the Centor criteria. If I'd actually done the full set of observations, then their NEW score would have been grossly elevated, because they would have had a temperature, with increased respiratory rate… I would have stuck with the Centor criteria." [P11]*

---

[27] Question was asked post-observation shift

6.3.2   Documentation errors

The PRF related to observation P9/11 (Appendix 30, p.391) was also found to be incomplete. It was missing one entire set of physiological measures and had no temperature or respiratory rate recorded at all (Figure 6.4 below). Two heart rate measures had been recorded, but one had been written erroneously in the respiratory rate field. While the patient was up and walking about, thus obviously alert, the one and only record of patient's level of consciousness, the Glasgow Coma Score (GCS) was incomplete. The primary assessment of this patient was clearly difficult, because P9 was working solo on a car, and the patient was intoxicated and located in a public place. The back-up crew however could have conducted a secondary assessment on route to hospital, but this may have been difficult because of the patient's alcohol induced demeanour.

Figure 6.4: Observation P9/11 – Only one set of vital signs recorded, no respiratory rate, heart rate recorded in respiratory rate field and incomplete Glasgow Coma Score

The PRF for observation P14/18 (Appendix 30, p.395) was also found to be missing a measurement for temperature and blood glucose levels, although I did observe both measures being assessed (Figure 6.5, below).

Figure 6.5: Observation P14/18 – Temperature not recorded

6.3.3   Notation of the NEWS on patient report forms

As with the physiological measures, there were opportunities for other paramedics (not being observed) to have calculated and recorded a NEWS when conveying the patient to hospital. Nevertheless, all scores that were recorded had been recorded by three of the paramedics being observed, those being P4, P6 and P17, but even then a NEWS had been documented on just six of their eight PRFs (Figure 6.6 & Table 6.2, p.189, see also observation summaries for P4, P6, and P17 in Appendix 30: pp.387-389 & pp.399-400).

Figure 6.6: Compliance – Documenting the NEWS
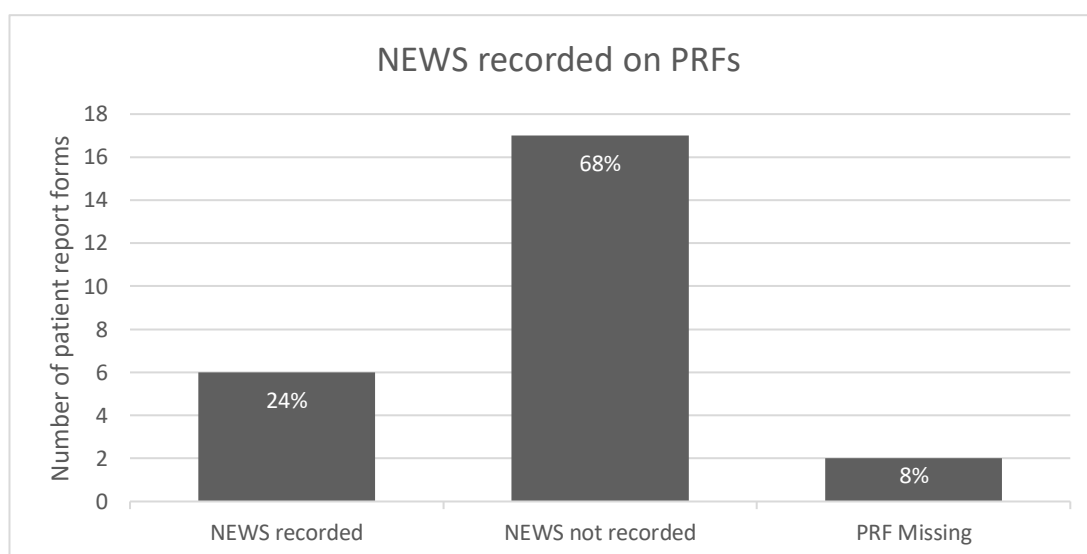
Table 6.2: PRFs completed by P4, P6 and P17 with a NEWS and decision outcomes

Observation	Clinical Compliant	NEWS recorded[28]	True score[29]	Outcome
P4/5	Ear infection	0	0	Discharged at Scene/GP referral
P4/6	UTI	3	3	Conveyed to ED
P6/7	UTI	0	3	UCC access denied, conveyed to ED
P6/8	Elbow injury	0	0	UCC access denied, conveyed to ED
P6/9	Hydrocephalus	Missing	1	Conveyed to ED
P17/23	UTI	1	0	Conveyed to ED
P17/24	Knee injury	6	4	Conveyed to ED
P17/25	Ankle injury	Missing	0	Conveyed to ED

In these cases, there seemed to be no one factor or obvious pattern influencing the utility of the tool. It was used to assess both male (n=4) and female (n=2) patients, of a wide age range (44-86 years). Four patients presented with medical complaints (i.e. P4/5, P4/6, P6/7 & P17/23), two of whom were presenting with signs and symptoms associated with Sepsis (i.e. P4/6 and P6/7). Two patients presented with traumatic injuries (i.e. P6/8 & P17/24). All bar one (i.e. P4/4), were conveyed to ED. Patient 23

---

[28] NEWS recorded by paramedic on PRF
[29] NEWS calculated from the last set of physiological measures recorded by paramedic on PRF

appeared to present P17 with a decree of indecision. Even though a NEWS was calculated it had little influence in the end, as the final decision, to go to ED or not, was left for the patient to make. This observation is discussed in more detail in section 6.6.1, p.204.

Locality does not seem to have been a discerning influence for utility either, as the patients were attended by paramedics working across all three sectors. Paramedic individuality or subjectivity may of course have been an influencing factor. P4, who had previously been involved with the Paramedic Pathfinder Programme, had used the NEWS to assess both patients attended, and had calculated the final NEWS accurately on both occasions (Table 6.2, p.189). There was no NEWS documented on the PRFs related to observations P6/9 and P17/25. And scores documented on PRFs relating to observations P6/7, P17/23 and P17/24 had been miscalculated.

I assessed whether there were any differences between those patients or contexts, where P6 and P17 had, or had not utilised the NEWS. The only perceptive difference between incidences P6/9 and P17/25 (i.e. where the NEWS had not been used) and those incidences where the NEWS had been used, was these patients were in a public place (Appendix 30 p.389 & p.400).

At incident P6/9, the DCA back-up arrived within five-minutes of our own arrival. In the preceding timeframe, P6 had completed preliminary assessment and concluded the patient needed to be conveyed to ED, but had not started documenting a PRF. And, P17 was the DCA back-up to an FRV already at scene. I am unable to provide an account of why P17 did not calculate a NEWS for Patient 25 whilst on route to ED. On neither occasion was a NEWS verbalised during the clinical handover of care between paramedics on scene, nor by P17 to nursing staff at ED.

6.3.4 Notation of Paramedic Pathfinder on patient report forms

Instructions on how Paramedic Pathfinder outcomes should be documented are provided in both the Paramedic Pathfinder Handbook (AMB-X NHS Trust, 2014a) and section 9.3 of the associated policy (AMB-X NHS Trust, 2015a). For instance, a patient

who has triggered a discriminator listed in the first box of the algorithm (e.g. NEWS >4) should be recorded on the PRF as PP1+ve. Those who have triggered a discriminator in the second or third box should be documented as PP2+ve or PP3+ve respectively. A patient who has not triggered any discriminators should be recorded as PP-ve. Despite these instructions being available to all, I observed Paramedic Pathfinder to have been documented by only three paramedics, those paramedics were the same paramedics who had documented a NEWS (Figure 6.7 below). The two instances where these paramedics had not documented an outcome for Paramedic Pathfinder, were on the same two occasions where a NEWS had not been recorded (i.e. P6/9 and P17/25).

Figure 6.7: Compliance – Documenting Paramedic Pathfinder
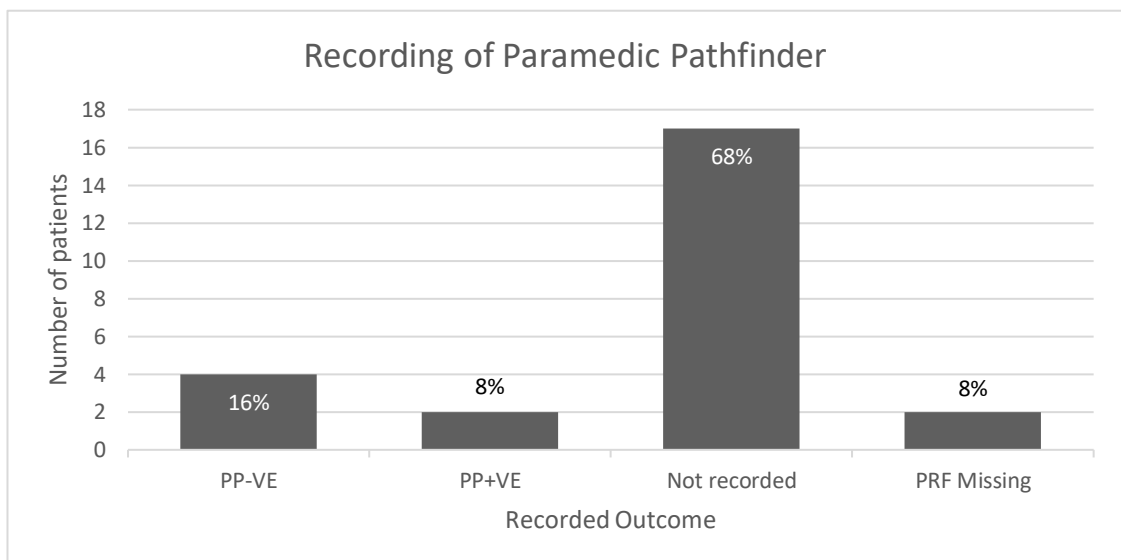
6.3.5   On-Station audit of patient report forms

P9 is a CTL, and one of the duties of a CTL is to conduct on-station audits of PRFs to ensure they have been completed compliantly. I observed P9 conduct an audit of a random sample of PRFs (n=100). The PRFs related to incidents attended during the preceding seven days; the date being 18/04/2016, two years after the introduction of the NEWS. The PRFs had been completed by ambulance clinicians based in Sector-2. Of those PRFs audited, only 14 had a NEWS recorded, of which eight had been calculated correctly. When P9 reviewed who had completed the PRFs, he stated all bar one had been completed by either a newly qualified EMT, or what he referred to as

'proactive' paramedics. He mentioned he had found previously, when observing and mentoring clinicians and conducting PRFs audits, that very few had used or had recorded a NEWS; bearing in mind the incomplete PRF illustrated in Figure 6.4 (p.187) had been completed by P9.

6.3.6   Accuracy of scores

Of the six NEW scores recorded on the PRFs, from the incidents observed, just three had been calculated/documented correctly (Table 6.2, p.189 and Appendix 30: P4/5 & P4/6, pp.387-387, & P6/8, p.389). None of the paramedics who calculated a NEWS used any form of aide memoire (e.g. the NEWS/Pathfinder pocketbook). All scores were calculated from memory.

P6 and P17 recorded just one NEW score on each PRF. P4 calculated and recorded two scores. The higher level of observed compliance by P4 may have been expected, having been a Paramedic Pathfinder Lead, although the outcome for Paramedic Pathfinder was still omitted on one of the two PRFs he completed, and one of the NEW scores had been incorrectly calculated/documented; i.e. the NEWS for observation P4/5 which I discuss next.

6.3.7   Observation P4/5 - an example of the NEWS and decision-making in context

The incident relating to observation P4/5 had originally been passed by the Emergency Operational Control as red category A call, blue light response (Appendix 30, p.387). The patient was believed to be having a stroke; i.e. cerebral vascular accident or transient ischaemic attack.

On arrival, the patient who lives alone, was found standing in the kitchen and complaining of head pain. When questioned, the patient was observed to be experiencing some difficulty speaking; i.e. she was having trouble finding her words. When the paramedic asked the patient whether she thought she was struggling to find words more than normal, the patient replied, *"No. I'm just frightened."* The patient explained she had experienced a 'mini-stroke' earlier in the year and was concerned she was experiencing another. The paramedic subsequently attempted to put the

patient at ease and assured her he would assess her thoroughly to see what was going on.

The assessment included measuring the patient's blood sugar level, which was within normal parameters (BM=5.1). The assessment of patient's cardiac systems indicated atrial fibrillation with a slight heart murmur. The patient was reassured this was nothing of concern. The patient's respiratory system was found to be clear. Patient's memory and mental capacity were assessed and other than an increased level of anxiety, all was satisfactory. Whilst patient showed some age-related decline in physical mobility, her face-arm-speech test was negative. The paramedic followed through with a more thorough assessment of the patient's neck, head and face including an oral assessment. This was because the patient had complained of pain on the side of her face and behind her ear.

Whilst the paramedic was not observed using the NEWS tool (i.e. the NEWS was calculated from memory), nor referring to the NEWS verbally, two NEW scores were documented on the PRF. All measures obtained during the first physical assessment conducted would have scored individual physiological parameter scores of zero, except for the patient's systolic blood pressure. The patient's systolic blood pressure was recorded as 220 mmHg, which should have been attributed an individual physiological parameter score of 3, but the total NEWS had been documented as zero (Figure 6.8, p.194).

Whilst the patient's blood pressure was high on our arrival, it had reduced once she had calmed down. P4 informed the patient he did not believe she was having a stroke. He stated he would like to arrange an appointment for her to see the doctor. This was agreed by the patient and subsequently arranged by telephone. During the telephone call, the paramedic summarised his assessment. Based on what the paramedic had described, the GP agreed with the diagnosis. The patient was subsequently left in the care of a relative.

Figure 6.8: Observation P4/5 – Inaccurate calculation/documentation of the NEWS

During the debrief, P4 described how he had ruled out a stroke or cerebral event in the first instance. Then, through a process of elimination, he had concluded the patient was suffering from an infection of the inner ear; i.e. the Eustachian tube. The high blood pressure measurement obtained initially was due to the patient's anxiety; documented on the PRF as '*Anxiety ++, ↑ BP*'. This had reduced by the time the second physiological assessment was conducted.

6.3.8 Outcomes

Where possible[30], I calculated a NEWS retrospectively using the physiological measures recorded by the attending paramedics. Except for one patient, all patients attended were found to have a low clinical risk score (Figure 6.9 below).[31] However, comparing the first and second physiological measures obtained, three patients showed signs of clinical deterioration (Appendix 30: P6/7, p.388, P10/12, p.391 & P14/19, p.395). The rest remained stable or showed signs of improvement (Figure 6.10, p.196).

Figure 6.9: Final NEWS based on last set of physiological parameters recorded on patient report forms[32]

Patients' final NEWS

---
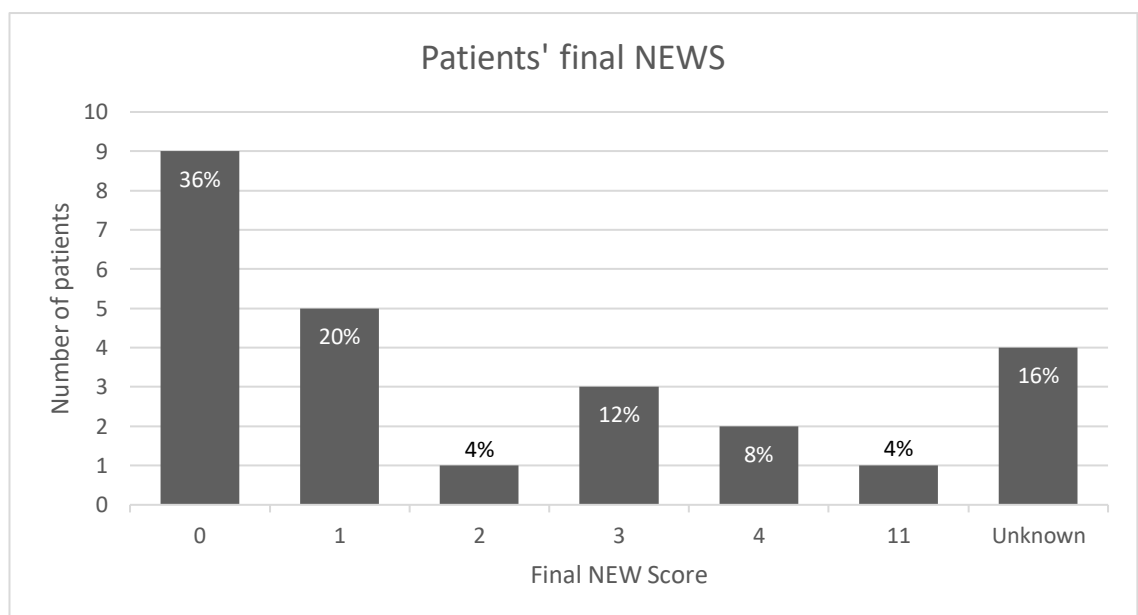
[30] A NEWS could not be calculated for patients who attended the ECP assessment unit, as no full set of physiological measures were obtained.

[31] Patients had an aggregated final NEWS ≤ 4, and all individual parameter scores were less than 3

[32] Missing physiological measure not recorded on the PRF were replaced using the last measure observed during the assessment

Figure 6.10: Changes to patients' well-being
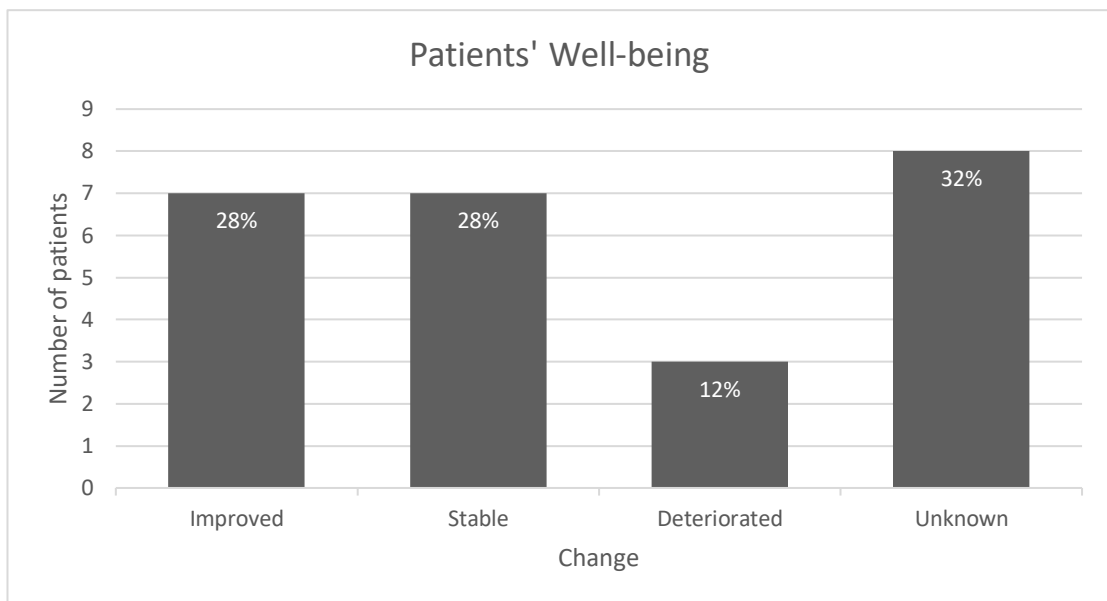
6.4 Decisions made to convey or treat closer to home

Whilst many of the patients attended were found to be presenting with a low clinical risk complaint and had either improved or were stable, most were conveyed to ED (Figure 6.11 below).

Figure 6.11: Numbers and proportions of patients conveyed to ED and those treated closer to home
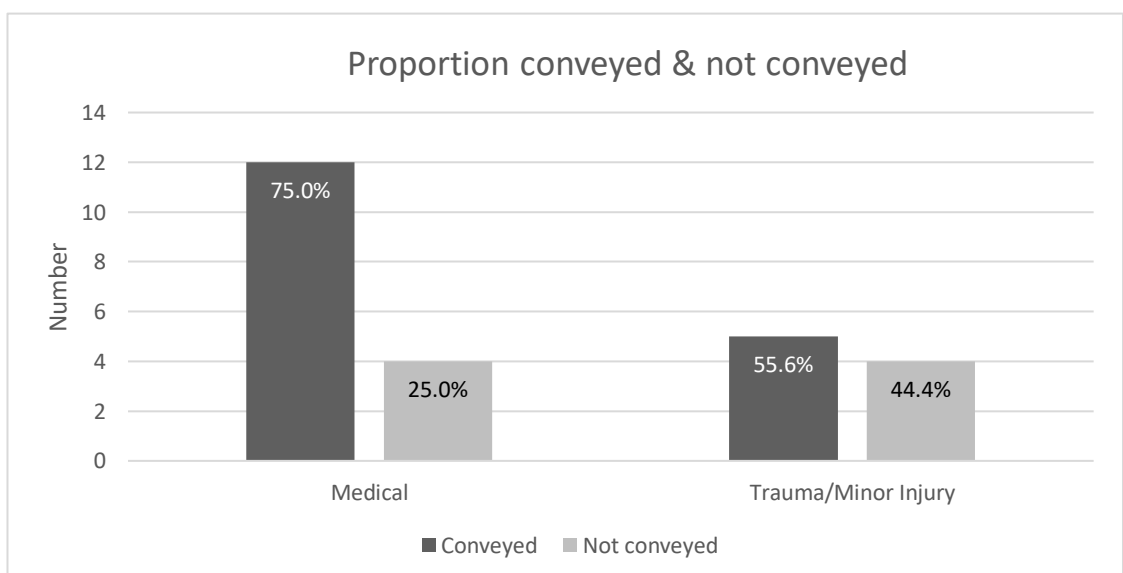
6.4.1 Influencing factors

Following the discharge of patient care at scene or handover of patient care at hospital, I asked the paramedics how they had formed a decision and what had influenced their decision to convey or treat patients closer to home. Sometimes the decisions made were made easily and unequivocally, particularly those for patients presenting with particularly high or low acuity conditions (e.g. P10/12 or P11/14, see Appendix 30: p.391 & p.392 respectively). More often, the decision-making process described was more complex, with decisions being influenced by multiple factors, some of which were non-medical but psychosocial factors (e.g. P6/7, see Appendix 30, p.388). In all, I found paramedics' decisions were influenced by eleven factors as illustrated in Figure 6.12 below.

Figure 6.12: Factors influencing paramedics' decisions
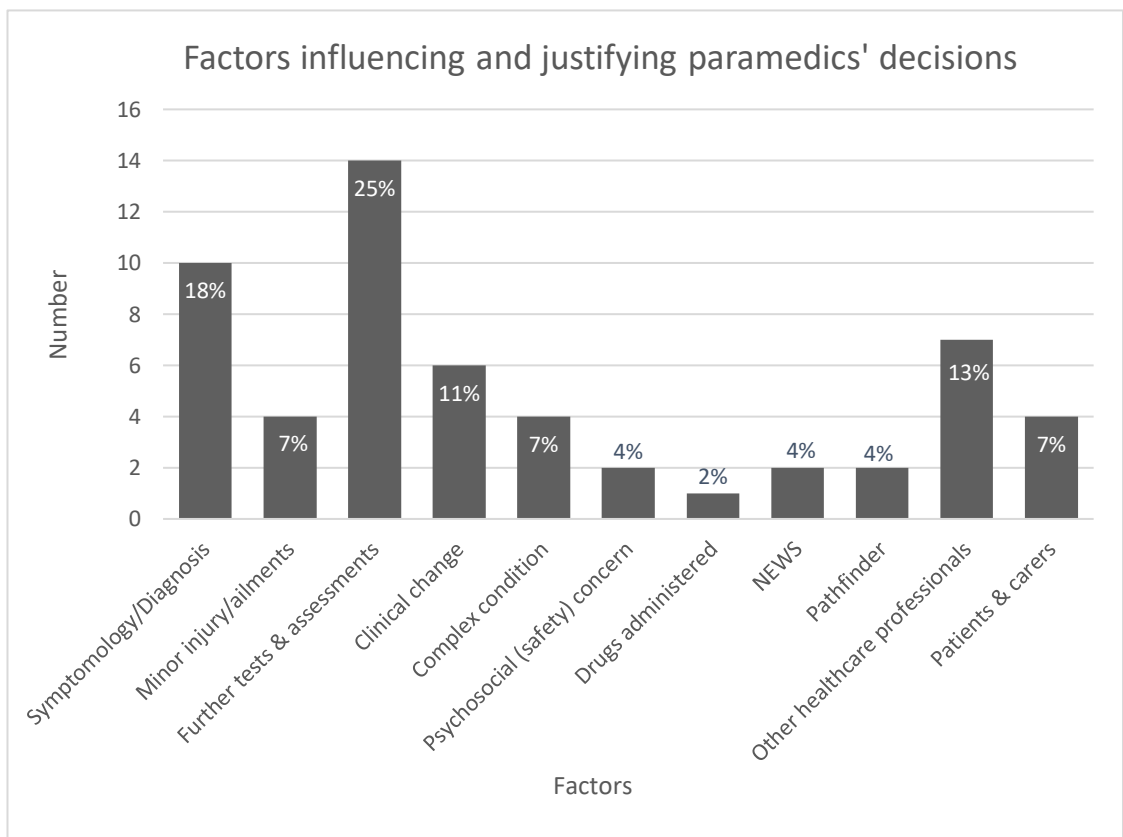
These factors were deemed to fall under three categories. The first category includes factors related to the patient's disposition, such as symptomology, diagnosis, clinical changes and psychosocial safety concerns. The second category relates to decisions influenced by policy, i.e. the NEWS, Paramedic Pathfinder and AMB-X's drug administration policy. The third category relates to decisions made or influenced by others, such as the patient's GP and other healthcare professionals, or the patient themselves and their carer. The eleven factors are each discussed in more detail below.

6.5   Decisions influenced by patient disposition

6.5.1   Symptomology and diagnosis

Paramedics referenced a wide range of physiological abnormalities and perceived diagnosis that had influenced their decisions to convey; such as the patient' level of consciousness, confusion, cardiac abnormalities or the potential that their patient may be suffering from kidney infection, sepsis or pleurisy to name just a few. Often their decision-making seemed to be overtly influenced by just one or two specific symptoms, which were considered red flag warning signs, or a pertinent negative which would redirect their clinical assessments and subsequent decision/diagnosis.

> *"He had been unconscious and that is a red flag. He needs to go in for a check." [P3/1]*
>
> *"It was the patient's heart rate that made me change my mind." [P4/6]*
>
> *"Could be a stroke, and if so then she would be taken to [location in County-1] City Hospital. But a stroke was ruled out as the patient was not FAST positive" [P14/18]*

As mentioned above, sometimes the seriousness of the patient's symptoms meant the decisions-made were unequivocal and the patient had to be conveyed to ED urgently. P10 and her crewmate were asked to attend as an amber back-up response (i.e. non-blue light) and convey an elderly patient to hospital (Appendix 30: P10/12, p.391). An FRV paramedic was already on scene. The original emergency call had been triaged as a Red 2 category A call. The 89-year-old patient was experiencing breathing difficulties. The patient, who resided at a nursing home having had a stroke two-years previously,

had been diagnosed with a chest infection by the GP the day before. The nursing staff advised the patient's condition had deteriorated during the last couple of hours. Both the patient's temperature and systolic blood pressure were within normal parameters, and whilst the patient was alert, he was visibly struggling to breathe. Respirations were audible; bubbly and rattily. Oxygen saturations had been 93% during the night, but on our arrival were 67%. The patient's respiratory rate was measured as 32 breaths per minute. Oxygen therapy was administered, along with glyceryl trinitrate and furosemide - the latter was administered intravenously.

Having administered treatment at scene, the decision was made to convey the patient to hospital on blue lights and sirens because the patient's condition was critical. Despite expedited conveyance to hospital and direct admission to the resuscitation unit, the patient died shortly after our arrival at the ED.

During the debrief, P10 informed me she had treated the patient for left ventricular heart failure rather than a chest infection because…

> *"…the patient's breathing pattern suggested a cardiac problem. And he didn't have a temperature." [P10/12]*

Salbutamol could not be given because of the patient's tachycardia; heart rate measured at the time was 167 beats per minute.

The PRF related to this observation could not be found, but from my notes and using the patient's first set of physical measurements, I had calculated the patient's NEWS to be 9. On arrival at ED, the patient's NEWS had increased to 11. I did not observe the NEWS tool being used, nor the score being communicated by any clinicians during this observation; i.e. neither the FRV paramedic, P10 or her crewmate, nor nursing or medical staff at the ED.

6.5.2   Minor injury or illness

Whilst some patients presented with serious and/or high acuity conditions, others presented with minor complaints. Once assessed and treated, advice would be given to the patient before being discharged at scene.

One such patient had attended the ECP assessment unit with a large blister on the upper part of her foot, where an ill-fitting shoe had been rubbing (Appendix 30: P11/14, p.392). P11 informed the patient that the top layer of skin needed to be removed from the blister, i.e. deroofing. Whilst cleansing the blister and surrounding area on the patient's foot, P11 explained what the treatment would entail. The blister was subsequently incised and then dried. P11 advised the patient to go barefoot as much as possible and to keep the wound clean. This was to allow the blister time to dry and to prevent further irritation. The patient was subsequently discharged. The NEWS was not used during this assessment or for any other assessment observed on the ECP unit.

6.5.3 Further tests and assessments required

A key criterion influencing paramedics' decisions to convey to ED was the opinion the patient needed further tests or assessments which the paramedic could not conduct at scene; such as X-rays or blood tests. As one paramedic stated, these tests could be arranged via GP, but in some circumstances, time was of the essence.

> *"… because of the patient's age, recent medical history, the time it would take to arrange, it would be quicker and easier to transport to ED."* [P14/17]

Some described it was necessary to convey owing to the circumstances at the time. As mentioned previously, patient 11 could not be assessed by P9 because the patient was outside in a public place and the weather was cold, and P9 had responded in an FRV. He therefore requested a DMA to convey the patient to ED (Appendix 30: P9/11, p.391). He reassured the patient, but explained…

> *"I don't think it's your heart, but I can't check it properly here."* [P9/11]

6.5.4 Clinical changes

Six decisions had been influenced by observed clinical changes. Some patients who improved were treated and discharged at scene, whereas those who had deteriorated, or did not recover as quickly as expected, were all conveyed. The NEWS however was

not used, despite its track-and-trigger ability, which could have legitimised the decisions made.

P14 had decided to convey one of her patients to ED, because her patient's condition had not improved as expected (Appendix 30: P14/20, p.396). The paramedic reassured the patient, who was reluctant to travel, that their condition was not life-threatening but going to hospital would be in their best interest.

> *"…your recovery has been a bit slow. You have had several episodes and another just now. I think you should go to A&E for a full assessment." [P14/20]*

During the debrief, the paramedic justified her decision by explaining the patient had been on the floor for an hour, for reasons which could not be explained.

> *"Had they got up and not had any further problems, then I may have felt more inclined to leave them at home and arrange for them to see their GP" [P14/20]*

Again, I did not observe the NEWS tool/score being referred to by P14 during the clinical handover of care.

6.5.5 Complex and comorbid conditions

Several of the patients conveyed to ED were conveyed because they had complex or comorbid conditions that posed a serious risk to the patient's life and well-being. For example, P6 attended a priority red category A call to a young adult female patient who was experiencing left-sided chest pain and shortness of breath (Appendix 30: P6/9, p.389).

Being a category A call, in a public place and P6 attending in an FRV, the call was automatically backed-up by a DCA. The DCA arrived within five-minutes of our arrival at scene, but in those five-minutes P6 began his preliminary assessment. The patient described pain and numbness down their left-side; in their left hand, arm, chest, neck and armpit. The patient was very anxious and upset; initial heart rate was 114 beats per minute and systolic blood pressure was 157 mmHg. From questioning, it became apparent the patient had experienced similar symptoms before, but never as bad as

she was experiencing that day. The symptoms had also worsened since speaking to NHS 111 earlier that day. Previously, the symptoms had been caused by fluid build-up on her brain and spinal cord (i.e. hydrocephalus). She had been having regular lumbar punctures to alleviate the symptoms. The last lumbar puncture had been done four-weeks before.

During the debrief, P6 advised the patient's previous medical history had been the key influencing factor for the decision made to convey the patient to ED. He believed there was little he or a GP could do for this patient…

"…she needed prompt assessment and treatment in hospital." [P6/9]

6.5.6 Psychosocial (safety) concerns

Two paramedics had decided it would have been unsafe to leave their patient at home (Appendix 30: P6/7, p.388 & P14/20, p.396). One patient, attended to by P6, had fallen earlier that evening and had not been able to get up. The patient had managed to crawl to the front-door to summon help. On assessment the patient was presenting signs and symptoms of a UTI, most probably from a Cystoscopy procedure undertaken earlier that week. P6 requested a DCA to convey the patient to the local UCC. Despite having a NEWS ≤4 and the patient being PP-ve, the staff at the UCC refused to accept the patient, due to dizziness and falls (Figure 6.13, p.203). The patient was subsequently transported to the main ED 25 miles away.

During the debrief, the paramedic explained he had considered referring the patient to out-of-hours and leaving the patient at home, but had decided it unsafe because…

> *"…the patient was unstable on his feet and was at risk of further falls."*
> *[P6/7]*

Figure 6.13: Observation P6/7 – A NEWS and Paramedic Pathfinder notated on patient report form

Figure 6.13 above, shows P6 had documented both Paramedic Pathfinder and a NEWS on the PRF. I also heard the NEWS being referred to verbally during the clinical handover of care, to the conveying DCA. However, I did not witness the NEWS tool being used or referred to which might explain why the NEWS that had been calculated was inaccurate. The physiological measurement for oxygen saturation was borderline and may have been incorrectly attributed an individual parameter score of zero, rather than one.

P6 made no reference to the NEWS during our observation debrief.

6.6 Decisions influenced by policy

6.6.1 The NEWS & Paramedic Pathfinder

P9 was the only paramedic who referred to the NEWS during the observation debrief, and P17 mentioned Paramedic Pathfinder. No other paramedic mentioned either tool when explaining or justifying their decisions.

P9 had attended a 47-year-old patient at a local gym who had experienced a vasovagal syncope; i.e. decrease in heart rate and blood pressure resulting in a brief loss of consciousness (Appendix 30: P9/10, p.390). P9 explained to the patient the syncope had occurred because they had overexerted themselves during their exercise, and they had an underlying chest infection. The patient was advised to make an appointment with the GP before undertaking anymore exercise. The patient was subsequently discharged from care.

During the debrief, P9 informed me that Paramedic Pathfinder states the patient should have been conveyed to ED, because the patient had experienced a neural deficit. They however felt ED was unnecessary…

> *"…because the patient had fully recovered by the time we had arrived. Their NEWS was probably zero or one." [P9/10]*

The patient's final NEWS was one, but from the first set of physiological measures obtained the patient's initial NEWS would have totalled three. P9 may have incorrectly concluded the NEWS on arrival was zero or one, because the initial measurements for the patient's oxygen saturation, systolic blood pressure and temperature were all borderline between the NEWS' parameters (Figure 6.14, p.205).

Whilst P9 verbally referred to the NEWS during the observation debrief, I did not observe him using the tool, nor was a score documented on the PRF. His reference to the NEWS suggests the NEWS may have been used in his decision-making to confirm or justify the final decision made.

Figure 6.14: Observation P9/10 – Borderline physiological measures

P17 had attended an 86-year-old female patient who had been admitted to hospital with abdominal pain the previous week (Appendix 30: P17/23, p.399). The patient had been hospitalised for one-day before being discharged home into the care of her GP. According to the patient, nothing abnormal had been discovered. Nevertheless, she had been prescribed and was taking Trimethoprim (an antibiotic prescribed for UTIs) and Ranitidine (a treatment for gastric problems such as stomach ulcers and gastroesophageal reflux to reduce stomach acid). Since being discharged from hospital, the abdominal pain had returned.

The patient described the pain as located at the bottom of her bladder; pain score = 7/10 without pain relief. She had been experiencing the pain for a few days. She had decided to call for an ambulance because she had been awake all night. The patient

had not taken any pain relief as the tablets made her sick. The patient was able to pass urine and was not constipated. The urine was described as strong smelling, but there was no sign of any bleeding, nor burning sensation and no back pain. The patient said she had been to see her GP, but they had found nothing untoward.

Having completed her assessment and documented a NEWS of one on the PRF (Figure 6.15 below), P17 gave the patient the option of either going to hospital or staying at home. If the patient decided to stay at home, P17 informed the patient she would arrange for her GP to visit. The patient replied, *"They won't come until 10 or 11 o'clock"*; the time then being 07:30 am. The paramedic left it a while before asking the patient again what she would like to do. The patient subsequently re-emphasised how unwell she felt and that she had hardly eaten, but as the hospital had already done a scan and could not find what was causing the pain, she didn't know what she should do. P17 therefore invited the patient's daughter to participate in her mother's decision-making. In the end, the patient chose to go to hospital.

Figure 6.15: Observation P17/23 – Notation of a NEWS and Paramedic Pathfinder on electronic patient report form

Chief Complaint:
Abdominal Pain / Problems;

COMMENTS
Pathfinder positive 1 - severe pain
NEWS 1

During the debrief P17 explained to me…

> *"Arranging a GP visit had been a possibility, but abdominal pain in the elderly can be complex. The patient had already spoken with the CAT and they had sufficient concern to upgrade the call. To me that's a red flag. The patient looked pale, possibly slightly jaundiced, and urine had been described as having an offensive odour."* [P17/23]

Nevertheless, P17 still gave the patient the option to stay at home and to arrange for her own doctor to visit because…

"... the patient's daughter did not seem too concerned. And, the patient had already seen a number of doctors for UTI and associated problems. And based on her history, alternative pathways would be an option. But, as the patient had given me a pain score of seven, this automatically ruled out Pathfinder." [P17/23]

Whilst a NEWS had been documented on the PRF, I had not witnessed the NEWS tool being used. The NEWS that had been documented, did not tally with either set of physiological measures. The first set of measures would derive a NEWS of two, owing to an increase in respiratory rate (Figure 6.16 below). The second set of measures would derive a NEWS of zero. P17 may have erroneously used the patients diastolic blood pressure measure, rather than systolic. Or more likely, she may have misattributed individual parameter scores to borderline physiological measures (see respiratory rate measurement in second row).

Figure 6.16: Observation P17/23 – Physiological measures recorded on electronic patient report form

VITAL SIGNS														
Time	HR	RR	BP-Sys	BP-Dia	SPO2	Peak Flow	EtCO2	BM	TEMP	Pain: Numeric	Pain: Visual	GCS	Position	Done By
M-07:03:52	66 BPM	22 BPM	178 mmHg	101 mmHg	98 %			'6.4' mmol/L	37.4 Celsius	7		E 4 V 5 M 6 15	Lying	RH
M-07:14:07	78 BPM	20 BPM	177 mmHg	104 mmHg	98 %					7		E 4 V 5 M 6 15	Lying	RH

6.6.2 Drugs administered

There was one occasion where the patient had to be conveyed in accordance with AMB-X's drug administration policy, because morphine had been administered for pain relief (Appendix 30: P3/2, p.386). Conveyance was further justified, during the debrief, because the patient needed additional tests and assessment that could only be undertaken at hospital.

"[The patient] … was visibly experiencing a lot of pain, although unable to provide a score. My priority was to get rid of the pain. Entonox was not appropriate [as the patient had Dementia] and giving morphine would mean she would need to go to hospital. This was necessary anyway, as possible causes that needed to be ruled-out included pulmonary embolism or fractured rib." [P3/2]

6.7 Decisions made or influenced by others

6.7.1 Other healthcare professionals and service accessibility

Paramedics' decisions can often be influenced or overridden by decisions made by other HCPs. For instance, P6 had been assigned to attend a patient who had fallen (Appendix 30: P6/8, p.389). The call had been categorised as a non-blue light emergency response (i.e. Green 4 call). On arrival at the care home, a member of staff explained they had telephoned the GP, but the GP had refused to attend until the patient had been x-rayed. The staff subsequently phoned NHS 111, who then called the ambulance service.

On examination, the paramedic found the patient had sustained an arm injury, but otherwise was fit and well and fully mobile. The patient was able to fully flex the arm, there was however some deformity; contusion and a haematoma was present. The paramedic subsequently diagnosed the possibility of a dislocation, or partial dislocation of the elbow joint. P6 informed the patient they needed to go to the hospital *"to have it looked at".* He personally conveyed the patient, by FRV, to the local UCC. The expectation was the medical staff there would x-ray the patient's arm and then manipulate the elbow if necessary, using a local anaesthetic. The nursing staff however refused to accept the patient, as they claimed the patient would need to be treated under a general anaesthetic. AMB-X had instructed Paramedics …

> *"… if following all assessments and the use of Paramedic Pathfinder, it is the clinicians' view that the patient does not require hospital treatment but does need further assessment, and despite the attending clinician's best efforts, a referral to a suitable alternative cannot be arranged, the patient should be transported to hospital. This should also be documented as a failed referral in the patient report form." (AMB-X NHS Trust, 2016, section 7.3, p.7)*

The attending paramedic complied with the instructions as directed (Figure 6.17, below).

Figure 6.17: Annotation of a NEWS and failed referral for treatment via an alternative care pathway

P6 subsequently conveyed the patient to the main ED. On arrival, the nursing staff questioned the paramedic, asking him why he had conveyed the patient there, rather than taking him to be treated at their local UCC (i.e. 25-miles away). The paramedic explained the nursing staff at the UCC had refused to accept the patient. When he reiterated what the UCC nurse had said, the ED nurse shrugged and stated they would not use a general anaesthetic, just a local. Neither the UCC nor ED nurse had examined the patient's injury in any detail.

As I observed, it is not only accessibility to community care pathways that can be difficult to access. Obtaining access to specific wards or departments at hospitals may also be restricted, particularly where patients have comorbidities. This can leave paramedics with little option other than to take patients to ED (e.g. Appendix 30: P14/18, p.395).

Paramedics' decision-making can also be influenced directly and/or indirectly by their work colleagues and peers. For example, the decision made by P17 to convey her patient was partly influenced by the fact the CAT had upgraded the 999-call; from a Hear & Treat, to a See & Treat call (Appendix 30: P17/23, p.399).

P3 had decided to request an amber (non-blue light) back-up response from a DCA, to convey one of his patients to hospital (Appendix 30: P3/1, p.385). P3 had decided on

an amber response, as it would give the patient more time to recover from a syncope, and for the crew to be stood down if necessary. P3 was not only concerned about inappropriate utilisation of resources, but also that his decision-making (to convey) could have been criticised (by his colleagues) had the patient recovered by the time the DCA arrived on scene.

Conversely, P10, who was working on a DCA, questioned the amber response decision made by the FRV paramedic who attended Patient 12. P10 believed the back-up request on this occasion should have been given as a red (blue-light) response because of the seriousness and the rapid deterioration of the patient's condition (Appendix 30: P10/12, p.391).

6.7.2 Patients' or carers' wishes

Decision outcomes for four patients were either influenced or made by the patients themselves, and/or their carers in accordance with AMB-X policy.

> *"When treating patients and determining conveyance/non-conveyance options, the patients' consent must be sought, and their capacity to consent to the care decisions made assessed and documented in line with the Capacity to Consent Policy and JRCALC guidance …" (AMB-X NHS Trust, 2016, section 8.1, p.7)*

One relative had informed P4 that she had already spoken to the patient's GP, who had instructed her that the patient should be taken to hospital (Appendix 30: P4/6, p.387). During the debrief, P4 stated his decision to convey had been influenced more by the patient's disposition, than the relative's expectation or GP's instruction.

Patient 3, who was taken unwell while at the dentist, refused to travel to ED, because she needed to be home for when her disabled child returned from day care (Appendix 30: P3/3, p.386). P3 assisted the patient to a relative's car which he subsequently escorted home. P3 explained to me afterwards that he believed the nurses at ED would do little more than observe the patient for a couple of hours - the patient's husband could do the same at home. He was therefore happy on this occasion to comply with the patient's request.

These examples show how the paramedic is willing to comply with patients' requests on some occasions, I did however observe one paramedic persuade a patient to go to ED, who had previously been unwilling to travel because of the doctors' strike (Appendix 30: 14/20, p.396). The patient stated that they felt a fraud going to hospital as they were feeling much better. The paramedic assured the patient that his situation was not life-threatening. She informed him that she had assessed the *"big stuff and all seemed fine",* but as his recovery had been slow, and he had experienced repeated episodes, she thought it best he goes to ED for a full assessment.

6.8   Summary

I found little evidence of the NEWS being used to support paramedics' clinical practice or decision-making. A NEWS was verbally referred to twice. Once during the clinical handover of care to the back-up ambulance crew. The other reference was made to me during an observational debrief and was used to justify the decision made. Of the scores that were documented, half had been calculated or recorded inaccurately. Errors and omissions were not particular to the NEWS, as similar mistakes were observed when other decision-making tools were used.

From the observational debriefs, other factors were found to be more dominant than NEWS in paramedics' decision-making process. The factors found to be most influential were related to patients' disposition. Patients' dispositions tended to be evaluated using traditional methods, that is, unsupported by the NEWS. Another factor found to be influential was the perceived necessity for further tests and assessment, whereby urgency and ease of access tended to prompt the paramedics' decision to convey. Decisions made by other HCPs, service accessibility criteria, patients' preferences and wishes of carers can all influence patient outcomes, sometimes over-riding the paramedic's decision, and irrespective of the NEWS.

In the next chapter I will integrate the findings from this chapter with the findings from Chapters 4 and 5.

7 Integration of results - The effectiveness and usefulness of the NEWS to support paramedics' decision-making

In Chapter 4, I presented the results from the interrupted time series analysis of ambulance data, which showed the introduction of the NEWS at AMB-X had little effect on non-conveyance or recontact rates. In Chapter 5, I presented the results from semi-structured interviews, which showed the effectiveness and usefulness of the NEWS to be subjective and context driven. The majority of those interviewed believed the introduction of the NEWS had not changed their decision-making process sufficiently to have impacted on decision outcomes. In Chapter 6, I presented the results from my observations of paramedics as they attended to their patients, from which I found little evidence of the NEWS being used to support clinical practice, or decision-making. The aim of this chapter is to integrate the key results from three previous chapters to provide a summary of my findings.

The integration process was discussed and illustrated previously in Chapter 3, section 3.9, Figure 3.10, p.119. But briefly, as a reminder, the pattern-matching approach adopted was used to corroborate the evidence from each work stream to my theoretical propositions. Should my pre-existing theories not be verified, then I would be required to seek further evidence, or propose alternative explanations.

I begin this chapter by revisiting my research questions and the two theoretical propositions proposed. I then present the overarching results, achieved from drawing on evidence from each workstream as a means of validating or invalidating each theory proposed. The evidence is then discussed, before being summarised.

7.1 Research questions and theoretical propositions revisited

My research was intended to address the following questions:

- What was the effect of the NEWS on the numbers and proportions of patients not conveyed to ED?
- What was the effect of the NEWS on numbers and proportion of patients discharged at scene who recontact AMB-X within 24-hours?

- How useful and effective did paramedics perceive the NEWS to be in supporting them in their decision to convey or treat patients closer to home?

- How was the NEWS being used by paramedics in the emergency prehospital care setting?

Related to these questions, I proposed two propositions, based on existing evidence.

The first proposition was that the NEWS would be effective and useful in supporting paramedics' decision-making to appropriately treat patients closer to home. The introduction of the NEWS at AMB-X would have a significant effect on non-conveyance rates and recontact rates. Paramedics would consider the NEWS useful and effective in most circumstances and would use it frequently and accurately in accordance with policy to support their clinical practice.

The second possible outcome was the NEWS would be ineffective and would not be useful in supporting paramedics' decision-making to appropriately treat patients closer to home. The introduction of the NEWS would have no significant effect on non-conveyance or recontact rates. This would be because paramedics would consider the NEWS useful in some contexts, but not others. Subsequently, the NEWS would be used less frequently than stipulated by AMB-X policy, and when it was used, it would often be calculated/documented inaccurately; i.e. 20% or more of the time.

7.2 Pattern-Matching

I matched the results from each workstream to my pre-existing theories, from which I found a greater body of evidence supported proposition two (Table 7.1, p.214 & Table 7.2, p.215). Having completed the pattern-matching exercise, I concluded there was no significant change in non-conveyance or recontact rates following the introduction of the NEWS. The usefulness and effectiveness of the NEWS was context dependent. There was a lack of compliance and accurate use of the NEWS.

Table 7.1: Summary of evidence illustrating my first proposition was unsupported

PROPOSITION 1	ITS Analysis	Semi-structured Interviews	Non-participant observations
Numbers and Proportions of patients treated closer to home will be significantly affected	Numbers and proportions did not differ significantly to that predicted. Proposition not supported.	Lack of evidence to suggest more, or less patients were being treated closer to home. Proposition not supported.	Most of the patients not conveyed, who were treated closer to home had attended the ECP assessment unit. The NEWS was never used to assess any of these patients. Where a NEWS had been documented (n=6), only one patient was discharged at scene. Two were denied access at the UCC. Proposition not supported.
Numbers and Proportions of patients who recontact will be significantly affected	Numbers and proportions did not differ significantly to that predicted. Proposition not supported.	Not assessed, but Paramedic Pathfinder Leaders believed decisions were being made more safely; as call volume had increased, non-conveyance rates had reduced, and serious untoward incidents had either remained the same, or had reduced.	Not assessed, but there was evidence that one patient had been attended to on several occasions previously and their condition had deteriorated significantly in the 7 days; i.e. 4% reattendance rate which is a similar rate to that found from ITS analysis. Proposition not supported.
The NEWS will be considered useful & effective in most circumstances	Proposition not assessed	The NEWS was useful in a limited number of contexts (i.e. when paramedics were uncertain what to do). Was not helpful when assessing patients with complex conditions, minor injuries or ailments or those seriously unwell who obviously needed to be conveyed (i.e. big sick). Proposition not supported.	The NEWS tool was not used. A NEWS was rarely documented. A NEWS was used verbally once to support clinical handover of care. A NEWS was verbally referred to once, during observation debrief, to justify a decision made. Proposition not supported.
The NEWS will be used frequently and accurately to support paramedics' decision-making	Proposition not assessed	A few paramedics claimed to use the NEWS frequently, the majority said they used it occasionally, some did not use it all. Several paramedics still preferred to use traditional methods and relied on gut instinct. Proposition not supported.	The NEWS tool was never used. The NEWS was rarely referred to verbally and was often not documented. Half the scores documented were incorrect. Lack of observed usage and poor documentation were corroborated by on-station audit. Proposition not supported.

Table 7.2: Summary of evidence illustrating my second proposition was supported

PROPOSITION 2	ITS Analysis	Semi-structured Interviews	Non-participant observations
Numbers and Proportions of patients treated closer to home will be unaffected	Numbers and proportions did not differ significantly to that predicted. Proposition supported.	Paramedic Pathfinder Leaders believed conveyance rates were reduced. Paramedics believed conveyance rates to ED had increased. Consensus was any change was because of Paramedic Pathfinder, not the NEWS. Proposition supported.	Most patients attended were conveyed, had a low score, and/or had physically improved or were stable. Decisions were more likely to be influenced by a range of other factors. Alternative care pathways were sometimes denied by HCPs. Proposition supported.
Numbers and Proportions of patients who recontact will be unaffected	Numbers and proportions did not differ significantly to that predicted. Proposition supported.	Not assessed, but Paramedic Pathfinder Leaders believed decisions were being made more safely; as call volume had increased, non-conveyance rates had reduced, and serious untoward incidents had either remained the same, or had reduced.	There was evidence that one patient had been attended to on several occasions previously and their condition had deteriorated significantly in the 7 days; i.e. 4% reattendance rate which is a similar rate to that found from ITS analysis. Proposition supported.
The NEWS will be considered useful and effective in some circumstances, but not others	Not assessed	The NEWS was useful when paramedics were unsure what to do. The NEWS supported the assessment of effectiveness of treatment provided. The NEWS was not useful when assessing patients with complex conditions, those who were 'big sick' or those with minor injuries/illnesses. Other tools sometimes more useful than the NEWS. Can be useful/effective when communicating with HCPs but sometimes can hinder. Proposition supported.	Paramedics rarely described using the NEWS to help or support their decision-making. The NEWS was referred to in observational debrief once, to justify a decision made. A NEWS was communicated once during a clinical handover to a DCA. Proposition supported.
The NEWS will be calculated and used to support paramedics' decision making only occasionally. When used, it will often be calculated/recorded inaccurately	Not assessed	Some paramedics use NEWS regularly (daily), but not to assess every patient. Others use it less often, e.g. once or twice a week. Some do not use it at all. Proposition supported.	NEWS tool not observed being used. Referred to once to justify a decision made. The NEWS was rarely documented (n=6) Half (n=3) of those scores documented were incorrect. 14% of PRFs audited on station (n=100) had a NEWS documented, 6 (43%) were calculated incorrectly. Proposition supported.

7.2.1 No significant change in non-conveyance or recontact rates after the NEWS was introduced

Paramedic Pathfinder Leaders believed conveyance to ED had been reduced without undue concerns or incident, although they could not be certain the improvements observed were due to the NEWS. This was because their assessment was focused on the effectiveness of the Paramedic Pathfinder Programme as a whole. Conversely, frontline clinicians thought conveyance rates to ED had increased, but they believed this was because of Paramedic Pathfinder and the associated policy, not the NEWS. In fact, I found statistically, that there had been no significant change in non-conveyance rates after the NEWS had been introduced.

Whilst the numbers of emergency calls attended to each month had remained constant, the numbers of higher acuity calls had increased, and therefore one would have expected non-conveyance rates to have decreased accordingly, which they did not. The lack of effect on this outcome measure may be because the increase in acuity calls were attributable to the changes implemented at NHS 111 and therefore not captured in this data set.

There was nevertheless a significant declining trend in numbers being treated and discharged at scene, indicating more patients were being conveyed for treatment via alternative care pathways – at UCCs, MIUs or similar. From both quantitative and qualitative evidence, it would seem this change is possibly due to transformations associated with the CAT. The increase in Hear & Treat call resolution means that proportionally more patients attended to are likely to be conveyed, as patients with lower acuity complaints would have been filtered out. Also, calls initially categorised as Hear & Treat and assessed by CAT, that are subsequently reassigned as a See & Treat call, are considered by some to be a red flag. The purpose of a red flag is to raise awareness and alert individuals of potential danger; however, the attributed red flag may also cloud a person's judgement (like red mist), resulting in indecision. So instead of basing a decision on the patient's physiological disposition and/or using the decision

tool to support their decision, paramedics may decide to convey to ED as a safety-measure or defer the final decision to the patient.

The appropriateness of decisions made by paramedics to treat patients closer to home, had not been formally assessed by the Pathfinder Leaders. Nevertheless, they believed these decisions were being made safely, and the decisions made to convey to ED were made appropriately. Their assertions were based on their observations and assessments at ED, and the fact there had been no increase in serious incidences or complaints that could be directly related to the Paramedic Pathfinder Programme. I also had found the numbers and proportions of patients who were treated and discharged at scene, who recontacted AMB-X within 24-hours, did not change significantly after the NEWS had been introduced.

Thus, the conclusive evidence indicates the introduction of the NEWS, at AMB-X, had little effect on non-conveyance or recontact rates, nor a detrimental or beneficial effect on patient safety.

7.2.2 *The usefulness and effectiveness of the NEWS was found to be context dependent*

The NEWS was considered practicable by all, although the mathematical symbolisation did cause some confusion initially. The usefulness of the NEWS was however subjective, and the utility was limited to certain contexts. Paramedic Pathfinder Leaders, operational managers and frontline clinicians all had a different agenda, and subsequently evaluated the NEWS differently. For instance, the Paramedic Pathfinder Leaders' assessment was focused on organisationally derived indicators and measures (e.g. serious untoward incidents, impact on operational demands, conveyance measures etc.). Whereas, the frontline paramedics' assessment was more self-serving and narrowly focused. Their evaluation of effectiveness and usefulness was based on whether the NEWS helped or hindered them personally. Thus, the information they used to evaluate usefulness and effectiveness was from their own experience and was measured on them achieving their expected outcomes or goals. For example, when a paramedic's uncertainty was corroborated by a borderline NEW score, or their decisions were retrospectively confirmed as being correct, then the NEWS was likely

to be reviewed positively; that is, it is more effective and/or useful. When the NEWS did not align with paramedics' expectations or desired outcome, its effectiveness may be questioned.

From the evidence, it appears the NEWS was less likely to be used at the opposing end of the paramedics' cognitive continuum. In uncomplicated situations, where decision outcomes were easily deduced or unequivocal, then paramedics did not use the NEWS but preferred to rely on their clinical experience and intuition (i.e. pre-existing rules and routines). Similarly, the NEWS would not necessarily be used to assess patients with comorbidities, as paramedics needed to undertake more critical analysis of the patient's condition. Virtually all claimed the NEWS was ineffective and useless when assessing patients with COPD.

Paramedics claimed the NEWS was most useful when there was a degree of ambiguity, what they referred to as grey areas and borderline cases. In this context, the NEWS would be used to provide them with additional cues (information) that added weight to the decisions being contemplated. However, from my observations even when paramedics were uncertain what they should do, other factors would be used more frequently as cues. Even when the NEWS had been calculated, these other factors tended to have more weight on the decisions made, than the NEWS. Based on the lack of reference to the NEWS during the observational debriefs, I deduced most of the scores calculated and recorded were for documentary evidence, rather than to inform or confirm a decision.

The NEWS was considered more meaningful and useful when it was used in localities where other HCPs were using the NEWS, and when other service providers working practices and policies were complimentary to AMB-X's referral procedure. In those circumstances, paramedics claimed the NEWS would be instrumental in the clinical handover of patient care, although I found little evidence of this in clinical practice. Conversely, the lack of awareness, understanding and use of the NEWS by HCPs in other areas, and lack of provision or accessibility to alternative care pathways, led to a lack of commitment and sustained effort by paramedics to continue using the NEWS.

Whilst I did not observe any difference in the adoption or the utility of the NEWS across the different sectors, I did witness futile attempts to access alternative care pathways, in the locality where local service providers were supposedly more aligned to AMB-X's aims and objectives. On both occasions, a NEWS had been calculated, and both the NEWS and Paramedic Pathfinder algorithm indicated that conveyance to ED was unnecessary. On one of these occasions, the receiving ED nursing team questioned why the alternative care pathway had not been used. This would suggest a lack of contextual integration of working practices existed even in this locality. Both incidents were documented on the respective PRFs, I am however unaware if or how it was reported to the Paramedic Pathfinder management team. As P1 stated, the commissioners need evidence, not only when and where things are working well, but also aspects which are acting as barriers or hindering appropriate decisions being made. Such barriers will not only compromise the successful adoption of the NEWS but the entire effectiveness of the Paramedic Pathfinder Programme.

From the evidence, I deduced the usefulness and effectiveness of the NEWS was context dependent.

7.2.3   The NEWS was not being compliantly or accurately used

AMB-X policy stipulates, the NEWS should be used when assessing every patient and should be documented on the PRF. There was however considerable variance in the proclaimed compliance of utility, ranging from always to never. From my observations of frontline clinicians, clinical mentors and leaders, I found the NEWS was rarely used to assess patients, or to form decisions or support the clinical handover of patient care. Whilst the overarching opinion was there had been a greater level of adoption in Sector-2, this was not substantiated by my observations, nor from the on-station audit conducted in this sector, which were conducted two years after the NEWS had been implemented. Even those who had claimed to have adopted the NEWS, acknowledged they were not using it consistently nor necessarily optimally.

Whilst AMB-X had provided paramedics with a pocket-sized version of the NEWS tool, paramedics admitted they rarely used it. There was also no observable evidence of the

tool being physically used during clinical practice. When the NEWS was used, it was conceptualised and calculated from memory, which resulted in erroneous calculations, most often when physiological measures were borderline between two NEW score parameters. Where the NEWS had been documented, the scores had often been calculated or documented incorrectly (i.e. ≥ 20% of occasions); regardless of a paramedics' role, clinical experience or expertise. It was not only the NEWS that was calculated or documented inaccurately, but also the physiological measurements assessed. There were several instances where some of the physiological measures, needed to calculate a NEWS, were not obtained.

Lack of adoption or compliance was not solely attributable to its lack of usefulness in some contexts. There was evidence of underlying dissatisfaction and turmoil between some of AMB-X's management teams and those working at the frontline; more so in Sector-3, than Sector-1 or Sector-2. Such socio-cultural stressors appeared to have resulted in some of the workforce being seditious, and less willing to accept and invest time and effort in the changes being implemented. As it was, many would not even attend the training, let alone participate in this study. Some considered the new working practices to be despotic and prescriptive, presenting a risk to their clinical skill and autonomy. A propensity to convey patients to ED unnecessarily existed, either as an act of rebellion or out of fear of disciplinary action.

The evidence from this study has shown compliance to policy to be lacking.

7.3   Summary of findings

When the evidence was integrated, the second (rival) proposition was found to be the best match; that is, the introduction of the NEWS at AMB-X had little effect on the numbers and proportions of patients not conveyed to ED, or the numbers and proportions of patients discharged at scene, who recontacted AMB-X within 24-hours. This is because the usefulness and effectiveness of the NEWS was context dependent. Subsequently, the expected level of compliance was lacking. Paramedics' decision-making and everyday clinical practice remained unchanged.

There was little evidence of the NEWS being used to support paramedics' decision-making. If it were used, it would be used to support equivocal or ambiguous decisions. Even then, the utility of the NEWS was nullified by a lack of integrated and supportive infrastructure, such as the provision and accessibility to alternative care pathways, leaving paramedics no option but to convey to ED. The lack of awareness, understanding and use of the NEWS by other HCPs, also limited its utility to support the communication of acute-illness severity to receiving hospitals, as recommended by the Royal College of Physicians (2012, 2017).

Ultimately, this study has shown the NEWS was ineffective and not useful in supporting paramedics' decision-making to appropriately treat patients closer to home. I believe the lack of integrated and supportive infrastructure, and lack of shared understanding, to be the main reasons why the NEWS was not embedded into everyday clinical practice. I will discuss this in more detail in the next chapter.

8 Discussion

Odell (2015, p.179) stated EWS systems are *'an oversimplified solution to a very complex and multifaceted problem.'* In this chapter, I illustrate this fact, using the wider literature and three pre-existing theories as conceptual framework for my discussion. The aim of my discussion is to offer some explanations of why the NEWS was ineffective and was not successfully adopted by paramedics.

8.1 The NEWS had not become normalised

May et al. (2007) defines a normalised process as the accomplishment of work undertaken by an ensemble in enacting, implementing and integrating a complex intervention that leads to the intervention becoming embedded into everyday routine practice. According to the Normalization Process Theory (May et al., 2015), the NEWS would only become routinely embedded when everyone (those at AMB-X and the associated stakeholders) worked individually, collectively and continuously to drive forward and support the integration of the NEWS. Before initiating any changes to existing practices, those implementing the changes needed to assess the probability of the changes becoming embedded, by assessing the readiness of the actors to accept the changes proposed (May and Finch, 2009). In this instance, the actors whose readiness needed to be assessed, were the paramedics and the managers employed by AMB-X, plus the other HCPs, service providers and commissioners across the region. The collective action that needed to be invested from the ensemble, for the NEWS to become embedded, relate to four generative (constructive) mechanisms, these being coherence, cognitive participation, collective action and reflexive monitoring (Table 8.1, p.223).

Table 8.1: *Normalization Process Theory – key constructs, investments and components associated to the implementation of the NEWS*

KEY CONSTRUCT (Generative mechanism)	INVESTMENT	COMPONENTS	Example definition
COHERENCE (i.e. sense making by participants)	Meaning	Differentiation	Actors understand how the NEWS requires them to work differently
		Communal specification	Actors have a shared understanding and agree the purpose of the NEWS
		Individual specification	Actors individually understand what the NEWS requires of them
		Internalisation	Actors construct a positive understanding of the benefits of the NEWS
COGNITIVE PARTICIPATION (i.e. engagement by participants)	Commitment	Initiation	Actors become involved in the implementation of the NEWS
		Enrolment	Actors communally become engage in the implementation of the NEWS
		Legitimation	Actors believe they can make a valid contribution to the implementation process
		Activation	Actors remain actively involved and continue to support the NEWS
COLLECTIVE ACTION (i.e. the work participants do to make the intervention function)	Effort	Interactional workability	Actors perform the task required by the NEWS
		Relational integration	Actors work collaboratively, supporting and using the NEWS
		Skill set workability	Actors have the knowledge and skills needed for the NEWS to be effective
		Contextual integration	Actors collaboratively support the NEWS & specified outcomes
REFLEXIVE MONITORING (i.e. participants reflect on or appraise the trial)	Appraisal	Systematisation	Information about the effects of the NEWS is sought and shared
		Communal appraisal	Actors appraise and considered the NEWS to be beneficial system-wide
		Individual appraisal	Actors consider the NEWS to be beneficial and worthwhile for their clinical practice
		Reconfiguration	Actors modify service delivery and clinical practice accordingly

(Developed and adapted from Murray et al., 2010, p.4)

8.1.1 Lack of invested effort and commitment

Most of the frontline paramedics, interviewed in this study, presented the attitude necessary for the NEWS to have been successfully adopted. They had bought into the idea and agreed that the NEWS should be part of their everyday clinical practice. Paramedics employed by other ambulance services in England shared this view (McClelland and Haworth, 2016). While many of those paramedics interviewed claimed to be using the NEWS on a regular basis, my observations would suggest their intentions (what they say they are going to do) and the initial effort invested had not been sustained.

Those managing the implementation process at AMB-X, also found the commitment and the effort invested to be lacking. They highlighted their difficulties in engaging the collective investment necessary from front-line staff and gaining cooperation and support from other management teams. They spoke of difficulty in obtaining investment from external stakeholders, specifically difficulties in gaining access to certain pathways. The difficulties related to the overly restrictive service criteria, which would have been stipulated within the service level agreements negotiated (prior to the implementation of Paramedic Pathfinder Programme) between AMB-X, the external service providers and respective commissioners. In practice, this meant there was an inequality in service provision across the region; in one sector, patients assessed as PP-ve would be able to access urgent care closer to home, 24-hours a day, 7-days a week, whereas in other sectors access to urgent care pathways for some PP-ve patients' was being denied.

Variations in commissioning, resulting in differences in accessibility to emergency and urgent care systems, have previously been found to significantly affect non-conveyance rates within ambulance services (O'Cathain et al., 2018b). The Paramedic Pathfinder Leaders acknowledged they needed to develop a strong business case before commissioners would be willing to commit and invest in related community pathways. To achieve this, they would need to obtain evidence of what access would be needed, where, and the associated cost-benefits. To obtain and provide this

evidence would be complex and time-consuming. Paramedic Pathfinder Leaders estimated it would take 10-years before the Paramedic Pathfinder Programme would be fully embedded. In the meantime, the investment from frontline staff would seem to have waned. This subsequently presented Pathfinder Leaders with a paradox, that is they needed paramedics to use the NEWS and to try and access alternative care pathways, to identify the barriers that existed, but the barriers were inhibiting the NEWS from being used and curtailed paramedics from attempting to use alternative pathways.

At the time of this study, the Pathfinder Leaders had initiated a review, and were in the process of appraising alternative care and service provisions across the region. This involved negotiating new service level agreements with many service providers and 22 clinical commissioning groups. The National Ambulance Commissioners Network (NACN) would support AMB-X with this process. In accordance with NHS England (2014) 'Five Year Forward View', the NACN agreed there was a need to focus on commissioning and providing systems that supported non-conveyance and the provision of the right care closer to home (National Ambulance Commissioners Network, 2015a). They had even acknowledge the implementation of Paramedic Pathfinder Programmes in other ambulance services to be evidence of good practice (National Ambulance Commissioners Network, 2015b). However, even with support from the NACN, a unified regional strategy can be difficult to achieve, because each CCG has different priorities (O'Cathain et al., 2018b). Rather than leading negotiations, the NACN can often end up being the mediator, trying to reduce conflicts of interests between the ambulance service and various CCGs (National Ambulance Commissioners Network, 2015a, O'Cathain et al., 2018b). Until service provisions were reconfigured, access to alternative care pathways by AMB-X's clinicians would remain restricted, which subsequently would be detrimental to sustained commitment and effort by those working at the frontline, to comply with the changes that had been introduced.

8.1.2 Lack of coherent understanding

Coherence is the work that defines and organises the objects, that is the thoughts, beliefs and behaviour of a specified practice (May and Finch, 2009). For the NEWS to be adopted and used effectively, there needed to be a shared understanding of the purpose of the NEWS; that is, an understanding of how the NEWS requires clinicians, individually and collectively, to think and behave differently, and agree that the NEWS is of value and has benefits, but a coherent understanding was lacking.

The usefulness or benefits of using the NEWS was undermined by the lack of access to alternative care pathways. Consequently, paramedics were unable to differentiate how the NEWS required them to work differently. As far as they were concerned, most of the time, they could make appropriate decisions unaided. Subsequently, the introduction of the NEWS had not changed how they worked or made decisions, they could not see what benefit it provided, and as a result collective effort was not sustained.

Coherence may have also been undermined by the content of the training delivered and communication disseminated by the Paramedic Pathfinder Leaders, which focused more on organisational performance benefits, than clinical benefits for the patient. The internalised 'organisational benefits' had led frontline clinicians to believe the changes implemented were a means of undermining their autonomy, and what Safire (1991) refers to as a cover-your-arse effort; a bureaucratic technique used by organisations to cover themselves and diffuse responsibility on to others. In this case, paramedics had perceived that should anything go wrong, when leaving patients at home, the responsibility had been diffused on to them. This may be the reason why numbers of patients being left at home were in significant decline.

This perception may have been precipitated or exacerbated by the underlying tensions between frontline staff and managers evidenced at the time, although cover-your-arse cultures have been evidenced in other ambulance services previously (see Porter et al., 2007, Porter et al., 2008, Halter et al., 2011, Simpson et al., 2017). Nevertheless, this highlights the importance of assessing the readiness of the actors before implementing

226

programmes like Paramedic Pathfinder. For instance, paramedics who perceive their organisation to be risk averse were found to be less motivated to treat patients closer to home, and subsequently non-conveyance rates were found to be lower (O'Cathain et al., 2018b). Half of all organisational transformation initiatives observed by Kotter (2007) had failed because of a lack of preparation resulting in fear paralysis. Kotter (2007) recommends spending time getting individuals into the right mindset, and preparing the infrastructure needed to drive people out of their comfort zones.

Investing more time to engage with actors external to AMB-X, prior to the introduction of the NEWS, would have been of value, as evidence has shown EWS systems have failed previously because of the lack of respective support from other HCPs and doctors (Ludikhuize et al., 2011, Neary et al., 2015, McClelland and Haworth, 2016). When Neary et al. (2015) asked doctors about the perceived impact of the NEWS, the overriding opinion was the NEWS had increased staff workload and stress, and provided little benefit for patient care. Such opinions could have had a detrimental effect on what AMB-X was trying to achieve, particularly as doctors often lead Clinical Commissioning Groups, and Type 3 and Type 4 facilities are GP-led.

Doctors are considered among the most trusted professionals in the UK (Clemence, 2018), and so their opinions are highly influential. Not only do they determine how non-pay NHS resources are spent, they also control and examine higher educational curriculums; direct at board level; lead clinical research and quality improvement programmes; and influence policies, guidelines and quality standards for best practice (Bohmer, 2012, Timmins, 2015, Oliver, 2017, Timmins, 2017). However, over the years, there has been an increase in use of guidelines, protocols, and tools like the NEWS, and whilst many EWS systems were developed in collaboration with physicians, some medics believe such guidelines and protocols erode their professional status, and constrain their medical autonomy (Edwards et al., 2002). Doctors do not lead or motivate by authority, but by the power provided by their position, knowledge and expertise (Bohmer, 2012, Gabel, 2012). Consequently, they can subtly influence how

others think, feel and act, by what they say and how they themselves behave (Bohmer, 2012, Gabel, 2012).

It is impossible to construe whether the doctors' opinions found by Neary et al. (2015) are in response to perceived threats to their values, goals and own roles. But ergonomically, a protocol that exacerbates task workload and stress, for little perceived benefit, is likely to have a negative impact on compliant behaviour. If medics and the nursing staff disregard the paramedics' NEWS out-of-hand, and/or over-ride the paramedic's decision derived using the NEWS, as was evidenced in my study, then it is unlikely paramedics will use the NEWS to assess every patient. Instead, the NEWS will only be used by a paramedic when it serves a useful purpose for them personally; that is, they will only use it when they are undecided what they should do. Any forced occupational changes that are perceived as unnecessary, for example using the NEWS to assess every patient, will be construed as arduous and a threat to occupational standing, status and autonomy (Siegrist, 1996).

8.1.3   Lack of collaboration

Another possible reason why the NEWS had not become embedded was because of the lack of ownership during implementation and thereafter. That is, for the paramedics at AMB-X, and the other HCPs and service providers across the region the changes were being imposed on 'to them' and not in association 'with them'. According to Normalization Process Theory, complex interventions such as the NEWS will only…

> *'…become routinely embedded (implemented and integrated) in their organizational and professional contexts as the result of people working, individually and collectively to implement them… and the continuous investment by people in ensembles of action that carry forward in time and space. It is not enough to adopt and diffuse complex intervention, people need to keep investing in it or it will atrophy.' - (May et al., 2015, Theory behind NPT: Core Propositions of NPT).*

8.1.4 Instigation of a nationwide initiative

According to NHS England (2018), approximately 70% of acute Trusts across England are now using the NEWS, although from my findings I would still question whether it is being used effectively. NHS England and NHS Improvement have acknowledged that a lack of coherence exists, because of the lack of utility or variations of EWS tools being used (Ingham Clark, 2018, NHS England, 2018, NHS Improvement, 2018). They have therefore launched an improvement initiative to increase the use of the NEWS to 100% in acute health and ambulance care settings by March 2019 (Ingham Clark, 2018, NHS England, 2018, NHS Improvement, 2018). By the end of June 2018, all acute hospital and ambulance trusts in England had to complete the following four actions.

- Raise awareness to all those in a leadership role of NHS Improvement's patient safety alert (ref: NHS/PSA/RE/2018/003), which highlighted the importance of using the NEWS to support the recognition and response to patients' clinical deterioration; and
- Identify a NEWS2[33] champion within their organisation to be the main contact for NHS England and to be an active member of the NEWS network; and
- Instigate a committee to plan widescale adoption of the NEWS, and a means of reporting progress, adoption and sharing best practice with the NEWS network; and
- Identify actions required to ensure by March 2019 there is trust-wide adoption of the NEWS.

(NHS Improvement, 2018)

Time will tell if this initiative will generate the shared meaning, and high level of collaborative commitment and effort necessary for the NEWS to become embedded into everyday clinical practice. Until the NEWS is embedded and used effectively, NHS-

---

[33] The NEWS tool introduced in 2012 was revised in 2017 and replaced by the NEWS2. This is discussed in section 0

wide, its full potential will not be realised, and it will continue to be outcompeted by other factors.

8.2   The NEWS was outcompeted by other influencers

Chapman and Sonnenberg (2000) provide a scheme that illustratively describes the associated relationships between various information categories, used by clinicians, to inform and confirm their decision models (Figure 8.1, below). Using this schema, I explain below how the NEWS can be outcompeted by other influencing factors.

Figure 8.1: Scheme of medical decision-making
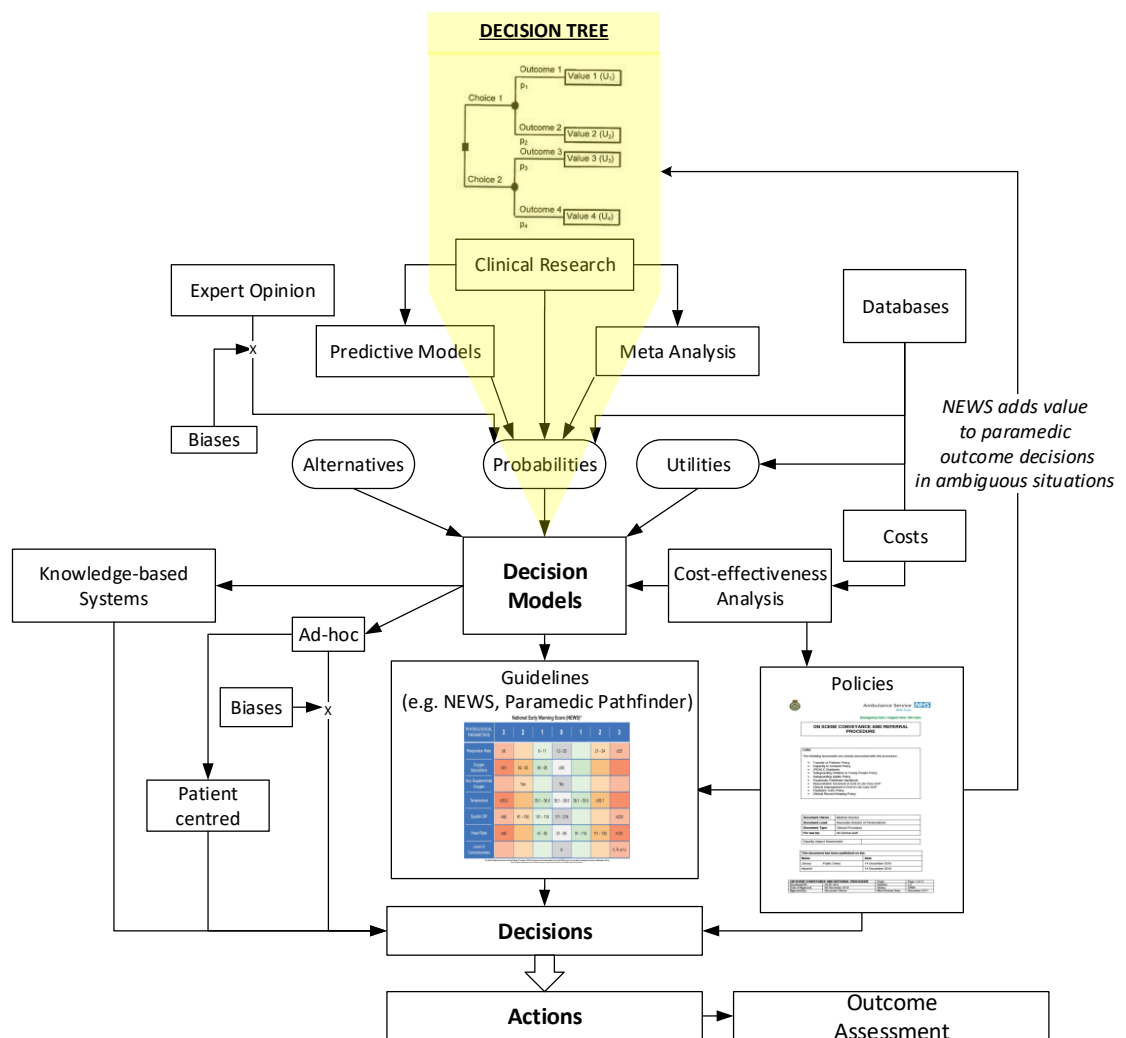
(Illustration adapted from Chapman and Sonnenberg, 2000, p.12 &, Roberts and Sonnenberg, 2000, p.26)

8.2.1 Decision modelling

Paramedics' conveyance decisions will be influenced by patient factors, aspects such as age, physical health and socioeconomic status, beliefs and attitudes (Ebrahimian et al., 2014a, O'Hara et al., 2014, Simpson et al., 2014, O'Cathain et al., 2018b). Cognitively, paramedics construct a variety of decision models (Figure 8.1, p.230), or mental representations pertaining to symptomology and potential diagnoses. The models are developed using a variety of methods including hypothetico-deductive reasoning (usually by those more experienced) or pattern recognition, where signs and symptoms observed are compared to conditions experienced previously (Croskerry, 2002, Mackway-Jones et al., 2013). Feasibility of each diagnosis may be determined by tests and assessments undertaken to provide a prediction of likelihood of that diagnosis being correct or incorrect; i.e. repetitive hypothesising and adoption of an informal Bayesian approach to decision-making (Croskerry, 2002, Mackway-Jones et al., 2013). Available heuristics (or rule of thumbs) related to the condition (e.g. prevalence of complaint) and how these relate to case profile (e.g. patients' medical history, current psycho-socio-physiological well-being, age, ethnicity and so on) may also be used to make rapid, 'intuitive' decisions and rule out worst case scenarios (Croskerry, 2002, Mackway-Jones et al., 2013). Paramedics' conveyance decisions will be framed around these models. The decision tree in Figure 8.1 (p.230) provides an illustration of this process.

However, it is estimated that 10-15% of diagnoses, made by clinicians, are incorrect, owing to cognitive biases linked to using heuristics (Croskerry, 2013). The use of the NEWS, at least initially, would support reflexive practice and 'decoupling'. Decoupling is a cognitive process where clinicians become more aware that their decisions are sometimes incorrect or inappropriate, and this raised awareness facilitates deliberate development of new mindware (mental rules, scripts, patterns and representations) that are stored and retrieved from memory at a later date when decision-making (Croskerry, 2013).

8.2.2   Lack of alternatives

Attached to each decision will be further sub-decisions, with attributed values that are evaluations relating to various treatments and care provision, and their availability. This would include an evaluation of the treatment needed, how quickly the treatment needs to be delivered, which care providers can deliver the treatment and whether they can deliver the treatment within the desired timeframe. For paramedics, this would involve utilising information relating to what is available at that time of day, on that day of the week, the distance the patient would need to travel to seek the treatment and the time it would take to get there.

As found in this case study, sometimes, the decision to convey is unequivocal, such as when a patient is seriously ill or injured and needs treatment, but when attending to patients with less urgent needs, reliable information related to ED 'alternatives' can be difficult to source. Ergo, it is unlikely the 'alternative' information will be sought and included in the paramedics' decision-model, because it is too effortful. Instead, decisions will be informed using their knowledge-base, formed from previous experience (Figure 8.1, p.230). So, if the paramedic has frequently been unable to access care, delivered by a local service provider, this information will add weight to their decision to convey to ED; where paramedics know the patient will be accepted 24-hours a day, seven-days a week. Others have previously highlighted the impact that inaccessibility to alternative care pathways can have on paramedics' conveyance decisions (O'Hara et al., 2014, O'Hara et al., 2015).

In 2014, NHS England released the Five Year Forward View strategy to encourage and support stakeholders with their review of existing emergency and urgent care provisions. The strategy discusses and defines future health care needs, and proposes several service delivery care models that would organise and simplify urgent and emergency care networks, enabling…

"...patients to get the right care, at the right time, in the right place, making more appropriate use of primary care, community mental health teams, ambulance services and community pharmacies, as well as the 379 urgent care centres throughout the country." (NHS England, 2014, p.21)

However, two years after the release of the proposed strategy, access to alternative care pathways remained difficult, time-consuming and disorganised. I found procedural and distributive injustices were compromising the equitability of care across the region; justice being one of the four principles of biomedical ethics that ensure care provisions are fairly distributed and accessible (Beauchamp and Childress, 2001). At the time, many WiCs were being closed or amalgamated with other services. Amalgamated services were often relocated and redefined as an UCC, or co-located within an existing ED (Monitor, 2014). In 2014, the region in England which this study was located (Region-X) had fewer WiCs per head of population than other regions nearby; Region-X = 2.2 centres per million residents, compared to Region-Y = 4.4 and Region-Z = 7.3 (Monitor, 2014).

Whilst thirteen centres were still in operation in Region-X, five had closed; one each in County2, County4 and County5, and two in County1 (Monitor, 2014). A further three centres were closed in the main city of County1 itself, which were subsequently replaced by one UCC (NHS [City in County1] North and East Clinical Commissioning Group, 2015). While no appointment was necessary, and a drop-in service was available 365 days a year, the service provided at the new centre was only available between 7am and 9pm.

Time restricted access was not unusual. Most MIUs and UCCs across the region were found to be unavailable after 9pm, Monday to Saturday, and 7pm on Sundays. Alternative care that was available 24-hours a day, was usually located at a main hospital offering services alongside the main Type 1 and Type 2 ED service provision, or at a downgraded hospital. For example, one general hospital located in the East of County3 and another hospital located in a university town in County5 had previously offered acute care (Type 1 or Type 2) at their ED, but these hospitals have been downgraded to a GP-led Type 3 or 4 facility.

Access to alternative care in the west of County3, had also been compromised because of a temporary night-time closure imposed at the local District Hospital; the hospital was closed between 6:30pm to 09:00am. The night-time closure came into place in August 2016 because of staff shortages and was expected to last just three months. In January 2018, the restricted hours were still in operation (Boles, 2018). In February 2018, the WiC in County3's main city centre was also closed (NHS [County3] West Clinical Commissioning Group, 2017). This left the paramedics located in Sector-2 with few options; they could attempt to book an appointment for their patient at the out-of-Hours service co-located at the main ED or take the patient to the ED themselves.

Even where alternative care pathways were available, patients with minor illnesses could be restricted from accessing services during the hours of general practice. For example, one UCC and another treatment centre in a town in County5 accept patients presenting with minor *injuries* from 08:30am to 9pm on weekdays, and 7pm at weekends and on bank holidays, but patients with minor *illnesses* are restricted from accessing services until after 5pm on weekdays (NHS [City in County5] Clinical Commissioning Group, 2018).

Having also explored out-of-hours pharmacy services across Region-X, only one Pharmacy in the main city of County1 offered a 24-hour service.[34] The latest opening times found in County2, County3 and County5 was midnight, and 11pm in County4 and County6.

In 2016, NHS England began funding the integration of pharmacy services into urgent care service networks, accessible to the public when they call NHS 111 or dial 999. One such service was integrated into the virtual clinical hub at a neighbouring ambulance service; the virtual clinical hub being akin to AMB-X's CAT. A paramedic, employed by the neighbouring ambulance service, proclaimed the support provided by the clinical pharmacist had given them the confidence in their decision to leave the patient at

---

[34] Out-of-hours pharmacy services were searched on NHS Choices webpage https://beta.nhs.uk/find-a-pharmacy/ searching by main 'town name' and Yell.com webpage searching for 'Find 24 hour pharmacy' by 'county' [Date searched: 20/02/2018]

home (NHS England, 2016). There was no clinical pharmacist employed by AMB-X at the time of this case study, but patients and paramedics could obtain medication advice via NHS 111; the NHS 111 contract was awarded in April 2016 to a social enterprise organisation and AMB-X consortium to provide NHS out-of-hours services for a number of the local clinical commissioning groups. Out-of-hours, the NHS 111 advisor could arrange a telephone call from the clinical team, which includes GPs, ECPs, Advanced Nurse Practitioners, Pharmacist Independent Prescribers and Mental Health Specialist Nurses. Following a recent change to existing legislation, from 2019, paramedics who have undertaken additional training will also be able to prescribe medicines themselves.

Nationally, variations in service provision have been found to be burdensome for paramedics and the…

> *'… sheer effort of making contact with a necessary service could result in a decision to convey to an emergency department because this was the easiest option.' (O'Cathain et al., 2018b, p.27)*

Non-conveyance was facilitated in areas where there was increased connectivity that enhanced collaborative working with the wider urgent and emergency care system (O'Cathain et al., 2018b). For example, the provision of a single point of access (SPA), responsible for locating and contacting alternative service providers on behalf of paramedics, was particularly supportive for those working in some ambulance services (O'Cathain et al., 2018b). However, other ambulance services considered SPA to be a hindrance, because the SPA service itself could not always be easily accessed because it was not reliably and consistently provided across the region (O'Cathain et al., 2018b).

8.2.3 Cost-effectiveness analysis

Nonmaleficence (do no harm) and beneficence (do good) are another two of the four ethical principles that need to be considered by healthcare providers to ensure the benefits of care or treatment provided outweigh the risk (Beauchamp and Childress, 2001, Collen, 2017). In this case study, those responsible for implementing the Paramedic Pathfinder Programme were mindful of the financial cost-effectiveness of

the interventions being implemented. This was because AMB-X was converting from a 'block contract' commissioning tariff (where AMB-X would be paid to provide and deliver a specified urgent and emergency care service across Region-X, regardless of the actual number of patients they attend), to the national incentivised tariff, where payment would be based on achieving specified results, i.e. reduction in number of patients being conveyed to ED. Financially, AMB-X would be paid approximately £100 more for every patient seen and treated closer to home, than those who were conveyed to ED. Organisationally, the additional funds and the reduction of inappropriate conveyance to ED would be beneficial to AMB-X and hospitals. A reduction in inappropriate conveyance to ED would also benefit patients, by improving patient-flow and expediting emergency care and treatment for those who needed it. However, the cost-consequence analysis undertaken by operational managers highlighted the Paramedic Pathfinder Programme could present some risk to patients, as the additional time needed on scene to access alternative care pathways would increase the risk of ambulance resources being depleted.

Similar risk-benefit evaluations are conducted by paramedics. Rightly or wrongly, paramedics not only consider the risk-benefits relating to the care delivered to their patients, but they also consider risks to themselves when making decisions (Snooks et al., 2005, Porter et al., 2007, Porter et al., 2008, O'Hara et al., 2014, O'Hara et al., 2015, Simpson et al., 2017, O'Cathain et al., 2018b). Decisions made to convey, can be influenced by the perceived risk of organisational reprisal and fear of investigation by regulatory bodies (Porter et al., 2007, O'Hara et al., 2014, O'Hara et al., 2015, Simpson et al., 2017). This can result in what some refer to as a *'you call, we haul'* approach to paramedic practice (Simpson et al., 2017). There was evidence from my case study that many paramedics still considered conveyance to ED to be the safer option for patients and paramedics alike. This might be being justified by differing thresholds of uncertainty associated with the various options (i.e., multiple alternatives bias), and/or considering worst case scenarios that drive paramedics' to make conservative decisions to maintain the status quo (Croskerry, 2002). However, it must also be borne

in mind that subjectively biased decisions to convey patients to ED can place patients at increased risk of infection.

8.2.4   Expert opinions

To refer to the outcome as being a paramedic's decision is a misnomer. Decision outcomes are generally a shared-decision, derived through discussion and agreement with patients and carers (Shaw et al., 2006). Like justice, nonmaleficence and beneficence, respecting patients' autonomy is another of the principles of biomedical ethics (Beauchamp and Childress, 2001). From a legal perspective, if the patient has demonstrated they have mental capacity to make an informed decision, the paramedic cannot implement a decision against the wish of that patient; irrespective of the 'wants' and 'wishes' of relatives or carers (Clarke et al., 2012). Whilst some patients may have their mind set on going to hospital, many would prefer to remain at home because it is less stressful (O'Hara et al., 2014). Patients with care responsibilities may request an ambulance for themselves, as a means of acquiring an immediate response to expedite their recovery, enabling them to resume their care responsibilities as soon as possible (Booker et al., 2014). Patients preferences may not always align with what the paramedic believes is appropriate, but unless the paramedic is successful in negotiating and persuading them otherwise, the paramedic can have little option than to concede (Snooks et al., 2004, Snooks et al., 2005, Porter et al., 2007, O'Hara et al., 2014).

I found non-conveyance decisions made by patients can be influenced by perceived delays or difficulties at hospital. Similarly, there is a higher likelihood of patients being conveyed to ED if paramedics believe patients can be off-loaded immediately, whereas delays or difficulties at ED will increase the likelihood of paramedics seeking care via alternative pathways (Simpson et al., 2017). Whilst not necessarily experienced on every occasion, difficulties during handover and poor interpersonal relationships between paramedics and hospital staff does occur (Bruce and Suserud, 2003, Bruce and Suserud, 2005, Dojmi Di Delupis et al., 2014). Clinical handovers can be particularly difficult and arduous when patients present with non-specific ambiguous complaints

(Bruce and Suserud, 2005), those being the very circumstances in which paramedics proclaim they are most likely to use the NEWS. However, on the few occasions when the NEWS had been used and documented by the paramedics in this case study, and they tried to access alternative care, the NEWS was disregarded by the nursing staff and the decision resulted in reproach; despite the decision having been made in accordance with the NEWS. Criticism such as this, can lead to cynicism, thus there is a perchance that the NEWS will be considered non-beneficial and similarly disregarded by paramedics in the future.

HCPs not only have the potential to influence NEWS usage, but they can also influence paramedics' conveyance decisions. For instance, conveyance rates were found to be 14% higher for emergency calls requested by a HCP than from the public (O'Cathain et al., 2018b). Amador et al. (2014) found three quarters of patients residing in residential care, that were attended to by ambulance at the request of a GP, were conveyed to ED, of which a third were discharged from hospital the same day. Whilst paramedics attending to patients residing in monitored care facilities may feel more reassured with decisions not to convey (O'Hara et al., 2014), Simpson et al. (2014) found such patients were twice as likely to be conveyed. This may be because paramedics consider ambulance attendance requests made by another HCP to be a 'red flag', which add weight to their decisions of a potential risk, regardless of the NEWS and other information which may indicate conveyance to ED unnecessary. However, as I found in this case study, conveyance to ED can often occur because of the pressure exerted on paramedics, by nursing staff, who themselves were following their own organisation's policy (Simpson et al., 2014).

8.2.5 Guidance and policies

Paramedics who participated in this case study, found the NEWS most effective and useful when they were uncertain whether to convey or treat the patient closer to home. The NEWS would then be calculated and used to add weight to one or other of the options being considered. Its usefulness could still be outcompeted by other tools, considered by the paramedic to be more appropriate for confirming a specific

diagnoses and outcome they already had in mind. There are also instances where using the NEWS to inform a decision is considered unnecessary, such as when attending a patient who is having a heart attack or having a stroke. Then paramedics are expected to refer to other guidelines and local policies to determine which definitive care pathway is most appropriate. However, as I found, it can sometimes be difficult to discern whether a patient is experiencing traumatic or non-traumatic chest pain, or whether a patient is unable to speak clearly and coherently because they have experienced a transient ischaemic attack or are merely anxious.

A previous review found ambulance clinicians complied just 60% of the time to non-transport guidelines (Gray and Wardrope, 2007). This may be because different organisational policies and procedures place paramedics in a paradoxical situation. Paramedics are aware of operational demands, and the organisational policies and performance measures in place to minimise time spent at scene, and the need to minimise conveyance, but to appropriately assess and instigate onward care for patients not being conveyed can be complex and time consuming (O'Hara et al., 2015). Conveyance to ED can therefore become the default decision because it is the quicker and easier option (Snooks et al., 2005, O'Hara et al., 2014, O'Hara et al., 2015).

Protocols can precipitate opposite or alternative effects to that intended. For example, the evidenced lack of compliance and non-adherence to AMB-X's on scene conveyance policy, may have been an act of revolt by paramedics, out of fear of losing personal autonomy. Alternatively, rather than being antagonistic act of protest, it may have been a defensive move, a means of protecting their professional identity. Paramedics can become frustrated when attending to patients with minor injuries and ailments because this makes them unavailable for more serious jobs, what Simpson et al. (2017, p.6) refers to as 'real paramedic work'.

> "…we're supposed to be doing the acutely unwell patients… we want to be available for that stuff." (Quote from paramedic interviewed by Simpson et al., 2017, p.6)

Some paramedics, interviewed by other researchers previously, believe the provision of protocols, like AMB-X's on scene and referral policy, provided them with greater personal protection not to convey (Snooks et al., 2005). Conversely, Simpson et al. (2017) found protocols such as these, provoked mistrust in the organisation, and subsequently paramedics were more likely to convey. Similarly, nurses clinical judgement of risk were found to have been more greatly influenced by the protocol than the Early Warning Scores themselves, which led to over-triaging (Thompson et al., 2009). There is however more evidence to suggest that most of the time neither scores nor associated protocols are adhered to by clinicians (Shearer et al., 2012, Hands et al., 2013, Niegsch et al., 2013, Martin, 2015, Odell, 2015).

Various reasons were given for the lack of compliance, including 'abnormal was normal' for that patient, or the patient appeared well despite having abnormal vital signs (Niegsch et al., 2013). Sometimes the patient had been given treatment but nursing staff were waiting to see what effect that would have before escalating care (Niegsch et al., 2013), or nurses believed the situation was under control and further treatment and/or referral was deemed unnecessary (Shearer et al., 2012, Martin, 2015). Hour of the day (e.g. in the middle of the night (Hands et al., 2013)) and day of the week (e.g. weekends (Odell, 2015)) were also found to be influential.

8.3   The NEWS and the individual's decision-making process

I have discussed socio-cultural, organisational and environmental influences that may facilitate or inhibit the NEWS from being useful and effective. Using Reason's (2009) generic decision and error model, I will now explain how and why the NEWS is, or is not used by individuals and reasons that impede its effective and accurate application.

8.3.1 Skill-based decisions

Figure 8.2: Generic decision & error model
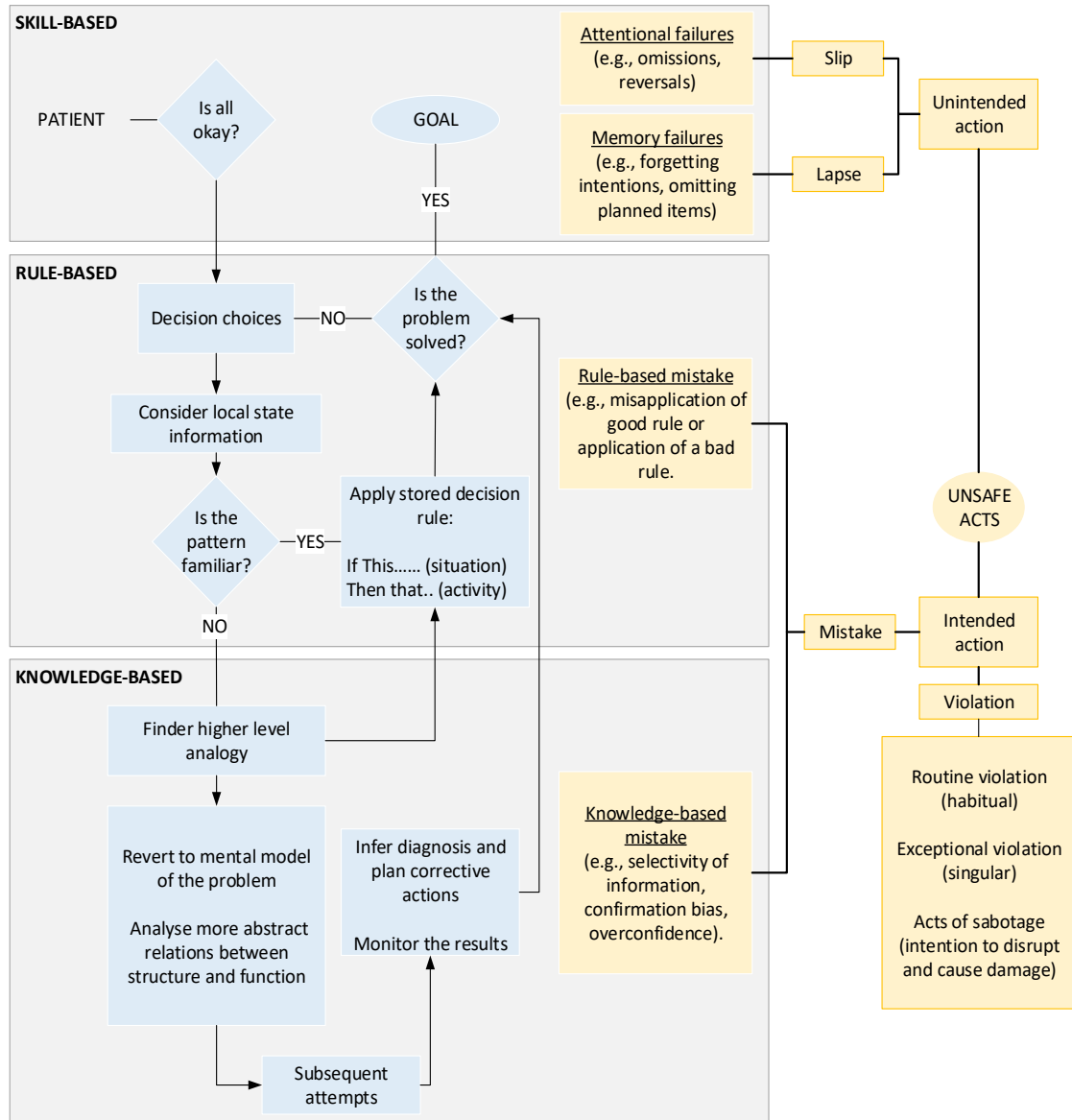
(Illustration adapted from Reason, 2009, p.64 & p.207)

Reason's (2009) model distinguishes decision-making into three levels, those being-skill-based, rule-based and knowledge-based decisions (Figure 8.2**Error! Reference source not found.**, above). Skill-based decisions are those made in familiar situations, where paramedics are provided with a simple, unambiguous well-presented task and many pertinent or predictable cues (Reason, 2009). Skill-based decisions are made

quickly, with minimal conscious effort and are based on intuition or made quasi-rationally, using common-sense and pattern-recognition from previous experience (Rasmussen, 1983, Reason, 2009). The NEWS was often not used to formulate a decision at this level, because paramedics felt it unnecessary; e.g. when assessing patients with minor ailments or illnesses, or those who obviously needed to be conveyed. Even when the NEWS was used in such circumstances, errors were found to have occurred.

Skill-based errors include unintentional slips and lapses, such as forgetting to document the physiological measures or the NEWS on the patient report form, or writing the wrong measure in the wrong field, e.g. heart rate written in respiratory rate field and vice versa. The latter is referred to as a reversal error, and were evidenced to have occurred in this case study, and may also have occurred in the study conducted by McClelland (2015); as highlighted in Chapter 2, section 2.5.8, p.72.

Omissions and recording errors have been evidenced previously in both the hospital and prehospital setting (e.g. Prytherch et al., 2006, Smith and Oakey, 2006, Ebrahimian et al., 2014b, McClelland, 2015). Skill-based errors can lead to delayed and inappropriate decisions, and/or erroneous activation of associated protocols (Prytherch et al., 2006). Such errors were considered to be a primary reason of why EWS systems failed to be effective (Odell, 2015). The Paramedic Pathfinder Leads at AMB-X had acknowledged the patient report forms needed to be modified to act as prompts and to minimise errors. However, there was also evidence that the NEWS was purposefully omitted by paramedics in some instances, this is a violation error and is discussed in more detail below.

8.3.2   Rule-based decisions

Rule-based decisions are those made using stored rules, derived empirically from previous personal experience and those learned from others, or dictated by policy and guidelines (Rasmussen, 1983). They are used in familiar situations and often follow an 'if-this-then-that' action scenario (Rasmussen, 1983, Reason, 2009). An 'if this' situation may be represented by red flags, signs and symptoms or a NEWS of a certain

score. The 'then that' situation would be actions defined by associated guidelines, protocols and training. For example, 'if' a patient elicits a red outcome on Paramedic Pathfinder (i.e. a NEWS >4), 'then' the patient should be conveyed to ED or a suitable treatment centre (AMB-X NHS Trust, 2015a, p.6, section 7.2). These system-aided decisions, lie between intuition and analysis on the cognitive continuum (Hammond, 1980, Hamm, 1988). The rules can be used to support intuitive skill-based decisions, as well as knowledge-based decisions which are made more analytically.

Whilst some paramedics claimed the NEWS would be readily adopted because paramedics are used to working with algorithms, it appeared that few paramedics had fully integrated the NEWS into their rule-base. Instead the NEWS would often be over-ruled or disregarded in favour of other pre-existing or better fitting rules. So for example, a NEWS ≥5 is a red flag for sepsis (Royal College of Physicians, 2017), yet some paramedics stated they still preferred using red flags, than using the NEWS, suggesting the NEWS was not considered to be a red flag in its own right. Other red flags associated with sepsis, would subsequently be given precedence over the NEWS. This may be because the original prehospital sepsis rules did not include an aggregated NEW score, just the associated vital signs. Thus, it could be inferred that the clinicians' rule-base and/or (expert) knowledge-base had not been updated; that is, the NEWS had not yet been added to their 'sepsis' rules. The NEWS rule may also have been poorly structured, and being unfamiliar and unskilled in its application, paramedics are more likely to opt and use another organising principle (e.g. other red flags) or revert to using an intuitive approach (Hammond, 1980, Hamm, 1988).

8.3.3   The impact of tool design on decision rules

Paramedics found using the NEWS to assess patients with complex conditions (such as COPD) increased task ambiguity and workload. This was because of a poorness of fit between the NEWS, the patients' condition and policy. No direct guidance was provided for COPD, until two years after the NEWS was introduced at AMB-X. The revised policy included a newly developed Paramedic Pathfinder algorithm, specifically

for COPD, that made no reference to the NEWS (AMB-X NHS Trust, 2016, p.9 section 10.8). Thus, the NEWS was indirectly excluded from use in this context.

The poorness of fit between the NEWS and the task related specifically to the measurement of oxygen saturation. A low oxygen saturation between 88%-92% is within the expected range for a patient with hypercapnic respiratory failure (i.e. COPD). Using the NEWS in this circumstance would however trigger a high NEW score that often led to inappropriate decisions and treatment when the previously recommended procedures were followed (Royal College of Physicians, 2017). Unless more effort was invested, the NEWS did not provide paramedics with an appropriate organising principle or improve the accuracy of their decisions. As time would often be of the essence in such circumstances, clinicians were more inclined to use their intuition and disregard the NEWS entirely.

The poorness of fit between the NEWS and the task of assessing patients with hypercapnic respiratory failure was acknowledged by the RCP. The NEWS, trigger thresholds and recommendations have subsequently been revised and the NEWS2 was introduced in 2017 (Figure 8.3, p.245).

The Royal College of Physicians now advise that …

> *'A competent clinical decision-maker should make the decision about whether to use the scale 2 oxygen saturation section of the NEWS chart, which is specific to patients with hypercapnic respiratory failure (usually COPD) who require their 'usual' oxygen saturations to be set at 88-92% in accordance with BTS guidelines.' (Royal College of Physicians, 2017, p.31)*

Whilst these revisions reduce ambiguity and improve the accuracy of the NEWS in COPD, the availability of the organising principle still needs to be considered. I found the pocketbook guidelines provided were never used, either because the paramedic did not have them on their person, or out of pride. Where the NEWS had been documented, it had been calculated from memory. This led to scores being inaccurately calculated, particularly in instances where physiological measures were borderline between two score thresholds (i.e. error in categorical recall). Such errors

are referred to by Reason (2009) as mistakes, and are often difficult for the individual themselves to detect.

Figure 8.3: Revised NEWS tool and trigger thresholds

Physiological parameter	Score						
	3	2	1	0	1	2	3
Respiration rate (per minute)	≤8		9–11	12–20		21–24	≥25
SpO$_2$ Scale 1 (%)	≤91	92–93	94–95	≥96			
SpO$_2$ Scale 2 (%)	≤83	84–85	86–87	88–92 ≥93 on air	93–94 on oxygen	95–96 on oxygen	≥97 on oxygen
Air or oxygen?		Oxygen		Air			
Systolic blood pressure (mmHg)	≤90	91–100	101–110	111–219			≥220
Pulse (per minute)	≤40		41–50	51–90	91–110	111–130	≥131
Consciousness				Alert			CVPU
Temperature (°C)	≤35.0		35.1–36.0	36.1–38.0	38.1–39.0	≥39.1	

NEW score	Clinical risk	Response
Aggregate score 0–4	Low	Ward-based response
Red score Score of 3 in any individual parameter	Low–medium	Urgent ward-based response*
Aggregate score 5–6	Medium	Key threshold for urgent response*
Aggregate score 7 or more	High	Urgent or emergency response**

* Response by a clinician or team with competence in the assessment and treatment of acutely ill patients and in recognising when the escalation of care to a critical care team is appropriate.
**The response team must also include staff with critical care skills, including airway management.

(Royal College of Physicians, 2017, pp.29-30)

8.3.4 Knowledge-based decisions

Knowledge-based decisions are those made towards the analytical end of the cognitive continuum, and are slower, more effortful and complex than skill and rule-based decisions (Rasmussen, 1983, Reason, 2009). Such decisions require the individual to undertake a higher level of conscious problem-solving, which involves seeking additional knowledge, evidence or information to develop mental models and various action plans (Rasmussen, 1983, Reason, 2009).

The NEWS was considered most useful in such circumstances where paramedics were uncertain what they should do and had no plan of action in mind. This corresponds with the evidenced-based decision-making theory proposed by Thompson et al. (2004), who claimed nurses needed a motive to seek further information or evidence to support their decision-making, the primary motive being a need to bridge a gap in their expert knowledge (e.g. no pre-existing rule). Having sought and obtained the evidence (e.g. a NEWS) they would critically appraise it and if deemed valid, would incorporate the evidence into a strategy for action (Thompson et al., 2004). However, in real-time context this approach was rarely used, and instead nurses relied on intuition or sought information from colleagues, and would only seek the evidenced-based information after the event (Thompson et al., 2004). Information selectivity is a knowledge-based error and is caused by the limitations of human conceptualisation (Rasmussen, 1983, Reason, 2009). It is a tactic adopted to simplify the cognitive process and can include not seeking or referring to the information in the first instance, and instead relying on intuition and pre-existing rules that are easily recalled. These factors need to be considered, because paramedics are constrained by time, they rarely have a copy of the NEWS tool on them, and they are unable to easily access evidenced-based information, or information from peers in real-time, thus their decisions may be particularly prone to error.

Errors associated with knowledge-based decision-making are confirmation bias and overconfidence (Reason, 2009). Confirmation bias occurs when a preliminary hypothesis or decision has been formulated early in the process, which interferes with

the interpretation of any subsequent data gathered (Reason, 2009). This equates to trusting one's gut instinct (intuition) and just using the NEWS as back-up, as was the proposed practice of some of those interviewed in this study. Overconfidence is the tendency to justify one's own decision by only using evidence that corroborates that decision and disregarding other data (Reason, 2009). Whilst some paramedics claimed they would re-evaluate their decision when necessary, others suggest the NEWS would be manipulated or disregarded if it did not align with a predefined outcome. Smith and Oakey (2006) had found similar behaviour by nurses previously. Intentional disregard and non-compliance to the NEWS, according to the non-conveyance and referral policy, would equate to a violation. Such behaviour are precipitated by the human tendency to take the path of least effort and an organisation that neither punishes deviance, nor rewards observance (Reason, 2009).

Whilst there was evidence of habitual violations, I believe the lack of compliance evidenced in this case study was more the result of other pre-existing rules being mistakenly used in favour of the NEWS; merely because these rules were cognitively stronger and therefore more easily recalled to mind. I would argue the cognitive strength of the NEWS is being compromised by factors limiting its usefulness in the prehospital setting; factors such as the lack of alternative care pathways and the lack of awareness, understanding and use by other HCPs which are inhibiting the NEWS from being used by paramedics. Consequently, paramedics remain unskilled and unfamiliar with the tool. Until the NEWS becomes firmly integrated and embedded into paramedic practice, paramedics' mindware will not be updated, subsequently the NEWS will be outcompeted in their decision-making process by the paramedics' own clinical intuition and/or other stronger, more dominant rules. But, for the NEWS to become embedded, its utility must be rewarded. Currently, this is being compromised by a lack of coherence between health care providers and lack of accessibility to alternative care pathways. Principally, the poor uptake of the NEWS found in this study was due to a lack of integration in health care services (Figure 8.4, p.248).

Figure 8.4: Root-cause – 5 whys analysis

```
┌─────────────────────────────────┐
│            EVIDENCE:            │
│      Lack of uptake of the NEWS │
└─────────────────────────────────┘
                │
             1. WHY?
                │
                ▼
┌─────────────────────────────────┐
│   Because: NEWS rules/scripts   │
│   are outcompeted by other      │
│   pre-existing rules/scripts    │
└─────────────────────────────────┘
                │
             2. WHY?
                │
                ▼
┌─────────────────────────────────┐
│   Because: NEWS is used less    │
│   frequently than other scripts,│
│   as a consequence they are     │
│   less easily recalled to mind. │
└─────────────────────────────────┘
                │
             3. WHY?
                │
                ▼
┌─────────────────────────────────┐
│   Because: The use of NEWS is   │
│   not rewarded                  │
└─────────────────────────────────┘
                │
             4. WHY?
                │
                ▼
┌─────────────────────────────────┐
│   Because: There is a lack of   │
│   coherence with other health   │
│   care providers and lack of    │
│   accessibility to alternative  │
│   care pathways                 │
└─────────────────────────────────┘
                │
             5. WHY?
                │
                ▼
┌─────────────────────────────────┐
│   Because: Lack of integration  │
│   in health service provision   │
│   and delivery                  │
└─────────────────────────────────┘
```

8.4 Summary

In this chapter, I have used Normalization Process Theory (May et al., 2015) to illustrate how there was a lack of socio-cultural infrastructure needed to support the NEWS from becoming embedded and normalised into everyday clinical practice. Whilst paramedics were initially willing to engage with the NEWS, the lack of shared investment by other key stakeholders compromised how the NEWS was used and appraised. Subsequently, the initial effort invested by paramedics, to use the NEWS, was not sustained. There was a need for all stakeholders to work together more collectively to achieve a common goal.

Chapman and Sonnenberg (2000) scheme of clinical decision-making provided a conceptual framework to explain how paramedics model their decisions and use a wide-range of information to inform, evaluate and confirm their decision models. Using the framework, I have been able to depict where the NEWS fits in this process. That is, a NEWS will be used to add weight to a model, which can be useful in equivocal circumstances. I have also illustrated how the NEWS can be outcompeted by other information or bypassed entirely, for example when paramedics believe there is no valid alternative care pathway.

The generic decision and error model developed by Reason (2009) provided a conceptual framework to explain compliance, that is how and why the NEWS was being applied or misapplied at the 'individual' level. Using this framework, I have shown how unequivocal decisions are skill-based decisions, and rather than using the NEWS, paramedic form a decision intuitively, or quasi-rationally using previous experience. Documentation errors, where physiological measures are not documented or are entered in the wrong field, are unintentional skill-based errors. The NEWS would be used to support rule-based and knowledge-based decision. Such decisions are more systematic and analytical than a skill-based decision, which can lead paramedics to make mistakes or violate rules. Instead of using the rules associated with the NEWS to inform their decisions, paramedics use other pre-existing rules that are easier to recall or deemed to be more appropriate. The cognitive strength attributed to the NEWS and

its ability to be recalled, is being weakened by its lack of utility in the prehospital setting.

The lack of adoption of the NEWS into everyday clinical practice would seem to have been hindered by a lack of supportive and integrated infrastructure. Until there is a shared understanding and agreed purpose for the NEWS, that ensures the benefits of the NEWS can be achieved system-wide, then it is unlikely paramedics will effectively use the NEWS to support their clinical practice and decision-making.

9   Reflexivity

In this chapter I reflect on my research. This includes a reflection on the strengths and limitations of the methodology I adopted, the data I collected, the analysis methods I used and how I personally, may have influenced the results. Finally, I offer some suggestions for future research and recommendations for those considering implementing the NEWS in the prehospital setting.

9.1   Methodology

When I began my preliminary research in 2011, the NEWS had not been released. Instead, I was evaluating the MEWS developed by Gray et al. (2010) and how it supported paramedics' decision-making (see Chapter 3, section 3.7, p.115). The following year the Royal College of Physicians released the NEWS, and recommended it be used NHS-wide; even though there was still a lack of evidence to support the reliability, validity and utility of track-and-trigger systems like the NEWS in the prehospital setting.

Whilst I had always intended using a pragmatic methodology and mixed methods, the methods used had to be modified, because of the changes that began to be implemented at AMB-X. For instance, I had originally intended conducting a cluster randomised control trial (C-RCT), argued to be the scientific gold standard method of assessing whether an intervention is effective (Robson, 2011). This would have meant recruiting a self-selected sample of paramedics at AMB-X, and then randomly allocating their base stations into either the intervention or control group arm; each group arm forming a cluster. The paramedics, who worked from stations randomly allocated to the intervention group arm, would then have been taught the relevance of the NEWS, how to calculate a score and how to use the NEWS to support their decision-making process. However, in 2013, my research was put on hold and was substantially delayed, because AMB-X began planning on introducing Paramedic Pathfinder and the NEWS trust-wide. This highlights the transitory nature of healthcare delivery and conditions of conducting research in the real-world setting.

I revised my research protocol according to AMB-X's plans and instead of conducting a C-RCT, I decided to conduct an ITS analysis using trust-wide data. It was necessary to include a quantitative measurement of decision outcomes, as a reduction in inappropriate conveyance to ED was a primary reason for the implementation of the Paramedic Pathfinder Programme. The quantitative method adopted enabled me to objectively measure and determine there was no significant difference in non-conveyance or recontact rates after the NEWS was introduced, compared to before. However, had I used quantitative methods alone then I believe the quality of my research would have been compromised. I had acknowledged from the outset that it would be impossible to infer from quantitative analysis alone, the effect the NEWS may have had on these measures. Not only because this was an uncontrolled quasi-experimental study conducted in the real-world context, where a wide-range of external factors would influence paramedics' decisions, but also because the NEWS had now been implemented in conjunction with Paramedic Pathfinder. Qualitative methods were therefore also adopted to provide greater insight.

By using qualitative methods, I have been able to provide original and thought-provoking insight of the complex utility of the NEWS in the prehospital setting that would not have been achieved if quantitative methods had been used alone. I have shown how the NEWS can be more effective and useful in some circumstances and not others, and why this might be, and the potential errors and violations that can occur at an individual level that can compromise effectiveness. I have provided insight of how socio-cultural influencing factors can help and hinder the NEWS from becoming adopted, embedded and normalised into clinical practice. Plus, I have highlighted the importance of continued investment by everyone, from those working at the frontline through to those providing and commissioning services, for the effectiveness of NEWS to be achieved and sustained. Overall, using mixed methods enabled me to successfully achieve my research aim and objectives.

9.2 Strengths and limitations of quantitative study

9.2.1 Data collection

I had carefully considered which data would be most appropriate to achieve my research aim and objectives, as collecting data for time series analysis can often be difficult and time consuming (Robson, 2011). Initially I had collected a combined sample of data sourced from e-PRFs (i.e. emergency care summary, or ECS data) and data sourced from the Emergency Operations Control room (i.e. computer aided dispatch system, or CAD data set). The combined ECSCAD data provided a wide-range of data, by day-of-the-week and time-of-day, including patient demographic information, such as age, sex, physiological measures and clinical complaint; AMPDS code; an auto-calculated NEWS based on physiological measures entered by the paramedic; and incident outcome, e.g. whether they were conveyed or not, and the type of facility where they were conveyed or referred to.

The original plan had been to capture data covering a 12-month period either side of the period of implementation; Pre-NEWS: April 2013 to March 2014 and Post-NEWS: April 2015 to March 2016 - the period of implementation being April 2014 to March 2015. However, there was a risk that the NEWS would not have been embedded in this timeframe as only 60% of staff had been trained to use the NEWS by April 2015 (see Figure 4.7, p.136). I therefore had several options to consider.

The first option was to conduct the analysis as planned, to see if a critical mass of adopters had been achieved and a subsequent tipping point of change had occurred. According to Xie et al. (2011), changing the minds of just 10% of the staff could have been sufficient for a wider effect of change to become evident (i.e. the tipping point). Conversely, there was a risk that changes to clinical practice may still have been too dilute to detect.

The second option was to time-shift the period to be analysed; i.e. Pre-NEWS: August 2013 to July 2014 and Post-NEWS: August 2015-July 2016. This would have imposed

an eight-month delay to my project plans, but more problematic was the use of the electronic ToughBook was in decline.

The ToughBook (a rugged laptop) was first introduced at AMB-X in 2009. Paramedics use it to access the ECS software necessary to create the e-PRF. Most paramedics had been reluctant to adopt the ToughBook system. This was because the poor connectivity (via the mobile emergency communications network) made the task too time-consuming. AMB-X managers had to continuously drive usage, but the driving-force had begun to wane, as the contract with the software provider was due to expire in 2016 and was not planned to be renewed. This had not only resulted in a decrease in the data available Pre-NEWS compared to Post-NEWS (Figure 9.1 below), but there was now an added risk that there would be no data to analyse beyond March 2016. This option was therefore deemed non-viable.

Figure 9.1: An illustration of the decline of use of Emergency Care Summary (ECS)
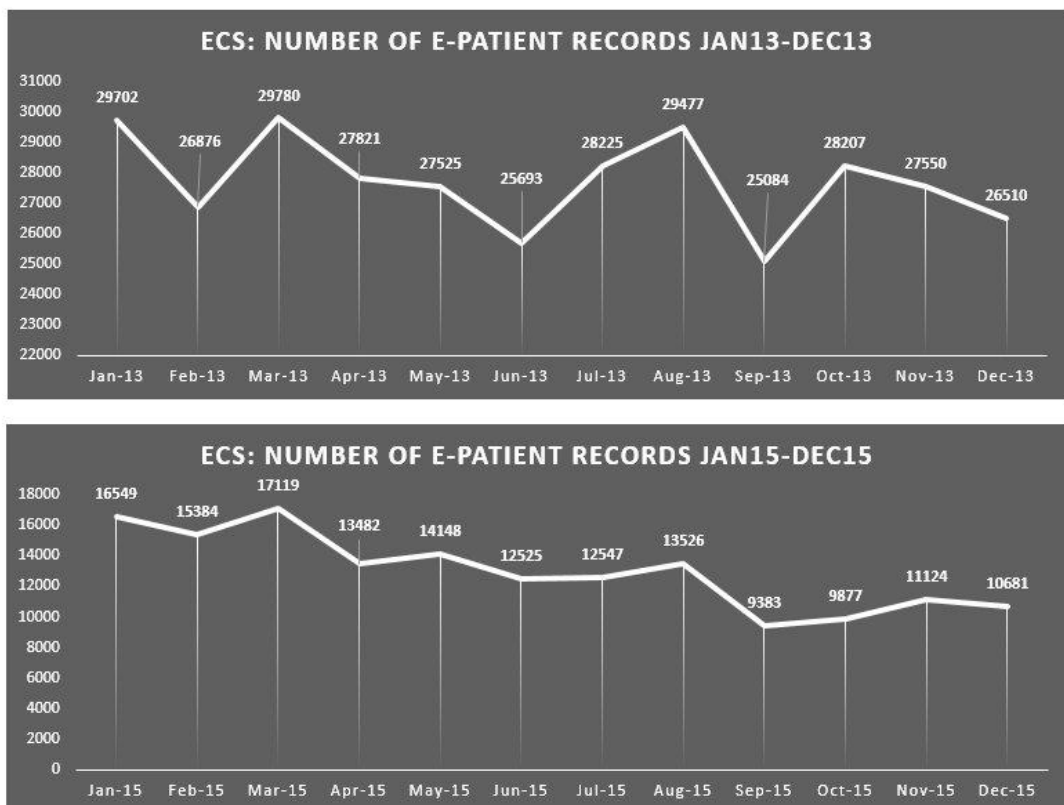
The third option was to abstract a smaller random sample from data already sourced; e.g. 9,000 records per month October to March 2013/14 and October to March 2015/16. The advantage of using data from this period was most staff would have been trained. It would have also captured a high incidence of Ambulatory Care Sensitive conditions, such as COPD during the autumn period, and influenza over the winter months. These are conditions that according to Tian et al. (2012) should be managed effectively closer to home. The main disadvantage was these are months which would include 'winter pressures', where the NHS implement other operational strategies to help manage increases in demand. Such strategies may have influenced the outcomes being measured.

The fourth and final option was to extend the period to ensure all staff had been trained, and to source AQI data from NHS England. These data sets used (see Chapter 3, section 3.5.1, p90) were in the public domain and provided outcomes for *all* patients attended across the whole trust. The key disadvantage being these data sets did not contain the same level of variable richness as the ECSCAD data, e.g., variable information relating to patient demographics and geographical information relating to outcome. There would also be a delay of six to eight-weeks to access the data, as it took this length of time for the data to be validated by AMB-X and NHS England. Nevertheless, this was considered the best option and was subsequently selected.

9.2.2   Internal validity

AQI data relating to patient recontact rates were analysed in this study as a means of comparing and assessing the appropriateness of the decisions made. There were however a couple of problems with using AQI data as a measurement of quality and safety. Firstly, the data were not patient specific, as the information captured is based on a call to attend a patient, of the same sex, at the same address (O'Cathain et al., 2018b). So, all calls received within 24-hours of attendance to an address with multiple residents (e.g. a nursing home or rest home) would be included in this data set. Secondly, some individuals may call for an ambulance frequently and decisions made not to convey may have been made appropriately; e.g. a frequent faller who only

requires assistance to get up. Therefore, rather than using this AQI measure, ambulance managers tend to assess quality and safety, on numbers and type of serious untoward incident reports and formal complaints received (O'Cathain et al., 2018b). As I was not directly privileged to this information, I did make enquiries during the interviews with Paramedic Pathfinder Leaders. In addition, O'Cathain et al. (2018b) had found from their research, that patients who did recontact, generally did so because they had expected to be transported to ED initially, rather than because their condition had deteriorated. They also reported that most of the ambulance service related deaths in England, approximately 50 per year, were because of delayed ambulance responses, rather than non-conveyance decisions (O'Cathain et al., 2018b).

Those considering conducting a similar study are also recommended to carefully consider the time points captured by the PRE-POST regressor dummy variables. In this study I considered the advantages and disadvantages of creating dummy variables that would evaluate outcomes bimonthly, quarterly and six-monthly. This is because the method of grouping data can have an impact on statistical significance (Garavaglia and Sharma, 2016). I did consider analysing the data quarterly but concluded this would be less optimal than bimonthly, primarily because of the time-shifting impact of some ambulatory care-sensitive conditions, such as influenza. Figure 9.2 (p.257) illustrates the variation in numbers of confirmed hospital admissions throughout the influenza season. From my rudimentary analysis, it appeared some years the influenza seasons can be much shorter than others, the average being approximately 27 weeks, but ranging from 14 weeks to 33 weeks. Most years, the influenza season begins in October, around week 40, give or take a few weeks. However, there are years when incidences will still be increasing, whereas at the same timepoint in other years, they had peaked and were decreasing. For instance, in 2014/15, GP consultations for influenza like illnesses peaked in January 2015, whereas in 2015/16, consultations peaked in March 2016 - approximately ten weeks later than the previous year (Public Health England, 2017).

Figure 9.2: Weekly numbers of influenza confirmed hospital admissions 2010-2017
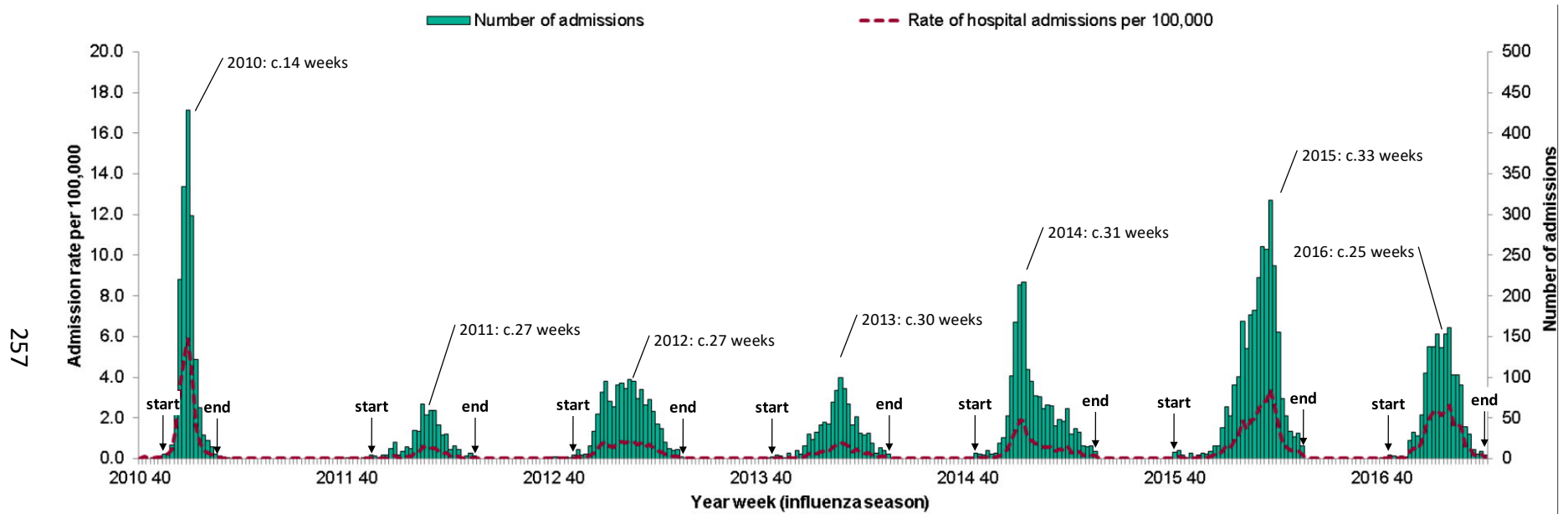
(Adapted from Public Health England, 2017, p.21)

9.2.3 External validity

Using the AQI data set provided a measure of the outcomes for the regional population rather than just a sample. However, the generalisability nationwide would still be limited because of other factors; such as, variations in population demographics, operational demands, NHS delivery and accessibility to services. Had the analysis been conducted using the ECSCAD sample data set, as originally planned, then a better understanding could have been achieved of how other factors may have influenced paramedics' decisions (e.g. patients age, sex, time of day). A national study of ten ambulance services in England found patients treated closer to home were more likely to be adults, to be male, to have fallen, to have made a 999-call out-of-hours, to live in an area of social deprivation and to have been triaged as a Green response, i.e. a non-emergency call (O'Cathain et al., 2018a, p.iii). Whilst it was not possible for me to provide similar understanding using the AQI data, the observation sample, though small, does provide some insight.

9.2.4 Reliability

As a consequence of the study conducted by O'Cathain et al. (2018b), the reliability of the AQI data was called into question by NHS England. Variations were identified in how ambulance services were interpreting NHS England's guidance of what calls to include in certain AQI data sets (e.g. to include or exclude NHS 111 calls (O'Cathain et al., 2018b)). Like other services, AMB-X had been including NHS 111 calls in their 999-call data, which should have been excluded. This had an impact on my quantitative study, as I had originally analysed all 999-calls received and their outcomes (which included Hear & Treat calls) and not just the outcomes of those attended. Once the error had been identified, AMB-X had to re-validate and re-submit their data for the previous year. This led to a significant level shift in April 2015, in the numbers of 999-calls being received (Figure 9.3, p.259). I therefore had little option than to narrow the focus of my analysis to include See & Treat calls only and associated outcomes. The analysis of Hear & Treat calls was nevertheless useful in providing an explanation for downward level shift of non-conveyance rates that occurred in 2015.

Figure 9.3: Numbers of 999-calls received at AMB-X
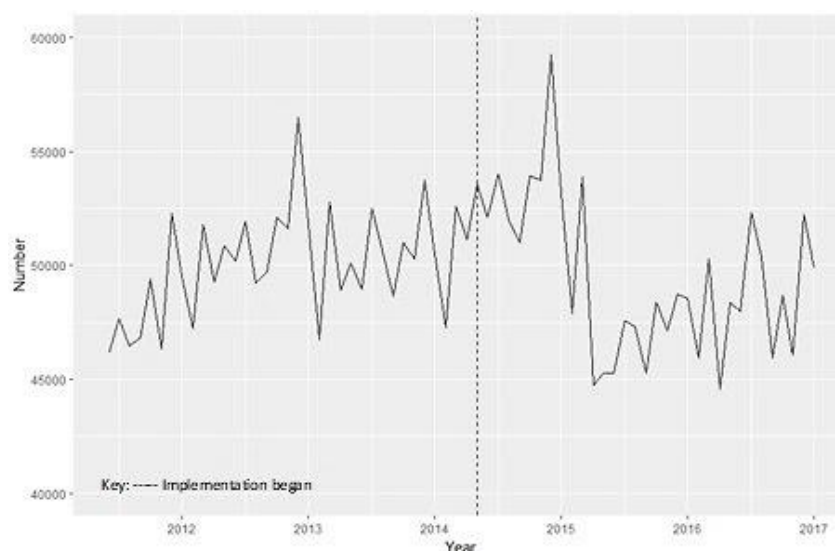
9.2.5   Replicability

A strength of quantitative data is that it is precise, reliable and the analysis is replicable, but as discussed above, the consistency, precision and reliability of data cannot always be assured, even though in this instance the collection methods were defined and administered by executive public bodies on behalf of the Government. Added to this, a clinical coding review[35] of AMPDS codes and review of AQI[36] led to new system indicators being introduced. From August 2017, all variables measured and analysed in this study would either be non-comparable or no longer available for future studies (see Kay, 2017, pp.2-4).

9.2.6   Quality criteria for ITS

Despite the issues discussed, my research fulfilled all but one criterion of the quality criteria, specified by Ramsay et al. (2003), for ITS designs (Table 9.1, p.260).

---

[35] Ambulance Response Programme (ARP) Phase 2: The Clinical Coding Review (CCR) was piloted in 2016 and rolled out to all Trusts in 2017. Instead of calls prioritised as Red 1, Red 2, Green 1, Green 2, Green 3 and Green 4, calls are now prioritised as Category 1: Immediately life-threatening calls with ambulance to arrive on scene within 7 minutes; Category 2: Emergency calls with 18 minutes response; Category 3: Urgent calls with 120 minutes response; and Category 4: Less urgent calls with advice provided over the phone or ambulance response in 180 minutes.

[36] Ambulance Response Programme (ARP) Phase 3: A review of Ambulance Quality Indicators was undertaken in 2017. Old system indicators were phased out and new or redefined system indicators were introduced in August 2017.

Table 9.1: Quality Criteria for Interrupted time series designs

1. Intervention occurred independently of other changes over time		
DONE	The intervention occurred independently	
NOT CLEAR	Not specified (will be treated as NOT DONE if information cannot be obtained from authors)	
NOT DONE	Reported that intervention was not independent of other changes in time	*See Chapter 3, section 3.2.*
2. Intervention was unlikely to affect data collection		
DONE	Reported that intervention itself was unlikely to affect data collection (for example, sources and methods of data collection were the same before and after the intervention)	*See Chapter 3, section 3.5.1*
NOT CLEAR	Not specified (will be treated as NOT DONE if information cannot be obtained from authors)	
NOT DONE	Intervention itself was likely to affect data collection (for example, any change in source or method of data collection reported)	
3. The primary outcome was assessed blindly or was measured objectively		
DONE	Stated explicitly that primary outcome variables were assessed blindly, or outcome variables are objective e.g. length of hospital stay, drug levels assessed by a standardised test	*See Chapter 3, section 3.5.1*
NOT CLEAR	Not specified (will be treated as NOT DONE if information cannot be obtained from authors)	
NOT DONE	Outcomes were not assessed blindly	
4. The primary outcome was reliable or was measured objectively		
DONE	Two or more raters with agreement ≥ 90% or kappa ≥ 0.8, or outcome assessment is objective e.g. length of hospital stay, drug levels assessed by a standardised test	*See Chapter 3, section 3.5.1*
NOT CLEAR	Reliability not reported for outcome measures obtained by chart extraction or collected by an individual (will be treated as NOT DONE if information cannot be obtained from authors)	
NOT DONE	Two or more raters with agreement < 90% or kappa < 0.8	

(Table 9.1 continued)

5. The composition of the data set at each time point covered at least 80% of the total number of participants in the study		
DONE	Data set covers 80-100% of total number of participants or episodes of care in the study	*See Chapter 3, section 3.5.1*
NOT CLEAR	Not specified (will be treated as NOT DONE if information cannot be obtained from authors)	
NOT DONE	Data set covers < 80% of the total number of participants or episodes of care in the study	
6. The shape of the intervention effect was prespecified		
DONE	A rational explanation for the shape of intervention effect was given by the author(s)	*See Chapter 2, 2.6.2*
NOT CLEAR	Not specified	
NOT DONE	Any of the conditions above are not met	
7. A rationale for the number and spacing of data points was described		
DONE	Rational explanation for the number of points stated (e.g., monthly data for 12 months) post intervention was used because the anticipated effect was expected to decay	*See Chapter 3, 3.5.1 and Chapter 9, 9.2.2*
NOT CLEAR	Not specified	
NOT DONE	Any of the conditions above.	
8. The study was analysed appropriately using time series techniques		
DONE	ARIMA models were used or time series regression models were used to analyse the data and serial correlation was adjusted/tested for	*See Chapter 3, sections 3.5.2, 3.5.3, 3.5.4, 3.5.5, 3.5.6, 3.5.7, 3.5.8, 3.5.9 and results in Chapter 4*
NOT CLEAR	Not specified	
NOT DONE	Any of the conditions above are not met	

9.3 Consideration of potential confounder variables and effects

Confounding variables are factors other than those under investigation that can have a direct or indirect effect on the variables being measured (Shadish et al., 2002). For example, there may have been changes in the health and/or behaviour of the population served by AMB-X that contributed to the increase in category A calls (as highlighted in Chapter 4, section 4.6, p. 143 and section section 4.7.5 p.149). Between 2009/10 and 2015/16, there was an increased variation in proportion of immediately life-threatening emergency calls received from the public, nationwide; the range for 2009/10 was 70.8% to 78.3% nationally, compared to 2015/16, 68.1% to 78.5% (Bardot et al., 2017, p.41). Assessing the seriousness of incidents attended to in this study was difficult to discern, because of changes to the AMPDS codes; as discussed previously in Chapter 4, section 4.7.4. There may however have been other factors that had a confounding effect, such as factors related to population demographics or organisational changes, both external and internal to AMB-X, which I discuss as follows.

9.3.1 Population demographics

The 2012 version of the NEWS was found to be unhelpful and ineffective when assessing patients with complex conditions like COPD. This may have had an impact on level of adoption, as some highly populated areas in Region-X, such as County1 and large parts of County3 have a high incidence of this condition compared to other regions in England. Adoption may be more successful in areas where incidences of COPD are lower.

9.3.2 Organisational factors external to AMB-X

There is a perception that NHS 111 is a risk-averse service that requests ambulance responses unnecessarily (O'Cathain et al., 2018b). The operational changes implemented by NHS 111 in 2015 were considered by AMB-X's management to have been the key contributor to the significant increase in category A calls (Gilbert, 2016). Whilst categorised by NHS 111 as presenting with a life-threatening complaint, AMB-X's Annual Report claims half these patients were treated closer to home (Gilbert,

2016). Concerns that calls were being over-triaged were raised by AMB-X with commissioners at the time (Gilbert, 2016).

I could not determine whether the calls received from NHS 111 were being over-triaged or not, but from my interviews with paramedics, it seemed NHS 111 can influence patients' expectation that they will be conveyed to ED. O'Cathain et al. (2018b) were unable to draw any definitive conclusion of the effect NHS 111 had on non-conveyance. Although, nationally they found non-conveyance rates were higher for calls which came from NHS 111 than emergency 999-calls from the public, i.e. 34% versus 29% (O'Cathain et al., 2018b). Of all calls received from NHS 111, 60% were conveyed to ED, 37% were treated closer to home and 3% were resolved by CAT (O'Cathain et al., 2018b).[37]

9.3.3 Factors at AMB-X not directly associated to the NEWS

The significant decrease in patients being treated closer to home, that occurred in April 2012, was likely to be related to the introduction of a new service model at AMB-X, in response to the NHS Act 2012 (Department of Health and Social Care, 2012). The model was complex, and to explore the potential impact of all the changes implemented is beyond the scope of this study. However, there was one change introduced that may have had a long-term impact on the useful application of the NEWS and the decision-outcomes measured. That change was the three tier-deployment model of ambulance resources (Table 9.2 & Figure 9.4, p.264).

At the time of this study, emergency 999-calls were responded to either by a solo paramedic working on an FRV, or DCA. Paramedics working on an FRV, often requested back-up from a DCA to convey their patient to hospital. If there were no DCAs available, they would wait on scene with the patient until the DCA arrived. DCAs may also be

---

[37] Ambulance services' CAT are not officially permitted to re-triage calls from NHS 111. Further information regarding the re-triaging of NHS 111 calls can be sourced here: https://www.england.nhs.uk/south/wp-content/uploads/sites/6/2015/11/external-invest-r3g5-call-secam.pdf

requested to back-up an urgent care ambulance consisting of two ECAs; who have responded to a GP request to convey a patient to hospital within a specified timeframe.

Table 9.2: Three-tier deployment model

Response	Deployment Type	Skill Level	Description
Level 1	Urgent Care Ambulance	Double ECA	Provide transport for patients who do not require paramedic care, but need transporting to hospital or other healthcare facility, within a timescale agreed by HCP.
Level 2	FRV	Paramedic	FRV, crewed by a solo paramedic, provides immediate response to life-threatening calls. The emphasis of the FRV is to attend high acuity patients ensuring patients with greatest need receive rapid response.
	Paramedic Ambulance	Paramedic & ECA or EMT	DCA designed to respond to 999-calls requiring paramedic care.
Level 3	ECP	ECP	Responds to calls assessed through the urgent care hub as requiring further clinical assessment, with the intention that patients will be treated at home or referred to another HCP. The emphasis will be to support community-based care.

(Milligan, 2012, pp.6-7)

Figure 9.4: Three-tier deployment model
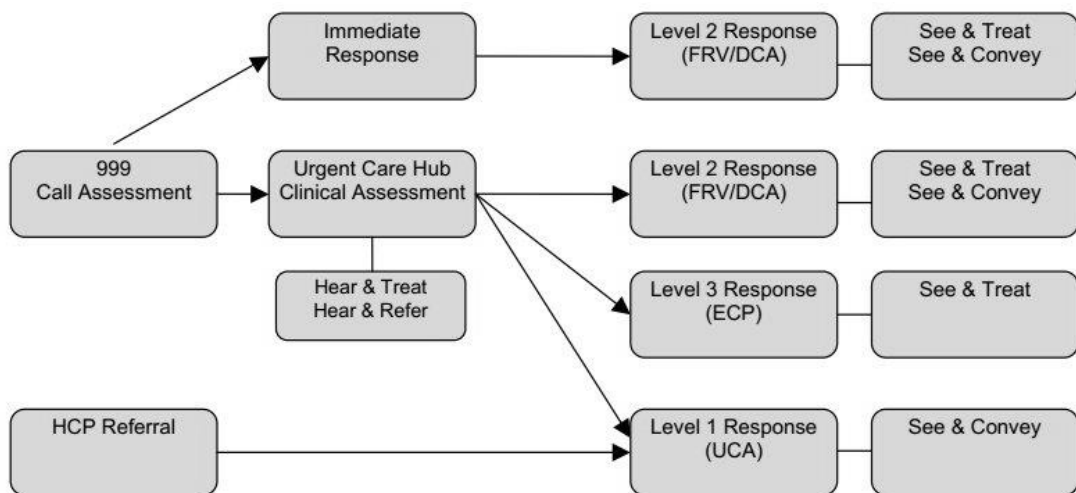
(Milligan, 2012, pp.6-7)

On arrival, the urgent care ambulance crew may have found the patient to be too sick for their level of care and would request a DCA to convey the patient instead. Again, they may have to wait until a DCA is available. On some occasions, emergency 999-call demand, back-up requests and delays at ED can exceed resource capacity, where no emergency resources are available and emergency care is delayed. In fact, AMB-X implemented their Over Capacity Plan, 10-24 times between September and December 2012 (Care Quality Commission, 2013). The plan would be executed when 25 or more emergency calls were waiting ambulance deployment. By the time a paramedic arrives on scene, the patient's condition may have deteriorated leaving the paramedic with little option than to convey. Even if the patient's condition were viable, it can be difficult for staff to suggest or negotiate care via an alternative care pathway when care has been delayed, and staff are faced with animosity.

> *"We called for an ambulance straight away and called again several times, but it took four hours for an ambulance to arrive. We were told that [AMB-X] were responding to a high number of calls of higher priority than ours. But when the ambulance crew arrived, they weren't aware of the delay and how long we had been waiting. They were very apologetic and understanding though." – 999-caller (Care Quality Commission, 2013, p.9)*

> *"Sometimes we get delayed calls from the control centre that mean when we get to the person they're already frustrated by the delay and we have to apologise for the wait." – Staff member (Care Quality Commission, 2013, p.9)*

Resource availability at AMB-X continued to be problematic in 2015, which had an impact on safety. Between April and December the number of back-up request delayed by more than 30-minutes ranged from 3,978 to 5,072, and there were occasions when back-up was delayed by 90-120 minutes (Care Quality Commission, 2016, pp.21-22). Ten percent of the serious incidents at AMB-X were attributed to lack of available resources or delayed response times, which potentially contributed to patients' deaths (Care Quality Commission, 2016, p.15). Such an incident led the HM Coroner to submit

a letter of Prevention of Future Death to the Trust (Care Quality Commission, 2016, p.15).[38]

9.4 Strengths and limitations of qualitative studies

9.4.1 Sample

Some may argue the sample sizes of paramedics interviewed (1%) and observed (0.5%) in this study were too small (for more details see Chapter 5, section 5.1, p.151 and Chapter 6, section 6.1, p.175). Small sample sizes such as these are however typical of qualitative research. Rather than focusing on quantity, I concentrated my efforts on the quality. I ensured those interviewed and observed were a heterogenous sample, as this would enable me to gain deeper insight, understanding and knowledge from a variety of perspectives. As recommended by Creswell (2014), I continued recruiting, interviewing and observing until no new knowledge, insight or themes arose. That is, I achieved the point of knowledge saturation that enabled me to fully address my research questions.

I attempted to ensure the sample interviewed were representative. The participant gender ratio was deemed to be proportionally representative of the western ambulance professional population (see Paramedics Australasia, 2012, Data USA, 2015, Health & Care Professions Council, 2017). The lack of participation from EMTs was unfortunate, but a sign of the times. Around 2007, AMB-X's clinical team structure shifted from being 'paramedics and EMTs' to being 'paramedics and ECAs'. The EMTs employed at the time were given the choice of completing the advanced clinical training necessary to qualify and register as paramedics. It was not until 2016 that EMTs began being recruited at AMB-X once again. The recruitment drive was undertaken to address the resource and staffing shortfall, precipitated by paramedics having to now qualify via the three-year university degree route, rather than IHCD qualification. The EMT recruitment drive was however too late for this study. It was

---

[38] Prevention of Future Deaths (PFD) reports are submitted by Coroners following an investigation of how death occurred. PFDs are intended to improve public health, welfare and safety and prevent death caused by similar circumstances from occurring in the future.

also disappointing not to have gained engagement and insight from those working at the frontline in Sector-3. I believe this was because of the breakdown in relations between frontline staff and the management team, as discussed. Whilst gaining their insight and perspective would have been of immense value, the lack of engagement itself speaks volumes.

9.4.2   Semi-structured interviews

Conducting and analysing the semi-structured interviews (Chapter 5) was less problematic than the quantitative data analysis (Chapter 4), and less time-consuming than the non-participant observation study (Chapter 6). Most of the interviews undertaken were conducted over the telephone, because of the scale of the area covered by the study, and fitting interviews around participants' 12-hour shift patterns. I found this to be an effective method of managing time and financial costs. Interviews conducted over the mobile telephone network did however pose some problems, such as poor sound quality and connectivity. When call signals dropped out, the conversation would be interrupted and sometimes the thread of discussion would be lost. The lack of visual clues may also have compromised the opportunity for further lines of enquiries being recognised and conversations being expanded. Nevertheless, I found telephone interviews more successful than face-to-face, owing to the unpredictability of the emergency care environment. Four out of five of the face-to-face interviews were interrupted. One face-to-face interview was interrupted after five-minutes and had to be rescheduled. It was rearranged for another day and conducted over the telephone.

I found discussions often veered more towards Paramedic Pathfinder than the NEWS, more so when interviewing the Paramedic Pathfinder Leaders than frontline clinicians. Sometimes this would be appropriate, such as when they compared the Pathfinder tools and NEWS to each other. On the occasions when the discussion about Paramedic Pathfinder was less relevant, I gently steered the conversation back to focus on the NEWS. Overall the interviews were successful. They provided paramedics with an opportunity to share their personal views and experiences about the changes being

implemented. This seemed to be a welcomed and an empowering experience, as on several occasions discussions continued for a considerable time after the interview had ended.

Wherever possible, participants were interviewed and observed before and after the NEWS was introduced. This was to mitigate the risk of participant demand bias, where the paramedic may proclaim to use the NEWS, or only use the NEWS when being observed, but not use it as part of their normal day-to-day clinical practice (Orne, 1962). This method also allowed the participants and I to become familiar with each other, and the study processes. However, because of the longitudinal nature of the study, some participants had left their employment with AMB-X or had changed roles, and therefore were unable to participate in the study post-NEWS. Therefore, some participants were interviewed but not observed, or vice versa.

9.4.3   Non-participant observations

Non-participant observations were very time-consuming (Chapter 6). This restricted the number that could be conducted. A further disadvantage of observing paramedics in the natural setting was the inability to control which incidents were attended. There was always a risk of having nothing to report at the end of a shift, although this did not occur. There were however several occasions where after 12-hours or more, I only had one or two observations to include, mainly because the patient's age or clinical complaint meant the observation had to be excluded from the study. Nevertheless, I found the observation study provided invaluable knowledge of what really occurs in context. Had I not observed paramedics as they worked and had solely relied on what had been said in interviews, then an alternative perspective would have been obtained that may have been less accurate. For instance, the interviews alone would lead one to believe the NEWS was being used to support decision-making more often than it really was.

Observational debriefs were kept to a minimum timeframe; less than five-minutes, which was enough. Conducting debriefs on the ECP assessment unit was more difficult, owing to the demand and patients queuing outside the vehicle. I never asked any

questions that may prompt the use of the NEWS at the time. If needed, I contacted the paramedic after the observation shift to clarify certain aspects. For example, I asked P11 during their interview (which took place after the observation shift) about their use of the Centor tool. Asking questions retrospectively did present some risk that their responses would be more generalised, rather than specifically related to the incident observed. Considering my research objectives and with my research propositions in mind, I believed this was an appropriate strategy to adopt.

9.4.4   Trustworthy criteria for qualitative research

Unlike quantitative research, it is more difficult to assert the inferences derived from qualitative research are reliable and valid. This is because the raw data collected are socially constructed and potentially biased interpretations of objects and events, that are then at risk of further contamination by the researcher's own subjectivism. As a means of strengthening the validity of my qualitative research, I followed the advice provided by Teddlie and Tashakkori (2009, p.212) and captured the interpretations held by others, accurately and without distortion. I also used a checklist founded on Lincoln and Guba's (1985) trustworthy criteria (Table 9.3, pp.270-271).

One prime strategy used to strengthen credibility, dependability and confirmability was sharing an anonymised summary of my analytical findings with key informants; including those who possessed relevant expertise and a sample of those who participated in the case study. I sought their opinions and obtained feedback on my interpretations and explanations to ensure they provided an accurate reflection of reality. All agreed that my interpretations and explanations provided valuable insight of events, and the inferences derived were realistic and valid.

> *"This is fantastic work. Wish we had had this level of insight during the project. All the comments seem to have been translated correctly."* [P1]

Table 9.3: Trustworthiness criteria for qualitative research

Criterion	Quantitative analogue	Technique for enhancing	Evidence
Credibility – the reconstructions of the researcher must be credible to the constructors (the participants) of the original multiple realities	Internal validity	**Prolonged engagement in field or research site** – where the researcher immerses themselves in the participants' world to gain understanding of core issues that may affect the quality of the data.	I have worked in ambulance setting since 1995. Employment at AMB-X began in 2006. Research related to this area of study began 2011. Interviews and observations relative to this study began in 2014 before the NEWS was introduced and continued until 2016.
		Persistent observation – to obtain an understanding of the participants' worldview, get to know their qualities and characteristics and how they may be influential, and ensure the presence of the researcher is minimised.	Where possible, participants were both observed and interviewed pre and post-NEWS.
		Triangulation techniques – use of different methods, data sources and theories to corroborate evidence and reduce bias.	I developed two contrasting propositions and used pattern-matching techniques to corroborate evidence from interrupted time series analysis of ambulance data, semi-structured interviews and non-participant observation study.
		Peer debriefing – to seek scholarly advice and feedback from academic staff and professionals with relative expertise and knowledge.	I have attended and hosted meetings with Paramedic Pathfinder management team, other academics (e.g. annual presentation peer review) and professors with relevant expertise.
		Negative case analysis – the identification of emerging data which contradicts the researcher's expectations.	Negative case analysis was designed into the study. The observation and interview study were intended to corroborate or identify conflicting results. My propositions provided alternative hypothetical outcomes. Results were subsequently matched to the propositions. Had a match not been achieved then alternative propositions would have been offered.
		Member checks – to check the trustworthiness of interpretations, participants and other members of the social scene are asked to assess the accuracy of the themes, interpretations and conclusions.	Quantitative and qualitative analysis results were shared with key informants and participants. Their opinions and feedback were invited accordingly. See included quote from member of

Criterion	Quantitative analogue	Technique for enhancing	Evidence
			Paramedic Pathfinder team following review p.**Error! Bookmark not defined.**.
Transferability – the ability to transfer inferences derived from one context to another	External Validity	**Thick description** – in a final report, of the data collection processes adopted, the context of the study and study sample to help other researchers replicate the study and compare results.	Research Thesis: Chapters 3-6 provide details of the population served by AMB-X, AMB-X's emergency care delivery model, how data were sourced and analysed, description of participant sample, other factors within the research context that may have been influential at the time.
Dependability – the extent to which the process of enquiry yields consistent results	Reliability	**Inter-rater agreement strategy** – For interviews, the researcher should code the same data twice, allowing at least one or two weeks between coding. The coding is then compared. Any differences identified should be resolved, through peer debriefing for example. Similarly, multiple observations should be undertaken, and analysis shared with others	A coding-recoding strategy was adopted when analysing interviews, with a period of 2-months between each. Interview and observation analysis and results were discussed during research supervisions hosted every 4 weeks. Opinions and feedback of results and inferences derived, were subsequently sought from peers, key informants and participants.
		Peer Examination – Researcher discusses their research process and findings with neutral colleagues	See peer debriefing and member checking above.
Confirmability – the extent to which the product of enquiry is confirmable (i.e. are the results grounded in data, are the inferences derived logical, is there evidence of researcher/observer bias?)	Objectivity	**Triangulation techniques** – see above	Research Thesis: Data from each workstream were analysed and reported independently in Chapters 4-6. The results were subsequently integrated using a pattern-matching method, as described in Chapter 7. The inferences derived were then confirmed using a variety of techniques including peer examination, member checking and utilisation of this trustworthy criteria checklist.

NB: Table constructed with information cited by and sourced from Bitsch (2005), Teddlie and Tashakkori (2009, p.295-297) and Anney (2014)

In addition, I found the information used by paramedics to inform their decisions, and the decision-making processes described in this study, were similar to those described by paramedics and managers employed by three other ambulance trusts in England, who were interviewed by O'Hara et al. (2014). The fact O'Hara et al. (2014) found greater variation across regions within the same trust, rather than between trusts, would further support that my findings are credible, transferable and dependable.

9.5   Considerations for future research

Had I interviewed and spent more time observing clinical staff at ED, MIU and UCC then I believe I would have been able to provide greater insight and understanding of factors that inhibited or facilitated the use of the NEWS during clinical handover. It is also possible that I did not allow enough time for the supporting infrastructure and the NEWS to become embedded at AMB-X. I would recommend other researchers who are considering similar studies to conduct their research over a longer-time frame. Whilst Silcock et al. (2015) proposed the calculation of a prehospital NEWS may facilitate earlier recognition of clinical deterioration and timelier delivery of care, there remains a gap in knowledge, that is how do we get paramedics to adopt the NEWS and calculate a score? This is a question for future research. The following provides some recommendations of how this may be achieved.

9.6   Recommendations

9.6.1   Assess decision-making rules and scripts

Before implementing an intervention intended to improve clinical decision-making, I would advocate further research is undertaken in accordance with the following recommendations proposed by Hamm et al. (2000).

1. Discover the clinicians' particular decision-making rules and scripts (of what to do in certain situations) and understand how their use is rewarded and how other rules and scripts compete with each other in context.

2. Analyse the rules/scripts and the situation to see how undesired outcomes are being produced. Consider how would the rules/scripts need to be changed and/or the situation need to be different to lead to the desired outcomes.

3. Develop new rules/scripts and/or new ways for the system to work so that the clinicians using the rules/scripts in that situation would make more suitable decisions.

4. Before implementing on a large-scale, undertake tests on a small scale to verify that the redesigned scripts and situations work.

5. Then implement the changes by explicitly training all relevant people to use the new scripts, along with needed system changes.

(Hamm et al., 2000, p.409)

9.6.2   Implement the NEWS using a collaborative approach

As discussed in Chapter 2, section 2.5.7, p.70, the implementation of quality improvement initiatives in prehospital settings can be more successful when the initiative is implemented using a collaborative approach. Such approaches are not always successful but are more likely to be successful if The Health Foundation's advice is followed (Table 9.4, p.274).

Table 9.4: Factors influencing the success of quality improvement collaboratives

Focus on who should be included	• Gain buy-in from senior leaders who provide encouragement to take part. • Involve multidisciplinary teams, including nurses. • Consider involving patients and carers as part of the improvement teams. • Include organisations that volunteer rather than making participation mandatory.
Consider the topic focus	• Focus on areas of change where a team approach is vital. • Be realistic about what collaboratives can achieve. • Focus on topics where there is established good practice and a large gap between current and ideal performance. • Begin with an overall 'theory of change' so there is a clear link between activities and planned outcomes.
Consider how to run activities	• Set clear goals that team members buy into and are accountable for. • Provide standardised change interventions but allow for tailoring to the local context and needs. • Use multiple methods of communication to build close participant network, including online and telephone support. • Include organisational coaching in addition to collaborative learning sessions.
Provide appropriate resources	• Ensure there is an appropriate IT infrastructure for collating data and sharing good practice. • Use simple measurement tools. • Ensure organisational support, appropriate resourcing and enough time for changes to be embedded. • Evaluate outcomes robustly, including comparing teams that do succeed and those that do not.

(De Silva, 2014, p.4)

The first step is to obtain buy-in from influential leaders across the relevant care and business sectors (Timmins, 2015), who will take co-ownership of the change initiative and have the courage to become a 'change evangelists' (Kumaraguru, 2007). Their objective is to rally collaborative support from significant others, including doctors, nurses, managers, allied health professionals and other internal and external facilitators (De Silva, 2014), and to begin readying the individuals for the changes to be implemented.

9.6.3   Develop an effective communication strategy

The adoption of the NEWS by frontline paramedics at AMB-X may have been compromised by the fact it was integrated into the Paramedic Pathfinder tool. This meant the NEWS itself was less visible, but also key messages were lost, confused or misconstrued (e.g. the changes were a cover-your-arse effort, rather than for patient benefits).

> *'People hear EVERYTHING through their own experience' (National Association of School Psychologists, 2016)*

The message being communicated needs to be tailored for the separate audiences; i.e. the content and method used to communicate with frontline staff should differ to that used to communicate with managers, which should differ to external stakeholders, commissioners and so on. A concise clear message needs to be communicated which states a) the problem; b) the action - what you suggest should be done and their role in achieving it; and c) the benefits - including who it will benefit (National Association of School Psychologists, 2016).

Ideally, communications for frontline clinicians should focus on benefits to patients, not operational or performance measures. Communication should be consistent, and updates should be provided to all involved on a regular basis. Careful consideration should be given to methods of dissemination with frontline staff as they do not have easy access to computers and can often go weeks without seeing managers, because of their shift patterns.

The national Ambulance Service Cardiovascular Quality Initiative (ASCQI)[39] collaborative provides one example of how change can be effectively achieved using such methods (see Siriwardena et al., 2014). ASCQI was funded by The Health Foundation.[40] It achieved its objectives using a variety of methods, but the

---

[39] http://ascqi.co.uk/
[40] See https://www.health.org.uk/programmes/closing-gap-through-clinical-communities/projects/improving-quality-cardiovascular-care

communication strategy adopted with paramedics focused on patient benefits -
specifically how paramedics can directly improve patient outcomes by changing their
practice. A clear message was communicated nationwide that highlighted the
'*problem*', i.e. premature deaths that could be prevented by early and effective
treatment; the required '*action*', i.e. deliver the entire specified bundle of care; and
the '*benefits*' for patients, i.e. reduced morbidity and mortality.

Information about the improvements being achieved were communicated regularly to
paramedics; e.g. 'CPI Friday' ensured clinical performance updates were
communicated on a weekly basis. A variety of methods were used to disseminate the
information, including leaflets, posters and factsheets sent to staff via email and
displayed on station noticeboards. Information was also disseminated face-to-face, at
workshops and/or drop-in sessions hosted at ED and on ambulance stations. Where
the reason for requested actions were unclear, a simple explanation would be
provided and supported by evidence (Figure 9.5, p.277). The information often
included humour, sometimes a fictional patient, and occasionally real stories
conveying better understanding from a patient's perspective (Figure 9.6, p. 278).
Patient and public involvement can be particularly persuasive in gaining buy-in from
those working at the front-line (Timmins, 2015). To sustain involvement, paramedics'
achievements were acknowledged and appreciated (Figure 9.6, p. 278). Ambulance
services who are considering implementing the NEWS, are recommended to consider
adopting a similar communication strategy as the ASCQI to engage frontline staff.

Figure 9.5: ASCQI communication strategy – poster developed by one ambulance service clarifying why there is the need to measure blood glucose when attending a patient who may have had a stroke (see Siriwardena, 2019)

Stroke—as paramedics, we know that a stroke is a loss of brain function due to disturbance in the blood supply to the brain due to ischaemia, caused by thrombosis, or haemorrhage.

So why do we measure a patient's blood sugar when we suspect they have had a stroke?

- 'It is well known that noncerebrovascular conditions can present with a clinical picture mimicking stroke, so early accurate differentiation of such 'mimics' from true strokes is essential.'[1] Hypoglycaemic patients can present with stroke-like symptoms including decreased GCS and hemiparesis.

- Most human studies show that hyperglycaemia in patients with acute stroke is associated with a worse clinical outcome than patients without hyperglycaemia[2]

- 'Normalisation of blood glucose during the first 48 hours of hospitalisation appears to confer a potent survival benefit in patients with thromboembolic stroke.'[3]

References 1 'Conditions That Mimic Stroke in the Emergency Department' (*R Libman, E Wirkowski, J Alvir and T Hemanth Rao*) 2 'The Role of Hyperglycaemia in Acute Stroke' (*N Kagansky, S Levy and H Knobler*) 3 'Decreased Mortality by Normalizing Blood Glucose After Acute Ischaemic Stroke' (*N Gentile, M Seftchick, T Huynh, L Kruus and J Gaughan*)

Figure 9.6: ASCQI communication strategy – development of CPI Friday and associated communication (see Siriwardena, 2019)

If we look at each STEMI CPI, our aspirin and GTN administration have gone from great to superb. Pain scores took a massive leap after the first CPI Friday in January 2011 purely because (like me), few people had fully appreciated the importance of a second score in proving you'd reassessed the patient's pain (or absence of) en route to hospital. Poor Doris didn't want to call you out in the first place, she's hardly going to disturb you mid journey to tell you her pain's getting worse – you need to be proactive, and boy, you certainly have been!!!!

STEMI Care Comparison

(2010 and 2011)
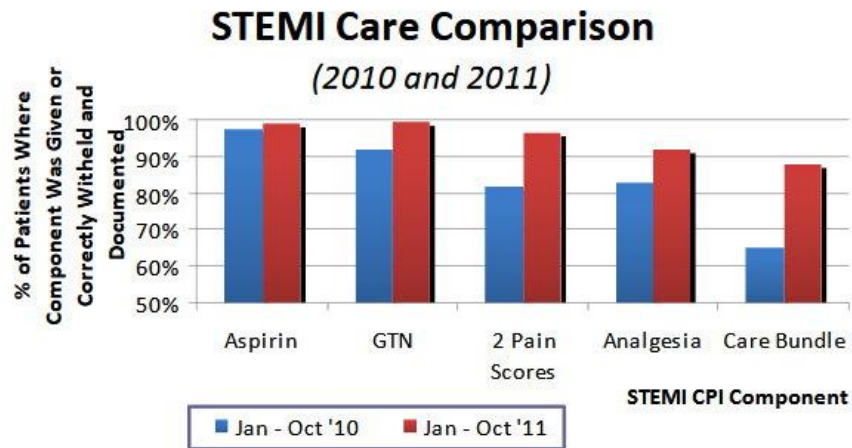
When it comes to analgesia however, there is definitely room for improvement and those of you bonkers enough to keep reading CPI Friday will know that the main points are:

- If the pain's not ZERO, Morphine needs to be given. A "niggle" still needs analgesia. No excuses.
- If Morphine's not possible (failed access, non-para crew, contraindications etc), then give entonox a try. No excuses either!

9.6.4 Focus on patient benefits

As mentioned, I would recommend focusing on the problem, action and benefits from solely a patient perspective, and NOT mention operational performance or organisational benefits.

e.g.

- Problem - For every hour clinical deterioration is not recognised, *your* patient is at increased risk of mortality.

- Action – *You* can support early recognition of clinical deterioration by calculating and documenting a NEWS on *your* patient's report form, and alerting nursing staff of the patient's baseline score during *your* clinical handover of patient care.

- Benefits – By documenting and communicating the NEWS during *your* clinical handovers, *you* will be helping to support the early detection and timelier response to patients' clinical deterioration, which will help reduce premature mortality.

By calculating and documenting the NEWS, Paramedics should start to become more aware of the patients overall physiological wellbeing and more mindful of any shortcomings in their own decision-making. Subsequently, this will provide an opportunity for them to develop and update their mindware.

9.6.5 Begin by engaging with early adopters

I would recommend focusing initially, on implementing changes in localities where resources, mindsets and working practice are more receptive and aligned to the proposed changes. Then review, identify and reform working practices collaboratively, in accordance with shared objectives. Once this location is operating as desired, use the improvements achieved as evidence of best practice, and the lessons learned to support dissemination across the wider area.

At AMB-X, it may have been more effective for the Paramedic Pathfinder Leaders to have focused their attention initially on implementing the Paramedic Pathfinder

Programme in Sector-2. The reason why I suggest Sector-2 is because one of the main acute care providers in this locality had already adopted the NEWS. The nursing staff, at this ED, were insisting paramedics provide a NEWS as part of their clinical handover. This had subsequently expedited the adoption of the NEWS by paramedics in this locality.

There were nevertheless still problems in that sector, inhibiting the NEWS from being used consistently and effectively. For example, the lack of contextual integration discussed previously (i.e. conflicts between UCC, ED and AMB-X policies), plus the extensive array of information about alternative care pathways, that was difficult to access and/or out-of-date, was causing confusion and inhibiting ED avoidance. Paramedics in Sector-2 also had access to a SPA, but this was not being used.

The SPA had been introduced in this sector in 2013, by the Admission Avoidance Programme Board (Windle et al., 2014). Paramedics could call the SPA and make a referral to a nurse practitioner who would subsequently deploy an urgent (e.g. Rapid Response Team) or longer-term care support service (e.g. district nurse) to support patient care at home (Windle et al., 2014). Despite being provided 24-hours a day, seven days a week, AMB-X clinicians were not utilising the resource, reasons for which were unknown (Windle et al., 2014).

A collaborative review to improve functionality of this service, at the time the NEWS and Paramedic Pathfinder were being implemented, could have enhanced SPA usage by paramedics, and the subsequent utilisation of alternative care pathways. Such service provisions have been found effective by other ambulance services (O'Hara et al., 2014, O'Cathain et al., 2018b), although some pathways needed to be streamlined (O'Hara et al., 2014).

A review of AMB-X's directives in association with stakeholder service level agreements and policies, prior to implementation, would also seemed to have been advantageous, to identify gaps in existing commissioning or pathway provisions. Improving access to alternative care pathways was deemed to be of utmost priority for

emergency care, by ambulance employees and patients alike (O'Hara et al., 2014). Had more alternative pathways been available and accessible to paramedics from the outset, then the adoption of the NEWS may have been more successful.

9.6.6 Integrate NEWS into patient report forms

Having concluded this study and found the NEWS to be rarely documented, I would recommend a text box should be included on the PRF in which the NEWS could be recorded. This would act as a visual prompt to paramedics to calculate and document a score. And, as half the scores calculated were inaccurate, the e-PRFs should automatically calculate a NEWS from the individual physiological measures entered. The e-PRF should also have the functionality to alert the paramedic when a physiological measure is absent, and/or when a significantly abnormal physiological measure is entered in a specified field; e.g. when 83 is entered in the respiratory rate field, as in Figure 6.4 (p.187). This would ensure as much as possible that the score calculated is accurate, thus supporting safer decision-making.

In 2017, AMB-X did introduce a text box on the paper-based PRF. A new e-PRF system was also introduced that automatically calculated a score from the physiological measures. The new e-PRF system did not however alert the paramedic when there was an entry error. And of course, not all paramedics would choose to use the e-PRF system and those who did, would not necessarily utilise the NEWS in their decision-making. But at least with the new e-PRF system, there would be a NEWS documented, providing a baseline measure for that patient, against which hospital clinicians could discern whether there has been any clinical deterioration. Potentially, this would facilitate delivery of any necessary treatment, such as antibiotics in cases of sepsis, 60-90 minutes sooner than was previously possible.

9.6.7 Adopt a proactive approach to assess treat & discharge decisions

I recommend managers adopt a proactive approach to assess the appropriateness of paramedics' treat and discharge decisions, rather than a reactive approach, where appropriateness of decisions are assessed on whether a complaint is made, or a serious untoward incident occurred. This could be achieved by regularly auditing and

reviewing a sample of PRFs, where incident outcomes have been documented as 'Treated and Discharged'. The audit should include a review of completeness of physiological measures documented, plus compliance of documenting a NEWS and the accuracy of the NEWS where appropriate (i.e. instances where a NEWS is not auto-calculated). Non-compliance should be addressed where necessary.

9.7   Summary

In this chapter, I have considered the strengths and limitations of my research. I have discussed how the quantitative analysis initially planned needed to be revised. And, despite careful consideration of data collected, the quality of this workstream may have been weakened by aspects out of my control. Whilst I was able to objectively measure the effect the changes implemented had on non-conveyance and recontact rates, the recontact data may not be a reliable or valid measure of quality or safety. Replicability has also been compromised because of the changes made to how performance is being measured nationally.

The inclusion of semi-structured interviews and non-participant observations were considered to have strengthened the study, by providing valuable insight of factors influencing clinical decisions, and the socio-cultural complexity that underlies clinical practice. The sample size of those who participated in the qualitative workstreams though small, was heterogenous and proportionally representative of the western ambulance profession. Telephone interviews were found to be a quicker method of gaining insight than the observations and were more effective and practicable than face-to-face interviews. The observations were however invaluable in providing insight of what occurs in real-life.

I have considered how the high incidence of COPD in the resident population may have had some impact on the adoption of the NEWS, and how the significant increase in category A calls may be attributable to changes in NHS 111 prioritisation. I also discussed the changes implemented to the operational structure at AMB-X, which may have delayed attendance to patients and subsequently compromised the paramedics' ability to negotiate, or effectively treat patients closer to home.

Based on prior evidence, I have recommended that the NEWS should be implemented using a collaborative approach. This will ensure co-ownership and effective leadership is achieved. A clear communication strategy should also be adopted, which succinctly describes the problem, desired action and benefits that can be achieved; ideally focusing on patient benefits. The NEWS should begin being implemented in an area that has the socio-cultural infrastructure necessary to support its adoption and easy accessibility to alternative care pathways. Lastly, I recommended that changes should be made to PRFs to prompt the utility and accurate documentation of the NEWS. These should be audited on a regular basis and non-compliance addressed where necessary.

10 Conclusion

When used prescriptively, the NEWS will support clinicians to identify patients at risk of critical illness and clinical deterioration. It had been suggested that the introduction of EWS systems, like NEWS, in the prehospital setting would support paramedics to make safer and more appropriate decisions and would assist them to identify patients who could be treated closer to home. There was however a paucity of quality evidence of EWS systems being used by paramedics in context. I therefore conducted this case study, my aim being to evaluate the effectiveness and usefulness of the NEWS to support paramedics' decision-making to appropriately treat patients closer to home. My objective being to answer the overarching research question which was, 'How effective and useful is the NEWS when used by paramedics to support their decision-making to appropriately treat patients closer to home?'. This was achieved by evaluating the effect the NEWS had on the numbers and proportions of patients not conveyed to ED, and numbers and proportion of patients discharged at scene who recontacted AMB-X within 24-hours. I also sought insight and understanding of how useful and effective paramedics perceived the NEWS to be in supporting them in their decision-making, and how the NEWS was being used by paramedics in the emergency care setting.

I adopted a pragmatic approach and used mixed methods. I used an interrupted time series design and an ARIMA method to evaluate the effects of the NEWS on non-conveyance rates and recontact rates, measuring rates before and after the NEWS was implemented. I conducted semi-structured interviews with a self-selected sample of paramedics to gain insight of how useful and effective paramedics perceived the NEWS to be in supporting them in their decision-making. I also observed a sample of paramedics as they attended to patients to gain insight of how the NEWS was being used in the real-world context. The findings from quantitative and qualitative research were integrated using a pattern-matching approach.

From the ARIMA analysis, I found the introduction of the NEWS had no effect on numbers or proportions of patients being treated closer to home, nor numbers or

proportions of patients discharged at scene who recontacted AMB-X within 24-hours. There was however a significant declining trend in numbers of patients being treated and discharged at scene. This would suggest more patients were being conveyed to MIU, UCC or similar, for treatment. When interviewed, paramedics did not believe the introduction of the NEWS had substantially changed their decision-making process or the outcomes of their decisions. Paramedics attributed any significant differences found (i.e. the declining trend in patients being discharged at scene) to be due to Paramedic Pathfinder, rather than NEWS. Further analysis of the number of 999-calls being resolved over the telephone also showed a significant reduction in lower acuity calls being attended to by ambulance, which subsequently could explain the reduction in numbers of patients being treated and discharged at scene.

Paramedics considered the NEWS supported their clinical practice and decision-making in some situations but not others. The NEWS was therefore used intermittently, depending on the context. There were occasions when the NEWS was considered inappropriate, such as when attending patients who were seriously unwell. In unequivocal situations, paramedics tended to rely on their existing clinical intuition and knowledge. There were also occasions when other tools, or protocols were considered more appropriate and these were used in preference. The NEWS was perceived to be most useful and effective in ambiguous situations, then the NEWS would be used to inform or confirm their decision options. While some paramedics claimed they integrate the NEWS in their analysis, there was little observed evidence of this occurring in practice. In complex situations, such as when attending patients with COPD, the NEWS was found to add ambiguity, in such circumstances, paramedics would adopt a more analytical approach to assess the situation, using other information from their knowledge-base. The high incidence of COPD rates in areas across Region-X may have impacted on paramedic uptake of the NEWS in those localities.

Based on the audits conducted by the Paramedic Pathfinder Leaders and CTLs, most of the decisions made to convey patients to ED were considered to have been made

appropriately. They also believed the changes implemented had not had any detrimental effect to the safety of patients being treated closer to home. There was however little evidence of the NEWS being used, as it was rarely documented on the patient report forms, and the scores that were documented were often inaccurate. Most of the mistakes could have been avoided had the paramedic used their pocketbook guidelines, and visually referred to the parameter ranges on the NEWS tool. If decisions had been based on these erroneous scores, then the effectiveness of the NEWS to support safe and appropriate decisions would have been compromised. There was evidence to suggest paramedics needed to update their mindware, that is the NEWS had not been adequately or appropriately integrated into their clinical rule-base. Subsequently, other pre-existing rules had greater influence, or would be used in preference when system-aided judgements were made.

The lack of contextual and relational integration of the NEWS with other service providers meant the meaning and purpose of the NEWS was incoherent to paramedics. The lack of perceived benefits subsequently failed to out-weigh the controversial beliefs held by some paramedics, that the NEWS had been introduced to place responsibility on them, should anything go wrong. All stakeholders needed to work together collaboratively, to develop the infrastructure necessary to support the NEWS becoming embedded into everyday clinical practice. This would include the commissioning and provision of appropriate and easily accessible care pathways, as ED avoidance was being compromised by difficulties in accessing care for patients closer to home.

Having completed this study, I conclude the introduction of the NEWS at AMB-X to have been ineffective and not useful in supporting paramedics' decisions to appropriately treat patients closer to home. The NEWS had no significant effect on non-conveyance nor recontact rates. Its usefulness was found to be context dependent and therefore it was used intermittently. When it was used, it was often calculated inaccurately, thereby compromising its effectiveness. The NEWS had not become firmly embedded or normalised into everyday clinical practice because of a lack of

collaboration and supporting infrastructure across the region, resulting in a lack of coherence and accessibility to alternative care pathways. Principally, this was due to a lack of integration in health service provision and care delivery. The findings and recommendations from this study would be of value to those considering introducing NEWS or similar systems into their organisation, such as NEWS2 Champions and the NEWS networks, plus commissioners and those responsible for integrating care services.

References

AAGAARD, T., LUND, H. & JUHL, C. 2016. Optimizing literature search in systematic reviews – are MEDLINE, EMBASE and CENTRAL enough for identifying effect studies within the area of musculoskeletal disorders? *BMC Medical Research Methodology,* 16**,** 161.

ABBOTT, T. E. F., CRON, N., VAID, N., IP, D., TORRANCE, H. D. T. & EMMANUEL, J. 2018. Pre-hospital National Early Warning Score (NEWS) is associated with in-hospital mortality and critical care unit admission: A cohort study. *Annals of Medicine and Surgery,* 27**,** 17-21.

ACADEMIC HEALTH SCIENCE NETWORK. 2017. *Speaking the same language: Safer care through early warning scores* [Online]. AHSN Network. Available: http://atlas.ahsnnetwork.com/speaking-the-same-language-safer-care-through-early-warning-scores/ [Accessed 07/04/2018].

ADAMS, B. D., BONZANI, T. A. & HUNTER, C. J. 2006. The anion gap does not accurately screen for lactic acidosis in emergency department patients. *Emergency Medicine Journal,* 23**,** 179-182.

AGABITI, N., STAFOGGIA, M., DAVOLI, M., FUSCO, D., BARONE, A. P. & PERUCCI, C. A. 2013. Thirty-day complications after laparoscopic or open cholecystectomy: a population-based cohort study in Italy. *British Medical Journal Open,* 3.

AGARWAL, S., LASWAY, C., L'ENGLE, K., HOMAN, R., LAYER, E., OLLIS, S., BRAUN, R., SILAS, L., MWAKIBETE, A. & KUDRATI, M. 2016. Family Planning Counseling in Your Pocket: A Mobile Job Aid for Community Health Workers in Tanzania. *Global Health Science and Practice,* 4**,** 300-10.

AHMAD, M. S. & WOOD, D. R. 2017. Building a visual aid for a triage tool in a developing health service. *Emergency Medicine Journal,* 34**,** 726-727.

AKAIKE, H. 1973. Information theory and an extension of the maximum likelihood principle. *In:* PETROV, B. N. & CSAKI, F. (eds.) *2nd International symposium on Information Theory.* Tsahkadour, Armenia: Akademiai Kiado.

ALAM, N., HOBBELINK, E. L., VAN TIENHOVEN, A. J., VAN DE VEN, P. M., JANSMA, E. P. & NANAYAKKARA, P. W. B. 2014. The impact of the use of the Early Warning Score (EWS) on patient outcomes: A systematic review. *Resuscitation,* 85**,** 587-594.

ALAM, N., VEGTING, I. L., HOUBEN, E., VAN BERKEL, B., VAUGHAN, L., KRAMER, M. H. H. & NANAYAKKARA, P. W. B. 2015. Exploring the performance of the National Early Warning Score (NEWS) in a European emergency department. *Resuscitation,* 90**,** 111-115.

ALBERT, B. & HUESMAN, L. 2011. EB125: Use of the electronic medical record in the development of a Modified Early Warning Score. *Critical Care Nurse,* 31**,** 53.

ALMUTAIRI, A. F., GARDNER, G. E. & MCCARTHY, A. 2014. Practical guidance for the use of a pattern-matching technique in case-study research: a case presentation. *Nursing and Health Sciences,* 16**,** 239-44.

ALRAWI, Y. A., PARKER, R. A., HARVEY, R. C., SULTANZADEH, S. J., PATEL, J., MALLINSON, R., POTTER, J. F., TREPTE, N. J. & MYINT, P. K. 2013. Predictors of early mortality among hospitalized nursing home residents. *Quarterly Journal of Medicine,* 106**,** 51-7.

ALSPACH, J. G. 2012. Recognize the tipping points in vital signs: beware the treacherous triads. *Critical Care Nurse,* 32**,** 10-1.

AMADOR, S., GOODMAN, C., KING, D., MACHEN, I., ELMORE, N., MATHIE, E. & ILIFFE, S. 2014. Emergency ambulance service involvement with residential care homes in the support of older people with dementia: an observational study. *BioMed Central Geriatrics,* 14**,** 95.

AMB-X NHS TRUST 2014a. Paramedic Pathfinder Handbook.

AMB-X NHS TRUST 2014b. Responding to your 999 calls.

AMB-X NHS TRUST 2015a. On scene conveyance and referral procedure.

AMB-X NHS TRUST 2015b. Role description: Paramedic Pathfinder.

AMB-X NHS TRUST 2016. On scene conveyance and referral procedure.

ANDERSON, I. 2016. A proposed Primary Health Early Warning Score (PHEWS) with emphasis on early detection of sepsis in the elderly. *Journal of Primary Health Care,* 8**,** 5-8.

ANDREWS, T. & WATERMAN, H. 2005. Packaging: a grounded theory of how to report physiological deterioration effectively. *Journal of Advanced Nursing,* 52**,** 473-81.

ANNEY, V. N. 2014. Ensuring the quality of the findings of qualitative research: Looking at Trustworthiness Criteria. *Journal of Emerging Trends in Educational Research and Policy Studies,* 5**,** 272-281.

ANON 2010. Expanded MEWS is more predictive. *ED Management,* 22**,** 46-7.

ANON 2016. Value of early warning scores in emergency departments. *Emergency Nurse,* 24**,** 11-11.

ASKIM, A., MOSER, F., GUSTAD, L. T., STENE, H., GUNDERSEN, M., ASVOLD, B. O., DALE, J., BJORNSEN, L. P., DAMAS, J. K. & SOLLIGARD, E. 2017. Poor performance of quick-SOFA (qSOFA) score in predicting severe sepsis and mortality - a prospective study of patients admitted with infection to the emergency department. *Scandinavian Journal of Trauma, Resuscitation and Emergergency Medicine,* 25**,** 56.

BACHMAIER, R., ARYEE, D. N., JUG, G., KAUER, M., KREPPEL, M., LEE, K. A. & KOVAR, H. 2009. O-GlcNAcylation is involved in the transcriptional activity of EWS-FLI1 in Ewing's sarcoma. *Oncogene,* 28**,** 1280-4.

BAEZ, A. A. 2015. The Pre-hospital Sepsis Score (PSS): an evidence-based early identification tool. *Emergency Medicine,* 6.

BAEZ, A. A. 2016. Miami Sepsis Score: New evidence-based prehospital sepsis identification tool. *JEMS: A Journal Of Emergency Medical Services,* 41**,** 35-35.

BAEZ, A. A. & COCHON, L. 2016. Acute Care Diagnostics Collaboration: Assessment of a Bayesian clinical decision model integrating the Prehospital Sepsis Score and point-of-care lactate. *American Journal of Emergency Medicine,* 34**,** 193-196.

BAEZ, A. A., HANUDEL, P. & WILCOX, S. R. 2013. The Prehospital Sepsis Project: Out-of-Hospital Physiologic Predictors of Sepsis Outcomes. *Prehospital and Disaster Medicine,* 28**,** 632-635.

BAILLY, A., LASCARROU, J. B., LE THUAUT, A., BOISRAME-HELMS, J., KAMEL, T., MERCIER, E., RICARD, J. D., LEMIALE, V., CHAMPIGNEULLE, B. & REIGNIER, J. 2015. McGRATH MAC videolaryngoscope versus Macintosh laryngoscope for orotracheal intubation in intensive care patients: the randomised multicentre MACMAN trial study protocol. *British Medical Journal Open,* 5.

BAN, J., BENNANI-BAITI, I. M., KAUER, M., SCHAEFER, K. L., POREMBA, C., JUG, G., SCHWENTNER, R., SMRZKA, O., MUEHLBACHER, K., ARYEE, D. N. & KOVAR, H. 2008. EWS-FLI1 suppresses NOTCH-activated p53 in Ewing's sarcoma. *Cancer Research,* 68**,** 7100-9.

BAN, J., JUG, G., MESTDAGH, P., SCHWENTNER, R., KAUER, M., ARYEE, D. N., SCHAEFER, K. L., NAKATANI, F., SCOTLANDI, K., REITER, M., STRUNK, D., SPELEMAN, F., VANDESOMPELE, J. & KOVAR, H. 2011. Hsa-mir-145 is the top EWS-FLI1-repressed microRNA involved in a positive feedback loop in Ewing's sarcoma. *Oncogene,* 30**,** 2173-80.

BARDOT, L., BEAUJET, H., BEDOCS, Z., JUDD, S., PULLEN, A., WHITLOCK, R., WILLIAMS, D. & WHITE, R. 2017. NHS Ambulance Services. *Health and Social Care.* London: National Audit Office.

BARRETT, J. 2016. National Early Warning Score Lactate (NEWS–L): is it good news for pre-hospital care? *Journal of Paramedic Practice,* 8**,** 515-516.

BAYER, O., SCHWARZKOPF, D., STUMME, C., STACKE, A., HARTOG, C. S., HOHENSTEIN, C., KABISCH, B., REICHEL, J., REINHART, K. & WINNING, J. 2015. An Early Warning Scoring System to Identify Septic Patients in the Prehospital Setting: The PRESEP Score. *Academic Emergency Medicine,* 22**,** 868-71.

BAYLISS, S. E., DAVENPORT, C. F. & PENNANT, M. E. 2014. Where and how to search for information on the effectiveness of public health interventions--a case study for prevention of cardiovascular disease. *Health Info Libr J,* 31**,** 303-13.

BAZELEY, P. & JACKSON, K. 2013. *Qualitative data analysis with NVIVO,* London, SAGE Publications Ltd.

BBC NEWS. 2014. *East Midlands Ambulance: Increase in paramedic stress* [Online]. BBC. Available: https://www.bbc.co.uk/news/uk-england-30546056 [Accessed 29/07/2018].

BEAUCHAMP, T. L. & CHILDRESS, J. F. 2001. *Principles of biomedical ethics,* New York, USA, Oxford University Press.

BITSCH, V. 2005. Qualitative research: a grounded theory example and evaluation criteria. *Journal of Agribusiness,* 23**,** 75-91.

BLODGETT, J. M., ROBERTSON, D., RATCLIFFE, D. & ROCKWOOD, K. 2017. An alternative model of pre-hospital care for 999 patients who require non-emergency medical assistance. *International Journal of Emergency Services,* 6**,** 99-103.

BOHM, K., KURLAND, L., BARTHOLDSON, S. & CASTREN, M. 2015. Descriptions and presentations of sepsis - A qualitative content analysis of emergency calls. *International Emergency Nursing,* 23**,** 294-8.

BOHMER, R. 2012. The instrumental value of medical leadership: Engaging doctors in improving services. London: The King's Fund.

BOLES, N. 2018. *Latest update on [name] Hospital* [Online]. Bluetree. [Accessed 19/02/2018].

BOOKER, M. J., SIMMONDS, R. L. & PURDY, S. 2014. Patients who call emergency ambulances for primary care problems: a qualitative study of the decision-making process. *Emergency Medicine Journal,* 31.

BORGERT, M., GOOSSENS, A., ADAMS, R., BINNEKADE, J. & DONGELMANS, D. 2015. Emergency care within hospitals: can it be done more efficiently? *British Journal of Nursing,* 24**,** 820-824.

BOTTLE, A. & AYLIN, P. 2009. Application of AHRQ patient safety indicators to English hospital data. *Quality and Safety in Health Care,* 18**,** 303-308.

BOUZA, E., PINTADO, V., RIVERA, S., BLÁZQUEZ, R., MUÑOZ, P., CERCENADO, E., LOZA, E., RODRÍGUEZ-CRÉIXEMS, M. & MORENO, S. 2005. Nosocomial bloodstream infections caused by Streptococcus pneumoniae. *Clinical Microbiology and Infection,* 11**,** 919-924.

BOWSER, D., OKUNOGBE, A., OLIVERAS, E., SUBRAMANIAN, L. & MORRILL, T. 2015. A Cost-Effectiveness Analysis of Community Health Workers in Mozambique. *Journal of Primare Care and Community Health,* 6**,** 227-32.

BOX, G. E. P. & JENKINS, G. M. 1970. *Time series analysis; forecasting and control,* San Francisco, Holden-Day.

BRADMAN, K., BORLAND, M. & PASCOE, E. 2014. Predicting patient disposition in a paediatric emergency department. *Journal of Paediatrics and Child Health,* 50**,** E39-E44.

BRAUN, R., LASWAY, C., AGARWAL, S., L'ENGLE, K., LAYER, E., SILAS, L., MWAKIBETE, A. & KUDRATI, M. 2016. An evaluation of a family planning mobile job aid for community health workers in Tanzania. *Contraception,* 94**,** 27-33.

BROOKE, M. 2014. A response to 'Paramedic Pathfinder: is it really better than current practice?'. *Journal of Paramedic Practice,* 6**,** 446-447.

BROUGHTON, W. 2017. PP11 Do paediatric early warning score relate to emergency department outcomes for children aged 0–2 years brought in by ambulance? *Emergency Medicine Journal,* 34**,** e3-e4.

BROWN, E. & BLEETMAN, A. 2006. Ambulance alerting to hospital: the need for clearer guidance. *Emergency Medicine Journal,* 23**,** 811-814.

BRUCE, K. & SUSERUD, B.-O. 2003. AMBULANCE NURSING PART THREE. *Emergency Nurse,* 11**,** 16.

BRUCE, K. & SUSERUD, B. O. 2005. The handover process and triage of ambulance-borne patients: the experiences of emergency nurses. *Nursing in Critical Care,* 10**,** 201-9.

BUNKENBORG, G., POULSEN, I., SAMUELSON, K., LADELUND, S. & AKESON, J. 2016. Mandatory early warning scoring--implementation evaluated with a mixed-methods approach. *Applied Nursing Research,* 29**,** 168-76.

BUNKENBORG, G., SAMUELSON, K., POULSEN, I., LADELUND, S. & AKESON, J. 2014. Lower incidence of unexpected in-hospital death after interprofessional implementation of a bedside track-and-trigger system. *Resuscitation,* 85**,** 424-30.

BURKE, T. F., HINES, R., AHN, R., WALTERS, M., YOUNG, D., ANDERSON, R. E., TOM, S. M., CLARK, R., OBITA, W. & NELSON, B. D. 2014. Emergency and urgent care capacity in a resource-limited setting: an assessment of health facilities in western Kenya. *British Medical Journal Open,* 4**,** e006132.

BURNHAM, K. P. & ANDERSON, D. R. 2002. *Model selection and multimodel inference,* New York, USA, Springer-verlag.

BURNHAM, K. P. & ANDERSON, D. R. 2004. Multimodel Inference: Understanding AIC and BIC in Model Selection. *Sociological Methods and Research,* 33**,** 261-304.

CAMERON, A., RODGERS, K., IRELAND, A., JAMDAR, R. & MCKAY, G. A. 2015. A simple tool to predict admission at the time of triage. *Emergency Medicine Journal,* 32**,** 174-9.

CAMPBELL, C., AL SHAIKH, L., SAIFELDEEN, K., BOWEN, J., PAP, R., ALINIER, G., MEYER, J. & NAIDOO, V. 2016. Validation of the pre-hospital Qatar Early Warning Score (QEWS) to determine transport priority. *Journal of Emergency Medicine, Trauma and Acute Care,* 2016**,** 104.

CAMPBELL, D. T. 1963. From description to experimentation: interpreting trends as quasi-experiments. *In:* HARRIS, C. W. (ed.) *Problems of measuring change.* Madison: University of Wisconsin Press.

CAMPBELL, D. T. 1975. Degrees of freedom and the case study. *Comparative Political Studies,* 8**,** 178-193.

CARBERRY, M. & HARDEN, J. 2016. A collaborative improvement project by an NHS Emergency Department and Scottish Ambulance Paramedics to improve the identification and delivery of sepsis 6. *British Medical Journal Quality Improvement Report,* 5.

CARE QUALITY COMMISSION. 2013. *Inspection Report for AMB-X* [Online]. Care Quality Commission [Accessed 02/03/2018].

CARE QUALITY COMMISSION. 2016. *Inspection report for AMB-X* [Online]. Care Quality Commission. [Accessed 24/02/2018].

CARMICHAEL, H. A., ROBERTSON, E., AUSTIN, J., MCCRUDEN, D., MESSOW, C. M. & BELCHER, P. R. 2011. A new approach to scoring systems to improve identification of acute medical admissions that will require critical care. *Scottish Medical Journal,* 56**,** 195-202.

CENTOR, R. M., WITHERSPOON, J. M., DALTON, H. P., BRODY, C. E. & LINK, K. 1981. The diagnosis of strep throat in adults in the emergency room. *Medical Decision Making,* 1**,** 239-46.

CENTRE FOR REVIEWS AND DISSEMINATION 2009. Systematic reviews: CRD's guidance for undertaking reviews in health care. University of York: CRD.

CHALLEN, K. & WALTER, D. 2010. Physiological scoring: an aid to emergency medical services transport decisions? *Prehospital & Disaster Medicine,* 25**,** 320-323.

CHAMPION, H. R., SACCO, W. J., CARNAZZO, A. J., COPES, W. & FOUTY, W. J. 1981. Trauma score. *Critical Care Medicine,* 9**,** 672-6.

CHAMPION, H. R., SACCO, W. J., COPES, W. S., GANN, D. S., GENNARELLI, T. A. & FLANAGAN, M. E. 1989. A revision of the Trauma Score. *Journal of Trauma and Acute Care Surgery,* 29**,** 623-9.

CHAPMAN, G. B. & SONNENBERG, F. A. 2000. Introduction. *In:* CHAPMAN, G. B. & SONNENBERG, F. A. (eds.) *Decision making in health care: theory, psychology and applications.* New York, USA: Cambridge University Press.

CHARBONNEAU, V., KWOK, E., BOYLE, L. & STIELL, I. G. 2018. Impact of emergency department surge and end of shift on patient workup and treatment prior to referral to internal medicine: a health records review. *Emergency Medicine Journal*.

CHEN, R., HUANG, Y. & YANG, J. 2010. Application of modified early warning score system in the integrated management of pre-hospital care. *Chinese General Practice,* 13**,** 1318-1319.

CHOWDHURY, R., MUKHERJEE, A., NASKA, S., ADHIKARY, M. & LAHIRI, S. 2013. Seasonality of tuberculosis in rural West Bengal: A time series analysis. *International Journal of Health & Allied Sciences,* 2**,** 95-98.

CHRISTENSEN, D., JENSEN, N. M., MAALOE, R., RUDOLPH, S. S., BELHAGE, B. & PERRILD, H. 2011. Low compliance with a validated system for emergency department triage. *Danish Medical Bulletin,* 58**,** A4294.

CLARKE, V., HARRIS, G. & COWLAND, S. 2012. Ethics and law for the paramedic. *In:* BLABER, A. Y. (ed.) *Foundations for paramedic practice: a theoretical perspective.* England: Open University Press.

CLEMENCE, M. 2018. *Trusts in professions: Long-term trends* [Online]. Ipsos MORI. Available: https://www.ipsos.com/ipsos-mori/en-uk/trust-professions-long-term-trends [Accessed 15/02/2018].

CLEMENTS, R. & MACKENZIE, R. 2005. Competence in prehospital care: evolving concepts. *Emergency Medicine Journal,* 22**,** 516-519.

CLIFTON, D. A., CLIFTON, L., SANDU, D.-M., SMITH, G. B., TARASSENKO, L., VOLLAM, S. A. & WATKINSON, P. J. 2015. 'Errors' and omissions in paper-based early warning scores: the association with changes in vital signs—a database analysis. *British Medicial Journal Open,* 5.

COCHRANE EFFECTIVE PRACTICE AND ORGANISATION OF CARE. 2017. *Interrupted time series (ITS) analyses* [Online]. Cochrane. Available: https://epoc.cochrane.org/resources/epoc-resources-review-authors [Accessed 30/07/2018].

COLLEN, A. 2017. *Decision making in paramedic practice*, Class Professional Publishing.

CONE, D. C. 2015. The Prehospital Sepsis Screen: A Test in Search of an Application? *Academic Emergency Medicine,* 22**,** 845-846.

CONNELL, C. J., ENDACOTT, R., JACKMAN, J. A., KIPRILLIS, N. R., SPARKES, L. M. & COOPER, S. J. 2016. The effectiveness of education in the recognition and management of deteriorating patients: A systematic review. *Nurse Education Today,* 44**,** 133-45.

CORFIELD, A. R., LEES, F., ZEALLEY, I., HOUSTON, G., DICKIE, S., WARD, K. & MCGUFFIE, C. 2014. Utility of a single early warning score in patients with sepsis in the emergency department. *Emergency Medicine Journal,* 31**,** 482-7.

CREDLAND, N. 2018. Recognition and response to the deteriorating patient. *Nursing in Critical Care,* 23**,** 6-7.

CRESWELL, J. W. 2014. *Research design: Qualitative, quantitative and mixed method approaches,* Thousand Oaks, CA, Sage.

CRESWELL, J. W. & PLANO CLARK, V. L. 2006. *Designing and conducting mixed methods research,* Thousand Oaks, CA., Sage Publications.

CROSKERRY, P. 2002. Achieving quality in clinical decision making: cognitive strategies and detection of bias. *Acad Emerg Med,* 9**,** 1184-204.

CROSKERRY, P. 2013. From Mindless to Mindful Practice — Cognitive Bias and Clinical Decision Making. *New England Journal of Medicine,* 368**,** 2445-2448.

DATA USA. 2015. *Emergency Medical Technicians & Paramedics* [Online]. Available: https://datausa.io/profile/soc/292041/#intro [Accessed 10/04/2018].

DAY, T. & OXTON, J. 2014. The National Early Warning Score in practice: a reflection. *British Journal of Nursing,* 23**,** 1036-40.

DE MEESTER, K., DAS, T., HELLEMANS, K., VERBRUGGHE, W., JORENS, P. G., VERPOOTEN, G. A. & VAN BOGAERT, P. 2013. Impact of a standardized nurse observation protocol including MEWS after Intensive Care Unit discharge. *Resuscitation,* 84**,** 184-8.

DE SILVA, D. 2014. *Improvement collaboratives in health care* [Online]. London: The Health Foundation. Available: https://www.health.org.uk/publication/improvement-collaboratives-health-care [Accessed 30/07/2018].

DENZIN, N. K. & LINCOLN, Y. S. 2011. *The SAGE handbook of qualitative research,* Thousand Oaks, CA, Sage.

DEPARTMENT OF HEALTH. 2009. *Tackling demand together: a framework for improving urgent and emergency care pathways by understanding increase in 999 demand* [Online]. London: Department of Health. Available: http://webarchive.nationalarchives.gov.uk/20130124051819/http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_106924.pdf [Accessed 30/07/2018].

DEPARTMENT OF HEALTH AND SOCIAL CARE 2012. Health and Social Care Act 2012. London: The Stationary Office.

DEWEY, J. 1937. Logic: The theory of inquiry. *In:* BOYDSTON, J. A. (ed.) *John Dewey the later works: 1925-1953.* Carbondale: Southern Illinois University Press.

DOJMI DI DELUPIS, F., PISANELLI, P., DI LUCCIO, G., KENNEDY, M., TELLINI, S., NENCI, N., GUERRINI, E., PINI, R. & FRANCO GENSINI, G. 2014. Communication during handover in the pre-hospital/hospital interface in Italy: from evaluation to implementation of multidisciplinary training through high-fidelity simulation. *Internal and Emergency Medicine,* 9**,** 575-82.

DOWDING, D. & THOMPSON, C. 2002. Decision analysis. *In:* THOMPSON, C. & DOWDING, D. (eds.) *Clinical decision making and judgement in nursing.* London: Churchill Livingstone.

DOWNEY, C. L., TAHIR, W., RANDELL, R., BROWN, J. M. & JAYNE, D. G. 2017. Strengths and limitations of early warning scores: A systematic review and narrative synthesis. *International Journal of Nursing Studies,* 76**,** 106-119.

DUCKITT, R. W., BUXTON-THOMAS, R., WALKER, J., CHEEK, E., BEWICK, V., VENN, R. & FORNI, L. G. 2007. Worthing physiological scoring system: derivation and validation of a physiological early-warning system for medical admissions. An observational, population-based single-centre study. *British Journal of Anaesthesia,* 98**,** 769-774.

EBRAHIMIAN, A., MASOUMI, G., JAMSHIDI-ORAK, R. & SEYEDIN, H. 2017. Development and Psychometric Evaluation of the Pre-hospital Medical Emergencies Early Warning Scale. *Indian Journal of Critical Care Medicine,* 21**,** 205-212.

EBRAHIMIAN, A., SEYEDIN, H., JAMSHIDI-ORAK, R. & MASOUMI, G. 2014a. Exploring Factors Affecting Emergency Medical Services Staffs' Decision about Transporting Medical Patients to Medical Facilities. *Emergency Medicine International,* 2014**,** 215329.

EBRAHIMIAN, A., SEYEDIN, H., JAMSHIDI-ORAK, R. & MASOUMI, G. 2014b. Physiological-social scores in predicting outcomes of prehospital internal patients. *Emergency Medicine International,* 2014**,** 312189.

EBRAHIMIAN, A., SHABANIKIYA, H. & KHALESI, N. 2012. The role of physiological scores for decision making in internal pre-hospital emergency situations. *HealthMed,* 6**,** 3612-3615.

EDWARDS, M., MCKAY, H., VAN LEUVAN, C. & MITCHELL, I. 2010. Modified Early Warning Scores: inaccurate summation or inaccurate assignment of score? *Critical Care,* 14**,** P257-P257.

EDWARDS, N., KORNACKI, M. J. & SILVERSIN, J. 2002. Unhappy doctors: what are the causes and what can be done? *British Medical Journal,* 324**,** 835-8.

EGDELL, P., FINLAY, L. & PEDLEY, D. K. 2008. The PAWS score: validation of an early warning scoring system for the initial assessment of children in the emergency department. *Emergency Medicine Journal,* 25**,** 745-9.

EMERSON, R. M., FRETZ, R. I. & SHAW, L. L. 2001. Participant observation and fieldnotes. *In:* ATKINSON, P., COFFEY, A., DELAMONT, S., LOFLAND, J. & LOFLAND, L. (ed.) *Handbook of Ethnography.* London: Sage Publications Ltd.

ENGELBRECHT, A., DU TOIT, F. G. & GEYSER, M. M. 2015. A cross-sectional profile and outcome assessment of adult patients triaged away from Steve Biko Academic Hospital emergency unit. *South African Family Practice,* 57**,** 208-213.

ENGLUND, A. & STUART, E. 2015. Survival of in hospital cardiac arrest related to the changes of vital parameters measured by the Modified Early Warning Score within 24h pre-arrest. *Resuscitation,* 96S**,** 145-146.

ENNIS, L. 2014. Paediatric early warning scores on a children's ward: a quality improvement initiative. *Nursing Children and Young People,* 26**,** 25-31.

ESSAM, N., WINDLE, K., MULLINEAUX, D., KNOWLES, S., GRAY, J. & SIRIWARDENA, N. 2015. Modified Early Warning Scores (MEWS) to support ambulance clinicians' decisions to transport or treat at home. *Emergency Medicine Journal,* 32**,** e1.

FIELD, A. 2009. Regression. *Discovering Statistics using SPSS.* 3rd ed. London: Sage.

FITZPATRICK, D., MCKENNA, M., ROONEY, K., BECKETT, D. & PRINGLE, N. 2014. Improving the management and care of people with sepsis. *Emergency Nurse,* 22**,** 18-24.

FLÔR DA ROCHA, T., GIBBON NEVES, J. & VIEGAS, K. 2016. Modified early warning score: evaluation of trauma patients. *Revista Brasileira de Enfermagem,* 69**,** 850-855.

FOX, N. 2009. *Using interviews in a research project* [Online]. Available: https://www.rds-yh.nihr.ac.uk/wp-content/uploads/2013/05/15_Using-Interviews-2009.pdf [Accessed 04/01/2018].

FRANKENHAEUSER, M. 1986. A psychobiological framework for research on human stress and coping. *In:* APPLEY, M. H. & TRUMBELL, R. (eds.) *Dynamics of stress. Physiological, psychological and social perspectives.* New York: Plenum.

FUIJKSCHOT, J., VERNHOUT, B., LEMSON, J., DRAAISMA, J. M. & LOEFFEN, J. L. 2015. Validation of a Paediatric Early Warning Score: first results and implications of usage. *European Journal of Pediatrics,* 174**,** 15-21.

FULLERTON, J. N., PRICE, C. L., SILVEY, N. E., BRACE, S. J. & PERKINS, G. D. 2012. Is the Modified Early Warning Score (MEWS) superior to clinician judgement in detecting critical illness in the pre-hospital environment? *Resuscitation,* 83**,** 557-62.

GABEL, S. 2012. Power, leadership and transformation: the doctor's potential for influence. *Medical Education,* 46**,** 1152-60.

GAO, H., MCDONNELL, A., HARRISON, D. A., MOORE, T., ADAM, S., DALY, K., ESMONDE, L., GOLDHILL, D. R., PARRY, G. J., RASHIDIAN, A., SUBBE, C. P. & HARVEY, S. 2007. Systematic review and evaluation of physiological track and trigger warning systems for identifying at-risk patients on the ward. *Intensive Care Medicine,* 33**,** 667-79.

GARAVAGLIA, S. & SHARMA, A. 2016. *A smart guide to dummy variables: four applications and a macro* [Online]. USA.: Institute for Digital Research and Education, University of California, Los Angeles (UCLA). Available: https://stats.idre.ucla.edu/wp-content/uploads/2016/02/p046.pdf [Accessed 11/20/2018].

GARDNER-THORPE, J., LOVE, N., WRIGHTSON, J., WALSH, S. & KEELING, N. 2006. The value of Modified Early Warning Score (MEWS) in surgical in-patients: a prospective observational study. *Annals of the Royal College of Surgeons of England,* 88**,** 571-5.

GAUMONT, D., CUMMINS, N., HANNIGAN, A. & RYAN, D. 2016. ViEWS from the prehospital perspective: a comparison with a prehospital score to triage categorisation in the emergency department. *Irish Medical Journal,* 109**,** 423.

GEROVASILI, V., STEFANIDIS, K., VITZILAIOS, K., KARATZANOS, E., POLITIS, P., KORONEOS, A., CHATZIMICHAIL, A., ROUTSI, C., ROUSSOS, C. & NANAS, S. 2009. Electrical muscle stimulation preserves the muscle mass of critically ill patients: a randomized study. *Critical Care,* 13**,** R161.

GILBERT, N. 2016. AMB-X: Annual Reports and Accounts 2015/16. *Extraordinary Trust Board Meeting.* AMB-X NHS Trust [Accessed: 24/02/1018].

GILL, C. J., LE NGOC, B., HALIM, N., NGUYEN VIET, H., LARSON WILLIAMS, A., NGUYEN VAN, T., MCNABB, M., TRAN THI NGOC, L., FALCONER, A., AN PHAN HA, H., ROHR, J., HOANG, H., MICHIEL, J., NGUYEN THI THANH, T., BIRD, L., PHAM VU, H., YESHITLA, M., HA VAN, N. & SABIN, L. 2016. The mCME Project: A Randomized Controlled Trial of an SMS-Based Continuing Medical Education Intervention for Improving Medical Knowledge among Vietnamese Community Based Physicians' Assistants. *PLoS One,* 11**,** e0166293.

GOLDHILL, D. R. 2005. Preventing surgical deaths: critical care and intensive care outreach services in the postoperative period. *BJA: British Journal of Anaesthesia,* 95**,** 88-94.

GOODLEY, D., LAWTHOM, R. & TINDALL, C. 2003. *Understanding people: qualitative methods,* Milton Keynes, The Open University.

GOULDING, J. 2014a. Paramedic Pathfinder: is it really better than current practice? *Journal of Paramedic Practice,* 6**,** 396-397.

GOULDING, J. 2014b. *Re: Clinical navigation for beginners: the clinical utility and safety of the Paramedic Pathfinder* [Online]. Emergency Medicine Journal. Available: http://emj.bmj.com/content/re-clinical-navigation-beginners-clinical-utility-and-safety-paramedic-pathfinder [Accessed 03/04/2018].

GRAY, J. T., CHALLEN, K. & OUGHTON, L. 2010. Does the pandemic medical early warning score system correlate with disposition decisions made at patient contact by emergency care practitioners? *Emergency Medicine Journal,* 27**,** 943-7.

GRAY, J. T. & WARDROPE, J. 2007. Introduction of non-transport guidelines into an ambulance service: a retrospective review. *Emergency Medicine Journal,* 24**,** 727-9.

GREEN, A. L. & WILLIAMS, A. 2006. An evaluation of an early warning clinical marker referral tool. *Intensive and Critical Care Nursing,* 22**,** 274-82.

GREEN, R. S., TRAVERS, A. H., CAIN, E., CAMPBELL, S. G., JENSEN, J. L., PETRIE, D. A., ERDOGAN, M., PATRICK, G. & PATRICK, W. 2016. Paramedic Recognition of Sepsis in the Prehospital Setting: A Prospective Observational Study. *Emergency Medicine International***,** 1-5.

GRESPAN, P. 2018. *The effect of implementing a Modified Early Warning Score on patient outcomes in an inpatient cardiology ward.* Master of Science in Nursing, University of British Columbia.

GRIFFITHS, J. R. & KIDNEY, E. M. 2012. Current use of early warning scores in UK emergency departments. *Emergency Medicine Journal,* 29**,** 65-6.

GUBA, E. G. & LINCOLN, Y. S. 1994. Competing paradigms in qualitative research. *In:* DENZIN, N. K. & LINCON, Y. S. (eds.) *Handbook of qualitative research.* Thousand Oaks, CA: Sage.

GUERRA, W. F., MAYFIELD, T. R., MEYERS, M. S., CLOUATRE, A. E. & RICCIO, J. C. 2013. Early detection and treatment of patients with severe sepsis by prehospital personnel. *Journal of Emergency Medicine,* 44**,** 1116-25.

HAINES, S. G. 1998. *The managers pocket guide to systems thinking and learning,* Canada, HRD Press.

HALAWEISH, I., NIKOLIAN, V., GEORGOFF, P., LI, Y. & ALAM, H. B. 2015. Creating a "Prosurvival Phenotype" Through Histone Deacetylase Inhibition: Past, Present, and Future. *Shock,* 44 Suppl 1**,** 6-16.

HALTER, M., VERNON, S., SNOOKS, H., PORTER, A., CLOSE, J., MOORE, F. & PORSZ, S. 2011. Complexity of the decision-making process of ambulance staff for assessment and referral of older people who have fallen: a qualitative study. *Emergency Medicine Journal,* 28.

HAMM, R. M. 1988. Clinical intuition and clinical analysis: expertise and the cognitive continuum. *In:* DOWIE, J. & ELSTEIN, A. (eds.) *Professional judgement: a reader in clinical decision making.* UK: Cambridge University Press.

HAMM, R. M., SCHEID, D. C., SMITH, W. R. & TAPE, T. G. 2000. Opportunities for applying psychological theory to improve medical decision making: two case histories. *In:* CHAPMAN, G. B. & SONNENBERG, F. A. (eds.) *Decision making in health care: theory, psychology and applications* New York, USA: Cambridge University Press.

HAMMOND, K. R. 1980. The integration of research in judgement and decision theory. Boulder, Colorado: Institute of Behavioural Science, University of Colorado.

HANCOCK, C. 2015. A national quality improvement initiative for reducing harm and death from sepsis in Wales. *Intensive and Critical Care Nursing,* 31**,** 100-5.

HANDS, C., REID, E., MEREDITH, P., SMITH, G. B., PRYTHERCH, D. R., SCHMIDT, P. E. & FEATHERSTONE, P. I. 2013. Patterns in the recording of vital signs and early warning scores: compliance with a clinical escalation protocol. *British Medical Journal Quality and Safety,* 22**,** 719.

HARRISON, G. A., JACQUES, T., MCLAWS, M. L. & KILBORN, G. 2006. Combinations of early signs of critical illness predict in-hospital death-the SOCCER study (signs of critical conditions and emergency responses). *Resuscitation,* 71**,** 327-34.

HASSAN, Z. A., SCHATTNER, P. & MAZZA, D. 2006. Doing A Pilot Study: Why Is It Essential? *Malaysian Family Physician,* 1**,** 70-73.

HAWKINS, D. 1980. *Identification of outliers,* Netherlands, Springer.

HEALTH & CARE PROFESSIONS COUNCIL. 2017. *Age and gender breakdown for Paramedics - November 2017* [Online]. Available: https://www.hcpc-uk.org/publications/foi/index.asp?id=1453 [Accessed 10/04/2018].

HEALTH RESEARCH AUTHORITY 2017. HRA: Designing Research - Decision Tool.

HIGGINS, J. P. T. & GREEN, S. 2011. *Cochrane Handbook for systematic reviews of interventions*, The Cochrane Collaboration.

HIGGS, J. & TITCHEN, A. 2001. *Professional practice in health, education and the creative arts,* Oxford, Blackwell Science.

HOCKEY, G. J. 2000. Work Environments and Performance. *In:* CHMIEL, N. (ed.) *Introduction to Work and Organizational Psychology: A European Perspective.* Oxford: Blackwell Publishing Ltd.

HOIKKA, M., LÄNKIMÄKI, S., SILFVAST, T. & ALA-KOKKO, T. I. 2016. Medical priority dispatch codes—comparison with National Early Warning Score. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine,* 24**,** 142.

HOIKKA, M., SILFVAST, T. & ALA-KOKKO, T. I. 2018. Does the prehospital National Early Warning Score predict the short-term mortality of unselected emergency patients? *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine,* 26**,** 48.

HOLLENBERG, J., SVENSSON, L. & ROSENQVIST, M. 2013. Out-of-hospital cardiac arrest: 10 years of progress in research and treatment. *Journal of Internal Medicine,* 273**,** 572-83.

HSIAO-YUN, C., PENG-HUI, L., SHEN-CHE, L., CHEN, C.-K., JIH-CHANG, C., YI-LIN, C., CHIN-CHIEH, W., BLANEY, G. N., ZHEN-YING, L., CHO-JU, W. & KUAN-FU, C. 2017. Association of In-Hospital Mortality and Dysglycemia in Septic Patients. *PLoS One,* 12.

HUNTER, C., STONE, A. & RALLS, G. 2016a. $EtCO_2$ to Identify Severe Sepsis: Prehospital sepsis screening and ED alerts in Orange County, Fla. *Journal of Emergency Medical Services,* 41**,** 40-47.

HUNTER, C. L., SILVESTRI, S., RALLS, G., STONE, A., WALKER, A. & PAPA, L. 2016b. A prehospital screening tool utilizing end-tidal carbon dioxide predicts sepsis and severe sepsis. *American Journal of Emergency Medicine,* 34**,** 813-819.

HYNDMAN, R. J. 2014. *Unit root tests and ARIMA models* [Online]. Available: https://robjhyndman.com/hyndsight/unit-root-tests/ [Accessed 07/11/2018].

HYNDMAN, R. J. 2017. _forecast:Forecasting functions for time series and linear models_. https://cran.r-project.org: The R Project for Statistical Computing.

HYNDMAN, R. J. & ATHANASOPOULUS, G. 2014. *Forecasting: Principles and Practice,* Melbourne, Australia, OTexts.com.

IBM 2013a. IBM SPSS Statistics for Windows. USA: IBM Corp.

IBM. 2013b. *SPSS forecasting 22* [Online]. USA: IBM Corp. Available: http://www.sussex.ac.uk/its/pdfs/SPSS_Forecasting_22.pdf [Accessed 30/07/2018].

IBM. 2016. *SPSS Modeler* [Online]. USA: IBM Corp. Available: http://www-01.ibm.com/support/docview.wss?uid=swg27046871 [Accessed 30/07/2018].

INGHAM CLARK, C. 2018. Here's the NEWS: great progress on sepsis but still more to do. Available from: https://www.england.nhs.uk/blog/heres-the-news-great-progress-on-sepsis-but-still-more-to-do/ [Accessed 22 February 2018 06/08/2018].

JACINTO, A., MOBARACALY, M. R., USTAB, M. B., BIQUE, C., BLAZER, C., WEIDERT, K. & PRATA, N. 2016. Safety and Acceptability of Community-Based Distribution of Injectable Contraceptives: A Pilot Project in Mozambique. *Global Health: Science and Practice,* 4**,** 410-21.

JO, S., LEE, J. B., JIN, Y. H., JEONG, T. O., YOON, J. C., JUN, Y. K. & PARK, B. Y. 2013. Modified early warning score with rapid lactate level in critically ill medical patients: the ViEWS-L score. *Emergency Medicine Journal,* 30**,** 123-9.

JOHNSON, R. B., ONWUEGBUZIE, A. J. & TURNER, L. A. 2007. Toward a Definition of Mixed Methods Research. *Journal of Mixed Methods Research,* 1**,** 112-133.

JONES, A. E., SAAK, K. & KLINE, J. A. 2008. Performance of the Mortality in emergency department Sepsis score for predicting hospital mortality among patients with severe sepsis and septic shock. *The American Journal of Emergency Medicine,* 26**,** 689-692.

JOUFFROY, R., SAADE, A., ELLOUZE, S., CARPENTIER, A., MICHALOUX, M., CARLI, P. & VIVIEN, B. 2017. Prehospital triage of septic patients at the SAMU regulation: Comparison of qSOFA, MRST, MEWS and PRESEP scores. *The American Journal of Emergency Medicine*.

JUNHASAVASDIKUL, D., THEERAWIT, P. & KIATBOONSRI, S. 2013. Association between admission delay and adverse outcome of emergency medical patients. *Emergency Medicine Journal,* 30**,** 320-3.

KALLIOMÄKI, J., KONTULA, T., KALLIOMÄKI, M.-L., ISO-AHO, E., KÄMÄRÄINEN, A., VIRKKUNEN, I., YLI-HANKALA, A. & HOPPU, S. 2016. The national early warning score (NEWS) could not predict secondary transportation to the tertiary hospital in Finnish prehospital care. *Resuscitation,* 106**,** e69-e69.

KASHIKAR, N. D., REINER, J., DATTA, A. & DATTA, P. K. 2010. Serine threonine receptor-associated protein (STRAP) plays a role in the maintenance of mesenchymal morphology. *Cell Signal,* 22**,** 138-49.

KAY, I. 2017. *NHS England AQI statistical note, 10 August 2017* [Online]. NHS England. Available: https://www.england.nhs.uk/statistics/statistical-work-areas/ambulance-quality-indicators/ambulance-quality-indicators-data-2016-17/ [Accessed 25/02/2018].

KELLY, L. & ST PIERRE-HANSEN, N. 2008. So many databases, such little clarity: Searching the literature for the topic aboriginal. *Can Fam Physician,* 54**,** 1572-3.

KESSLER, D. O., WALSH, B., WHITFILL, T., GANGADHARAN, S., GAWEL, M., BROWN, L., AUERBACH, M., INVESTIGATORS, I. I. & DUDAS, R. A. 2016. Disparities in Adherence to Pediatric Sepsis Guidelines across a Spectrum of Emergency Departments: A Multicenter, Cross-Sectional Observational In Situ Simulation Study. *Journal of Emergency Medicine (0736-4679),* 50**,** 403-415.e3.

KIM, J. Y., YOON, Y. H., PARK, S. M., CHOI, S. H., CHO, Y. D. & HONG, Y. S. 2014. Heart rate variability measurement in sepsis patients. *Hong Kong Journal of Emergency Medicine,* 21**,** 73-79.

KOTTER, J. P. 2007. Leading change: why transformation efforts fail. *Harvard Business Review,* January.

KUMAR, A., ROBERTS, D., WOOD, K. E., LIGHT, B., PARRILLO, J. E. & SHARMA, S. 2006. Duration of hypotension before initiation of effective antimicrobial therapy is the critical determinant of survival in human septic shock. *Critical Care Medicine,* 34**,** 1589-1596.

KUMARAGURU, K. 2007. Being a change evangelist: inspiring your organization to play the new game with new rules. *PMI Global Congress 2007 - North America.* Atlanta, GA: Newton Square, PA: Project Management Institute.

KWIATKOWSKI, D., PHILLIPS, P. C. B., SCHMIDT, P. & SHIN, Y. 1992. Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Applied Econometrics,* 11**,** 601-618.

LE LAGADEC, M. D. & DWYER, T. 2017. Scoping review: The use of early warning systems for the identification of in-hospital patients at risk of deterioration. *Australian Critical Care,* 30**,** 211-218.

LEUNG, S. C., LEUNG, L. P., FAN, K. L. & YIP, W. L. 2016. Can prehospital Modified Early Warning Score identify non-trauma patients requiring life-saving intervention in the emergency department? *Emergency Medicine Australasia,* 28**,** 84-9.

LINCOLN, Y. S. & GUBA, E. G. 1985. *Naturalistic Inquiry,* Newbury Park, CA, Sage.

LIPSCOMB, M. 2011. Critical realism and realist pragmatism in mixed methods: Problematics of event identity and abductive inference (evolving paradigms in mixed methods research). *American Educational Research Association Annual Meeting.* Lousianna, New Orleans, USA.

LJUNG, G. M. 1993. On outlier detection in time series. *Journal of the Royal Statistical Society,* 55**,** 559-567.

LJUNG, G. M. & BOX, G. E. P. 1978. On a measure of a lack of fit in time series model. *Biometrika,* 65**,** 297-303.

LOFTUS, S. & SMITH, M. 2008. A history of clinical reasoning research. *In:* HIGGS, J., JONES, M. A., LOFTUS, S. & CHRISTENSEN, N. (eds.) *Clinical reasoning in the health professions.* Third edition ed. Croydon, UK: Elsevier.

LOPEZ-DE-LACALLE, J. 2017. Detection of outliers in time series. *Package 'tsoutliers'.* https://cran.r-project.org: The R Project for Statistical Computing.

LUDIKHUIZE, J., DE JONGE, E. & GOOSSENS, A. 2011. Measuring adherence among nurses one year after training in applying the Modified Early Warning Score and Situation-Background-Assessment-Recommendation instruments. *Resuscitation,* 82**,** 1428-33.

LUDIKHUIZE, J., SMORENBURG, S. M., DE ROOIJ, S. E. & DE JONGE, E. 2012. Identification of deteriorating patients on general wards; measurement of vital parameters and potential effectiveness of the Modified Early Warning Score. *Journal of critical care,* 27**,** 424 e7-13.

MACDONALD, S. P. J. & BROWN, S. G. A. 2015. Near-infrared spectroscopy in the assessment of suspected sepsis in the emergency department. *Emergency Medicine Journal,* 32**,** 404-408.

MACKWAY-JONES, K., MARSDEN, J. & WINDLE, J. 2013. *Emergency Triage: Manchester Triage Group,* Chichester, England, Wiley Blackwell.

MARTIN, R. 2015. Midwives' experiences of using a modified early obstetric warning score (MEOWS): a grounded theory study. *Evidenced Based Midwifery,* 13**,** 59-65.

MAY, C. & FINCH, T. 2009. Implementing, Embedding, and Integrating Practices: An Outline of Normalization Process Theory. *Sociology,* 43**,** 535-554.

MAY, C., FINCH, T., MAIR, F., BALLINI, L., DOWRICK, C., ECCLES, M., GASK, L., MACFARLANE, A., MURRAY, E., RAPLEY, T., ROGERS, A., TREWEEK, S., WALLACE, P., ANDERSON, G., BURNS, J. & HEAVEN, B. 2007. Understanding the implementation of complex interventions in health care: the normalization process model. *BioMed Central Health Service Research,* 7**,** 148.

MAY, C., RAPLEY, T., MAIR, F. S., TREWEEK, S., MURRAY, E., BALLINI, L., MACFARLANE, A., GIRLING, M. & FINCH, T. L. 2015. *Normalization Process Theory On-line Users' Manual, Toolkit and NoMAD instrument* [Online]. Available: http://www.normalizationprocess.org [Accessed 02/08/2018].

MCBRIDE, J., KNIGHT, D., PIPER, J. & SMITH, G. B. 2005. Long-term effect of introducing an early warning score on respiratory rate charting on general wards. *Resuscitation,* 65**,** 41-4.

MCCLELLAND, G. 2015. A retrospective observational study to explore the introduction of the National Early Warning Score in NEAS. *Journal of Paramedic Practice,* 7**,** 80-89.

MCCLELLAND, G. & HAWORTH, D. 2016. A qualitative investigation into paramedics' thoughts about the introduction of the National Early Warning Score. *British Paramedic Journal,* 1**,** 9-14.

MCCLELLAND, G. & JONES, J. 2015. A pilot study exploring the accuracy of pre-hospital sepsis recognition in the North East Ambulance Service. *Journal of Paramedic Practice,* 7**,** 459-465.

MCDOWALL, D., MCCLEARY, R., MEIDINGER, E. E. & HAY, R. A. J. 1980. *Interrupted time series analysis,* United States of America, Sage Publications.

MCGILL, F., HEYDERMAN, R. S., MICHAEL, B. D., DEFRES, S., BEECHING, N. J., BORROW, R., GLENNIE, L., GAILLEMIN, O., WYNCOLL, D., KACZMARSKI, E., NADEL, S., THWAITES, G., COHEN, J., DAVIES, N. W., MILLER, A., RHODES, A., READ, R. C. & SOLOMON, T. 2016. The UK joint specialist societies guideline on the diagnosis and management of acute meningitis and meningococcal sepsis in immunocompetent adults. *Journal of Infection,* 72**,** 405-38.

MCNEILL, G. & BRYDEN, D. 2013. Do either early warning systems or emergency response teams improve hospital patient survival? A systematic review. *Resuscitation,* 84**,** 1652-1667.

MILLIGAN, P. 2012. Being there for patients - Our programme to improve response times. *Public Board of Directors Meeting.* AMB-X NHS Trust.

MILLS, A., SAXBY, D., SMITH, S. & SWINBURN, A. 2014. Paramedic Pathfinder Handbook. AMB-X NHS Trust.

MISSEN, K., PORTER, J. E., RAYMOND, A., DE VENT, K. & LARKINS, J. 2018. Adult Deterioration Detection System (ADDS): An evaluation of the impact on MET and Code blue activations in a regional healthcare service. *Collegian,* 25**,** 157-161.

MITCHELL, I. A., MCKAY, H., VAN LEUVAN, C., BERRY, R., MCCUTCHEON, C., AVARD, B., SLATER, N., NEEMAN, T. & LAMBERTH, P. 2010. A prospective controlled trial of the effect of a multi-faceted intervention on early recognition and intervention in deteriorating hospital patients. *Resuscitation,* 81**,** 658-66.

MOHAMMED, M., HAYTON, R., CLEMENTS, G., SMITH, G. & PRYTHERCH, D. 2009. Improving accuracy and efficiency of early warning scores in acute care. *British Journal of Nursing,* 18**,** 18-24.

MOHAMMED, M., MUHAMMAD, F., DONALD, R., ROBIN, H., KEVIN, B., KEVIN, S. & JOHN, W. 2017. Impact of the level of sickness on higher mortality in emergency medical admissions to hospital at weekends. *Journal of Health Services Research and Policy,* 22**,** 236-242.

MOHER, D., LIBERATI, A., TETZLAFF, J. & ALTMAN, D. G. 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *British Medical Journal* 339.

MONITOR. 2014. *Final report and recommendations* [Online]. Gov.UK: Monitor. Available: https://www.gov.uk/government/publications/nhs-walk-in-centre-services-in-england-review [Accessed 30/07/2018 Publication code: IRRES 02/14].

MORGAN, R. J. M., WILLIAMS, F. & WRIGHT, M. M. 1997. An early warning scoring system for detecting developing critical illness. *Clinical Intensive Care,* 8**,** 100.

MORRIS, E., MCCARTNEY, D., LASSERSON, D., VAN DEN BRUEL, A., FISHER, R. & HAYWARD, G. 2017. Point-of-care lactate testing for sepsis at presentation to health care: a systematic review of patient outcomes. *British Journal of General Practice,* 67**,** e859-e870.

MOSESON, E. M., ZHUO, H., CHU, J., STEIN, J. C., MATTHAY, M. A., KANGELARIS, K. N., LIU, K. D. & CALFEE, C. S. 2014. Intensive care unit scoring systems outperform emergency department scoring systems for mortality prediction in critically ill patients: a prospective cohort study. *Journal of intensive care,* 2**,** 40.

MULLER, M. P., MCGEER, A. J., KAZI, H., MARSHALL, J., CHRISTIAN, M. & FOR THE TORONTO INVASIVE BACTERIAL DISEASE, N. 2010. Evaluation of Pneumonia Severity and Acute Physiology Scores to Predict ICU Admission and Mortality in Patients Hospitalized for Influenza. *PLoS One,* 5.

MUNJAL, K. G., SILVERMAN, R. A., FREESE, J., BRAUN, J. D., KAUFMAN, B. J., ISAACS, D., WERNER, A., WEBBER, M., HALL, C. B. & PREZANT, D. J. 2011. Utilization of emergency medical services in a large urban area: description of call types and temporal trends. *Prehospital Emergency Care,* 15**,** 371-80.

MURRAY, E., TREWEEK, S., POPE, C., MACFARLANE, A., BALLINI, L., DOWRICK, C., FINCH, T., KENNEDY, A., MAIR, F., O'DONNELL, C., ONG, B., RAPLEY, T., ROGERS, A. & MAY, C. 2010. Normalisation process theory: a framework for developing, evaluating and implementing complex interventions. *BMC Medicine,* 8**,** 63-63.

NAEEM, N. & MONTENEGRO, H. 2005. Beyond the intensive care unit: a review of interventions aimed at anticipating and preventing in-hospital cardiopulmonary arrest. *Resuscitation,* 67**,** 13-23.

NAJAFI, Z., ZAKERI, H. & MIRHAGHI, A. 2018. The accuracy of acuity scoring tools to predict 24-h mortality in traumatic brain injury patients: A guide to triage criteria. *International Emergency Nurse,* 36**,** 27-33.

NANNAN PANDAY, R. S., MINDERHOUD, T. C., ALAM, N. & NANAYAKKARA, P. W. B. 2017. Prognostic value of early warning scores in the emergency department (ED) and acute medical unit (AMU): A narrative review. *European Journal of Internal Medicine,* 45**,** 20-31.

NASA, P., JUNEJA, D. & SINGH, O. 2012. Severe sepsis and septic shock in the elderly: An overview. *World Journal of Critical Care Medicine,* 1**,** 23-30.

NATIONAL AMBULANCE COMMISSIONERS NETWORK. 2015a. *Developing an Ambulance Commissioning Strategy: Five Year Forward View and Beyond* [Online]. London: NHS Clinical Commissioners. Available: https://www.nhscc.org/networks/ambulance-commissioners/ [Accessed 30/07/2018].

NATIONAL AMBULANCE COMMISSIONERS NETWORK. 2015b. *Good practice in ambulance commissioning* [Online]. London: NHS Clinical Commissioners. Available: https://www.nhscc.org/networks/ambulance-commissioners/ [Accessed 30/07/2018].

NATIONAL ASSOCIATION OF SCHOOL PSYCHOLOGISTS. 2016. *Effective communications: Tips for school psychologists* [Online]. Bethesda, Maryland. USA.: National Association of School Psychologists. Available: https://www.nasponline.org/research-and-policy/advocacy-tools-and-resources/communications-strategies-and-resources/effective-communications-strategies [Accessed 22/07/2018].

NATIONAL HEALTH AND MEDICAL RESEARCH COUNCIL 1999. A guide to the development, implementation and evaluation of clinical practice guidelines. Canberra, Australia: Office of the National Health and Medical Research.

NATIONAL INSTITUTE FOR HEALTH AND CARE EXCELLENCE. 2007. *Acutely ill patients in hospital - recognition of and response to acute illness in adults in hospital* [Online]. London: NICE. Available: https://www.nice.org.uk/guidance/cg50 [Accessed 30/07/2018].

NEARY, P. M., REGAN, M., JOYCE, M. J., MCANENA, O. J. & CALLANAN, I. 2015. National early warning score (NEWS) – evaluation in surgery. *International Journal of Health Care Quality Assurance,* 28**,** 245-252.

NESTOR, P. 2014. Baron Dominique Jean Larrey 1766 – 1842. *Australasian Journal of Paramedicine,* 1.

NEUWIRTH, E. 2014. RColorBrewer: ColorBrewer Palettes. https://cran.r-project.org: The R Project for Statistical Computing.

NEWTON, M., TUNN, E., MOSES, I., RATCLIFFE, D. & MACKWAY-JONES, K. 2013. Clinical navigation for beginners: the clinical utility and safety of the Paramedic Pathfinder. *Emergency Medicine Journal*.

NHS [CITY IN COUNTY1] NORTH AND EAST CLINICAL COMMISSIONING GROUP. 2015. *Changes to the NHS Walk-in Centres in [City in County1]* [Online]. [Accessed 19/02/2018].

NHS [CITY IN COUNTY5] CLINICAL COMMISSIONING GROUP. 2018. *Urgent care and treatment centres* [Online]. The Digital Agency. [Accessed 19/02/2018].

NHS [COUNTY3] WEST CLINICAL COMMISSIONING GROUP. 2017. *Walk-in centre governing body decision - statement* [Online]. Drumbeat. [Accessed 19/02/2018].

NHS ENGLAND. 2013a. *Ambulance Quality Indicators guidance* [Online]. NHS England. Available: https://www.england.nhs.uk/statistics/statistical-work-areas/ambulance-quality-indicators/ [Accessed 29/11/2017 Version 1.3].

NHS ENGLAND. 2013b. *Transforming urgent and emergency care services in England: Urgent and Emergency Care Review End of Phase 1 Report* [Online]. NHS England. Available: https://www.england.nhs.uk/2014/08/update-uec-review/ [Accessed 30/07/2018].

NHS ENGLAND. 2014. *NHS Five Year Forward View* [Online]. NHS England. Available: https://www.england.nhs.uk/publication/nhs-five-year-forward-view/ [Accessed 30/07/2018].

NHS ENGLAND. 2015. *Improving outcomes for patients with sepsis: a cross-system action plan* [Online]. NHS England. Available: https://www.england.nhs.uk/wp-content/uploads/2015/08/Sepsis-Action-Plan-23.12.15-v1.pdf [Accessed 03/08/2018].

NHS ENGLAND. 2016. *Integrating pharmacy into urgent care* [Online]. NHS England. [Accessed 19/02/2018].

NHS ENGLAND. 2018. *National Early Warning Score (NEWS)* [Online]. NHS England,. Available: https://www.england.nhs.uk/nationalearlywarningscore/ [Accessed 06/08/2018].

NHS IMPROVEMENT 2018. Patient safety alert: Resources to support the safe adoption of the revised National Early Warning Score (NEWS2). *In:* NHS ENGLAND (ed.). NHS Improvement: Patient Safety Improvement.

NIEGSCH, M., FABRITIUS, M. L. & ANHØJ, J. 2013. Imperfect Implementation of an Early Warning Scoring System in a Danish Teaching Hospital: A Cross-Sectional Study. *PLOS ONE,* 8**,** e70068.

NOBLE, A. J., SNAPE, D., GOODACRE, S., JACKSON, M., SHERRATT, F. C., PEARSON, M. & MARSON, A. 2016. Qualitative study of paramedics' experiences of managing seizures: a national perspective from England. *British Medicial Journal Open,* 6.

NUNN, C. 2014. Role of Acute Oncology in the Transition to Palliative Care. *St Christopher's End of Life Journal,* 4**,** 1-6.

O'CATHAIN, A., KNOWLES, E., BISHOP-EDWARDS, L., COSTER, J., CRUM, A., JACQUES, R., LAWSON, R., MARSH, M., O'HARA, R., SIRIWARDENA, A. N., STONE, T., TURNER, J. & WILLIAMS, J. 2018a. Scientific Summary - Understanding variation in ambulance service non-conveyance rates: a mixed methods study *Health Service Delivery Research,* 6 Issue 19.

O'CATHAIN, A., KNOWLES, E., BISHOP-EDWARDS, L., COSTER, J., CRUM, A., JACQUES, R., LAWSON, R., MARSH, M., O'HARA, R., SIRIWARDENA, A. N., STONE, T., TURNER, J. & WILLIAMS, J. 2018b. Understanding variation in ambulance service non-conveyance rates: a mixed methods study. *Health Service Delivery Research,* 6 Issue 19.

O'HARA, R., JOHNSON, M., HIRST, E., WEYMAN, A., SHAW, D., MORTIMER, P., NEWMAN, C., STOREY, M., TURNER, J., MASON, S., QUINN, T., SHEWAN, J. & SIRIWARDENA, A. N. 2014. A qualitative study of decision-making and safety in ambulance service transitions. *Health Service Delivery Research,* 2 Issue 56.

O'HARA, R., JOHNSON, M., SIRIWARDENA, A. N., WEYMAN, A., TURNER, J., SHAW, D., MORTIMER, P., NEWMAN, C., HIRST, E., STOREY, M., MASON, S., QUINN, T. & SHEWAN, J. 2015. A qualitative study of systemic influences on paramedic decision making: care transitions and patient safety. *Journal of Health Services Research & Policy,* 20**,** 45-53.

ODELL, M. 2015. Detection and management of the deteriorating ward patient: an evaluation of nursing practice. *Journal of Clinical Nursing,* 24**,** 173-82.

ODELL, M., VICTOR, C. & OLIVER, D. 2009. Nurses' role in detecting deterioration in ward patients: systematic literature review. *Journal of Advanced Nursing,* 65**,** 1992-2006.

OLIVER, D. 2017. David Oliver: Challenging the victim narrative about NHS doctors. *British Medical Journal* 359:j4304.

ORMEROD, R. 2006. The history and ideas of pragmatism. *Journal of the Operational Research Society,* 57**,** 892-909.

ORNE, M. 1962. On the social psychology of the psychological experiment with particular references to demand characteristics and their implications. *American Psychologist,* 17**,** 776-786.

OSTERAS, O., HELTNE, J. K., TONSAGER, K. & BRATTEBO, G. 2018. Outcomes after cancelled helicopter emergency medical service missions due to concurrencies: a retrospective cohort study. *Acta Anaesthesiologica Scandinavica,* 62**,** 116-124.

PAGE, M., BLABER, I. & SNOWDEN, P. 2008. Implementing a Modified Early Warning Score system for critically ill patients in an acute private hospital. *The World of Critical Care Nursing,* 6**,** 57-64.

PARAMEDICS AUSTRALASIA 2012. Paramedics in the 2011 census. Victoria, Australia: Paramedics Australasia.

PARHAM, G. 2012. Recognition and response to the clinically deteriorating patient. *Australian Medical Student Journal,* 3**,** 18-22.

PATEL, M. S., JONES, M. A., JIGGINS, M. & WILLIAMS, S. C. 2011. Does the use of a "track and trigger" warning system reduce mortality in trauma patients? *Injury,* 42**,** 1455-9.

PATERSON, R., MACLEOD, D. C., THETFORD, D., BEATTIE, A., GRAHAM, C., LAM, S. & BELL, D. 2006. Prediction of in-hospital mortality and length of stay using an early warning scoring system: clinical audit. *Clinical Medicine,* 6**,** 281-4.

PATRICK, J. 2000. Training. *In:* CHMIEL, N. (ed.) *Introduction to Work and Organizational Psychology: A European Perspective.* Oxford: Blackwell Publishing Ltd.

PELGRIN, F. 2011. *Lecture 5: Box-Jenkins methodology* [Online]. University of Lausanne: Ecole des HEC. Available: http://math.unice.fr/~frapetti/CorsoP/Chapitre_5_IMEA_1.pdf [Accessed 30/07/2018].

PELUCCHI, C., GRIGORYAN, L., GALEONE, C., ESPOSITO, S., HUOVINEN, P., LITTLE, P. & VERHEIJ, T. 2012. Guideline for the management of acute sore throat. *Clinical Microbiology and Infection,* 18 Suppl 1**,** 1-28.

PERIS, A., ZAGLI, G., MACCARRONE, N., BATACCHI, S., CAMMELLI, R., CECCHI, A., PERRETTA, L. & BECHI, P. 2012. The use of Modified Early Warning Score may help anesthesists in postoperative level of care selection in emergency abdominal surgery. *Minerva Anestesiologica,* 78**,** 1034-8.

PETRILLO-ALBARANO, T., STOCKWELL, J., LEONG, T. & HEBBAR, K. 2012. The use of a modified pediatric early warning score to assess stability of pediatric patients during transport. *Pediatric Emergency Care,* 28**,** 878-882.

PETTICREW, M. 2011. When are complex interventions 'complex'? When are simple interventions 'simple'? *European Journal of Public Health,* 21**,** 397-398.

PIRNESKOSKI, J., NURMI, J., OLKKOLA, K. & KUISMA, M. 2017. 21 Prehospital national early warning score (NEWS) does not predict one day mortality. *British Medicial Journal Open,* 7**,** A8-A9.

PLATT, J. 1992. Case study in American methodological thought. *Current Sociology,* 40**,** 17-48.

PLUYE, P. & HONG, Q. N. 2014. Combining the power of stories and the power of numbers: Mixed methods research and mixed studies reviews. *Annual Review of Public Health,* 35**,** 29-45.

PLUYE, P., ROBERT, E., CARGO, M., BARLETT, G., O'CATHAIN, A., FGRFFITHS, A., BOARDMAN, F., GAGNON, M. P. & ROUSSEAU, M. C. 2011. Proposal: A mixed methods appraisal tool for systematic mixed studies reviews. McGill University, Montreal, Canada: Department of Family Medicine.

POLITO, C., ISAKOV, A., YANCEY, A., MARTIN, G., WILSON, D., ANDERSON, B., BLOOM, I. & SEVRANSKY, J. 2014. Pre-hospital identification of patients with severe sepsis: Development of a novel prediction score. *Critical Care Medicine,* 42**,** A1593.

POLITO, C. C., ISAKOV, A., YANCEY, A. H., 2ND, WILSON, D. K., ANDERSON, B. A., BLOOM, I., MARTIN, G. S. & SEVRANSKY, J. E. 2015. Prehospital recognition of severe sepsis: development and validation of a novel EMS screening tool. *American Journal of Emergency Medicine,* 33**,** 1119-25.

POPAY, J., ROBERTS, H., SOWDEN, A., PETTICREW, M., ARAI, L., RODGERS, M., BRITTEN, N., ROEN, K. A. & DUFFY, S. 2006. Guidance on the Conduct of Narrative Synthesis in Systematic Reviews. London: Institute for Health Research.

PORTER, A., SNOOKS, H., YOUREN, A., GAZE, S., WHITFIELD, R., RAPPORT, F. & WOOLLARD, M. 2007. 'Should I stay or should I go?' Deciding whether to go to hospital after a 999 call. *Journal of Health Service Research and Policy,* 12.

PORTER, A., SNOOKS, H., YOUREN, A., GAZE, S., WHITFIELD, R., RAPPORT, F. & WOOLLARD, M. 2008. "Covering our backs": ambulance crews' attitudes towards clinical documentation

when emergency (999) patients are not conveyed to hospital. *Emergency Medicine Journal,* 25**,** 292-295.

PORTZ, K., NEWELL, R. & ARCHIBONG, U. 2012. Rising Ambulance Life-Threatening Call Demand in High and Low Socioeconomic Areas. *Journal of Psychological Issues in Organizational Culture,* 3**,** 5-19.

PRICE, L. C., DIMOPOULOS, K., MARINO, P., ALONSO-GONZALEZ, R., MCCABE, C., KEMNPY, A., SWAN, L., BOUTSIKOU, M., AL ZAHRANI, A., COGHLAN, G. J., SCHREIBER, B. E., HOWARD, L. S., DAVIES, R., TOSHNER, M., PEPKE-ZABA, J., CHURCH, A. C., PEACOCK, A., CORRIS, P. A., LORDAN, J. L., GAINE, S., CONDLIFFE, R., KIELY, D. G. & WORT, S. J. 2017. The CRASH report: emergency management dilemmas facing acute physicians in patients with pulmonary arterial hypertension. *Thorax,* 72**,** 1035-1045.

PRYTHERCH, D. R., SMITH, G. B., SCHMIDT, P. E. & FEATHERSTONE, P. I. 2010. ViEWS-- Towards a national early warning score for detecting adult inpatient deterioration. *Resuscitation,* 81**,** 932-7.

PRYTHERCH, D. R., SMITH, G. B., SCHMIDT, P. E., FEATHERSTONE, P. I., STEWART, K. & KNIGHT, D. 2006. Calculating early warning scores - a classroom comparison of pen and paper and hand-held computer methods. *Resuscitation,* 70.

PUBLIC HEALTH ENGLAND 2017. Surveillance of influenza and other respiratory viruses in the UK: Winter 2016 to 2017. Public Health England: Respiratory Diseases Department.

QSR INTERNATIONAL PTY LTD. 2012. NVivo qualitative data analysis Software.

R CORE TEAM 2013. R: A language and environment for statistical computing. Vienna, Austria: The R Foundation for Statistical Computing.

RAMASAMY, R., WILLIS, L., KADAMBARI, S., KELLY, D. F., HEATH, P. T., NADEL, S., POLLARD, A. J. & SADARANGANI, M. 2018. Management of suspected paediatric meningitis: a multicentre prospective cohort study. *Archives of Disease in Childhood*.

RAMSAY, C. R., MATOWE, L., GRILLI, R., GRIMSHAW, J. M. & THOMAS, R. E. 2003. Interrupted time series designs in health technology assessment: lessons from two systematic reviews of behavior change strategies. *International Journal of Technology Assessment in Health Care,* 19**,** 613-23.

RASMUSSEN, J. 1983. Skills, rules and knowledge: signals, signs and symbols and other distinctions in human performance models. *Institute of Electircal and Electronic Engineers (IEEE) Transactions on Systems, Man and Cybernetics* 13**,** 257-266.

REASON, J. 2009. *Human Error,* New York, USA, Cambridge University Press.

REAY, G., NORRIS, J. M., ALIX HAYDEN, K., ABRAHAM, J., YOKOM, K., NOWELL, L., LAZARENKO, G. C. & LANG, E. S. 2017. Transition in care from paramedics to emergency department nurses: a systematic review protocol. *Systematic Reviews,* 6**,** 260.

RIC, T. 2013. The capacity of NSW paramedics to recognise septic patients with a screening tool (PASTa study). *Australasian Journal of Paramedicine,* 10**,** 21.

ROBB, G. & SEDDON, M. 2010. A multi-faceted approach to the physiologically unstable patient. *Quality and Safety in Health Care,* 19**,** e47.

ROBERTS, M. S. & SONNENBERG, F. A. 2000. *Decision modelling techniques,* New York, USA, Cambridge University Press.

ROBERTSON-STEEL, I. 2006. Evolution of triage systems. *Emergency Medicine Journal,* 23**,** 154-155.

ROBSON, C. 2011. *Real World Research,* Chichester, UK, Wiley.

ROBSON, W. & DANIELS, R. 2011. Sepsis must be seen as emergency. *Emergency Nurse,* 19**,** 9.

ROLLIN, L., DARMONI, S., CAILLARD, J. F. & GEHANNO, J. F. 2010. Searching for high-quality articles about intervention studies in occupational health--what is really missed when using only the Medline database? *Scand J Work Environ Health,* 36**,** 484-7.

ROMERO-ORTUNO, R., WALLIS, S., BIRAM, R. & KEEVIL, V. 2016. Clinical frailty adds to acute illness severity in predicting mortality in hospitalized older adults: An observational study. *European Journal of Internal Medicine,* 35**,** 24-34.

ROYAL COLLEGE OF PHYSICIANS 2012. National Early Warning Score (NEWS): standardising the assessment of acute-illness severity in the NHS. London: RCP.

ROYAL COLLEGE OF PHYSICIANS. 2017. *National Early Warning Score (NEWS) 2: Standardising the assessment of acute-illness severity in the NHS. Updated report of a working party* [Online]. London: Royal College of Physicians. Available: https://www.rcplondon.ac.uk/projects/outputs/national-early-warning-score-news-2 [Accessed 30/07/2018].

RUAN, H., ZHU, Y., TANG, Z. & LI, B. 2016. Modified early warning score in assessing disease conditions and prognosis of 10,517 pre-hospital emergency cases. *International Journal of Clinical and Experimental Medicine,* 9**,** 14554-14558.

SAFIRE, W. 1991. *Coming to terms,* New York, Doubleday.

SAID, S. E. & DICKEY, D. 1984. Testing for unit roots in autoregressive moving-average models with unknown order. *Biometrika,* 71**,** 599-607.

SALOTTOLO, K., CARRICK, M., JOHNSON, J., GAMBER, M. & BAR-OR, D. 2017. A retrospective cohort study of the utility of the modified early warning score for interfacility transfer of patients with traumatic injury. *British Medicial Journal Open,* 7.

SAS INSTITUTE INC. 2012. *The X12 Procedure - OUTLIER statement (Syntax)* [Online]. North Carolina, USA: SAS Institute Inc. Available: http://support.sas.com/documentation/cdl/en/etsug/65545/HTML/default/viewer.htm#etsug_x12_syntax14.htm [Accessed 30/07/2018].

SAX, C. 2017. seasonal: R Interface to X-13-ARIMA-SEATS. https://cran.r-project.org: The R Project for Statistical Computing.

SCHAAF, B., KRUSE, J., RUPP, J., REINERT, R. R., DROEMANN, D., ZABEL, P., EWIG, S. & DALHOFF, K. 2007. Sepsis severity predicts outcome in community-acquired pneumococcal pneumonia. *The European Respiratory Journal,* 30**,** 517-524.

SCHWARZ, G. E. 1978. Estimating the dimension of a model. *Annals of Statistics,* 6**,** 461-464.

SEAK, C. J., YEN, D. H., NG, C. J., WONG, Y. C., HSU, K. H., SEAK, J. C., CHEN, H. Y. & SEAK, C. K. 2017. Rapid Emergency Medicine Score: A novel prognostic tool for predicting the outcomes of adult patients with hepatic portal venous gas in the emergency department. *PLoS One,* 12**,** e0184813.

SEIGER, N., MACONOCHIE, I., OOSTENBRINK, R. & MOLL, H. A. 2013. Validity of different pediatric early warning scores in the emergency department. *Pediatrics,* 132**,** e841-50.

SEKIMURA, A., YOSHIMATSU, T., YAMASHITA, N., HIGA, H., MIYATA, T., KAWANO, D. & SO, T. 2017. Endobronchial Watanabe Spigot in Treating Pleural Empyema with Fistula. *Kyobu Geka,* 70**,** 163-168.

SEYMOUR, C. W., REA, T. D., KAHN, J. M., WALKEY, A. J., YEALY, D. M. & ANGUS, D. C. 2012. Severe sepsis in pre-hospital emergency care: analysis of incidence, care, and outcome. *American Journal of Respiratory and Critical Care Medicine,* 186**,** 1264-71.

SHADISH, W. R., COOK, T. D. & CAMPBELL, D. T. 2002. Quasi-experiments: Interrupted time-series designs. *Experimental and quasi-experimental designs for generalized causal inference.* Boston: Houghton Mifflin Company.

SHANG-KAI, H., NG, C.-J., CHANG-FU, K., ZHONG NING LEONARD, G., LU-HSIANG, H., CHIH-HUANG, L., YI-LING, C., YI-MING, W., JOANNA CHEN-YEEN, S., CHEN-KEN, S. & CHEN-JUNE, S. 2017. Comparison of the Mortality in Emergency Department Sepsis Score, Modified Early Warning Score, Rapid Emergency Medicine Score and Rapid Acute Physiology Score for predicting the outcomes of adult splenic abscess patients in the emergency department. *PLoS One,* 12.

SHAW, D., DYAS, J. V., MIDDLEMASS, J., SPAIGHT, A., BRIGGS, M., CHRISTOPHER, S. & SIRIWARDENA, A. N. 2006. Are they really refusing to travel? A qualitative study of prehospital records. *BioMed Central Emergency Medicine,* 6**,** 8.

SHAW, J., FOTHERGILL, R. T., CLARK, S. & MOORE, F. 2017. Can the prehospital National Early Warning Score identify patients most at risk from subsequent deterioration? *Emergency Medicine Journal,* 34**,** 533-537.

SHEARER, B., MARSHALL, S., BUIST, M. D., FINNIGAN, M., KITTO, S., HORE, T., STURGESS, T., WILSON, S. & RAMSAY, W. 2012. What stops hospital clinical staff from following protocols? An analysis of the incidence and factors behind the failure of bedside clinical staff to activate the rapid response system in a multi-campus Australian metropolitan healthcare service. *British Medical Journal Quality and Safety,* 21**,** 569-575.

SHIUH, T., SWEENEY, T., RUPP, R., DAVIS, B. & REED, J., III 2012. An Emergency Medical Services Sepsis Protocol With Point-of-Care Lactate Accurately Identifies Out-of-Hospital Patients With Severe Infection and Sepsis. *Annals of Emergency Medicine,* 60**,** S44.

SHU, E., IVES TALLMAN, C., YOUNG, M., FRYE, W., FARSHIDPOUR, L. & CAMPAGNE, D. 2018. Prehospital qSOFA score as predictor of sepsis and mortality. *Critical Care Medicine,* 46**,** 697.

SIEGRIST, J. 1996. Adverse health effects of high-effort/low-reward conditions. *Journal of Occupational Health Psychology,* 1**,** 27-41.

SILCOCK, D. J., CORFIELD, A. R., GOWENS, P. A. & ROONEY, K. D. 2015. Validation of the National Early Warning Score in the prehospital setting. *Resuscitation,* 89**,** 31-5.

SIMPSON, P., THOMAS, R., BENDALL, J., LORD, B., LORD, S. & CLOSE, J. 2017. 'Popping nana back into bed' - a qualitative exploration of paramedic decision making when caring for older people who have fallen. *BioMed Central Health Services Research,* 17**,** 299.

SIMPSON, P. M., BENDALL, J. C., TOSON, B., TIEDEMANN, A., LORD, S. R. & CLOSE, J. C. 2014. Predictors of nontransport of older people who have fallen who receive ambulance care. *Prehospital Emergency Care,* 18.

SINGH, J. M., GUNZ, A. C., DHANANI, S., AGHARI, M. & MACDONALD, R. D. 2016. Frequency, Composition, and Predictors of In-Transit Critical Events During Pediatric Critical Care Transport. *Pediatric Critical Care Medicine,* 17**,** 984-991.

SIRIWARDENA, A. N. 2019. *Ambulance Service Cardiovascular Quality Initiative (ASCQI)* [Online]. University of Lincoln: BeandFour Design Agency. Available: http://ascqi.co.uk/ [Accessed 2018].

SIRIWARDENA, A. N., SHAW, D., ESSAM, N., TOGHER, F. J., DAVY, Z., SPAIGHT, A. & DEWEY, M. 2014. The effect of a national quality improvement collaborative on prehospital care for acute myocardial infarction and stroke in England. *Implementation Science,* 9**,** 17.

SMITH, A. F. & OAKEY, R. J. 2006. Incidence and significance of errors in a patient 'track and trigger' system during an epidemic of Legionnaires' disease: retrospective casenote analysis. *Anaesthesia,* 61**,** 222-228.

SMITH, G. B. 2010. In-hospital cardiac arrest: is it time for an in-hospital 'chain of prevention'? *Resuscitation,* 81**,** 1209-11.

SMITH, G. B., PRYTHERCH, D., PEET, H., FEATHERSTONE, P. I., SCHMIDT, P., KNIGHT, D., STEWART, K. & HIGGINS, B. 2006. Automated calculation of 'early warning scores'. *Anaesthesia,* 61**,** 1009-10.

SMITH, G. B., PRYTHERCH, D. R., JARVIS, S., KOVACS, C., MEREDITH, P., SCHMIDT, P. E. & BRIGGS, J. 2016. A Comparison of the Ability of the Physiologic Components of Medical Emergency Team Criteria and the U.K. National Early Warning Score to Discriminate Patients at Risk of a Range of Adverse Clinical Outcomes. *Critical Care Medicine,* 44**,** 2171-2181.

SMITH, G. B., PRYTHERCH, D. R., MEREDITH, P., SCHMIDT, P. E. & FEATHERSTONE, P. I. 2013. The ability of the National Early Warning Score (NEWS) to discriminate patients at risk of early cardiac arrest, unanticipated intensive care unit admission, and death. *Resuscitation,* 84**,** 465-70.

SMITH, G. B., PRYTHERCH, D. R., SCHMIDT, P. E. & FEATHERSTONE, P. I. 2008a. Review and performance evaluation of aggregate weighted 'track and trigger' systems. *Resuscitation,* 77**,** 170-9.

SMITH, G. B., PRYTHERCH, D. R., SCHMIDT, P. E., FEATHERSTONE, P. I. & HIGGINS, B. 2008b. A review, and performance evaluation, of single-parameter "track and trigger" systems. *Resuscitation,* 79**,** 11-21.

SMITH, M., HIGGS, J. & ELLIS, E. 2008c. Factors influencing clinical decision making. *In:* HIGGS, J., JONES, M. A., LOFTUS, S. & CHRISTENSEN, N. (eds.) *Clinical reasoning in the health professions.* 3rd Edition ed. Croydon, UK: Elsevier Butterworth Heinemann.

SMYTH, M. A., BRACE-MCDONNELL, S. J. & PERKINS, G. D. 2016. Identification of adults with sepsis in the prehospital environment: a systematic review. *British Medicial Journal Open,* 6**,** e011218-e011218.

SNOOKS, H. A., DALE, J., HARTLEY-SHARPE, C. & HALTER, M. 2004. On-scene alternatives for emergency ambulance crews attending patients who do not need to travel to the accident and emergency department: a review of the literature. *Emergency Medicine Journal,* 21**,** 212-215.

SNOOKS, H. A., KEARSLEY, N., DALE, J., HALTER, M., REDHEAD, J. & FOSTER, J. 2005. Gaps between policy, protocols and practice: A qualitative study of the views and practice of emergency ambulance staff concerning the care of patients with non-urgent needs. *Quality and Safety in Health Care,* 14.

SO, S. N., ONG, C. W., WONG, L. Y., CHUNG, J. Y. & GRAHAM, C. A. 2015. Is the Modified Early Warning Score able to enhance clinical observation to detect deteriorating patients earlier in an Accident & Emergency Department? *Australasian Emergency Nursing Journal* 18**,** 24-32.

SOUTO, R., KHANASSOV, V., HONG, Q. N., BUSH, P. L., VEDEL, I. & PLUYE, P. Systematic mixed studies review: Reliability testing of the Mixed Methods Appraisal Tool. Mixed Methods International Research Association Conference (MMIRA), 2014 Boston, USA.

SOUTO, R. Q., KHANASSOV, V., HONG, Q. N., BUSH, P. L., VEDEL, I. & PLUYE, P. 2015. Systematic mixed studies reviews: Updating results on the reliability and efficiency of the mixed methods appraisal tool. *International Journal of Nursing Studies,* 52**,** 500-501.

STELLWAGEN, E. 2017. *Forecasting 101: A guide to forecast error measurment statistics and how to use them* [Online]. Forecast Pro. Available: http://www.forecastpro.com/Trends/forecasting101August2011.html [Accessed 20/08/2017].

STENHOUSE, C., COATES, S., TIVEY, M., ALLSOP, P. & PARKER, T. 2000. Prospective evaluation of a modified Early Warning Score to aid earlier detection of patients developing critical illness on a general surgical ward. *British Journal of Anaesthesia,* 84**,** 663-663.

STEVINSON, C. & LAWLOR, D. A. 2004. Searching multiple databases for systematic reviews: added value or diminishing returns? *Complement Ther Med,* 12**,** 228-32.

STIELL, I. G., MCKNIGHT, R., GREENBERG, G. H. & ET AL. 1994. Implementation of the ottawa ankle rules. *JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,* 271**,** 827-832.

SUBBE, C. P., GAO, H. & HARRISON, D. A. 2007. Reproducibility of physiological track-and-trigger warning systems for identifying at-risk patients on the ward. *Intensive Care Medicine,* 33**,** 619-24.

SUBBE, C. P., KRUGER, M., RUTHERFORD, P. & GEMMEL, L. 2001. Validation of a modified early warning score in medical admissions. *Quarterly Journal of Medicine,* 94**,** 521-526.

SUBBE, C. P. & SABIN, J. 2014. Choose the NEWS you like? Reliable identification of risk necessary first step to safer systems. *Acta Anaesthesiologica Scandinavica,* 58**,** 377-379.

SUBBE, C. P., SLATER, A., MENON, D. & GEMMELL, L. 2006. Validation of physiological scoring systems in the accident and emergency department. *Emergency Medicine Journal,* 23**,** 841-845.

SUN, J. H., TWOMEY, M., TRAN, J. & WALLIS, L. A. 2012. The need for a usable assessment tool to analyse the efficacy of emergency care systems in developing countries: proposal to use the TEWS methodology. *Emergency Medicine Journal,* 29**,** 882-6.

SWAIN, A. H. 2017. Does a New Zealand early warning score contribute more to the pre-hospital assessment of patient acuity than ambulance status codes? *Australian Journal of Paramedicine,* 14**,** 12.

SWAN, K. L., KEENE, T. & AVARD, B. J. 2018. A 12-Month Clinical Audit Comparing Point-of-Care Lactate Measurements Tested by Paramedics with In-Hospital Serum Lactate Measurements. *Prehospital and Disaster Medicine,* 33**,** 36-42.

SZAKMANY, T., LUNDIN, R. M., SHARIF, B., ELLIS, G., MORGAN, P., KOPCZYNSKA, M., DHADDA, A., MANN, C., DONOGHUE, D., ROLLASON, S., BROWNLOW, E., HILL, F., CARR, G., TURLEY, H., HASSALL, J., LLOYD, J., DAVIES, L., ATKINSON, M., JONES, M., JONES, N., MARTIN, R., IBRAHIM, Y., HALL, J. E. & ON BEHALF OF WELSH DIGITAL DATA COLLECTION PLATFORM, C. 2016. Sepsis Prevalence and Outcome on the General Wards and Emergency Departments in Wales: Results of a Multi-Centre, Observational, Point Prevalence Study. *PLoS One,* 11.

TAECKER, M. 2012. Is the Modified Early Warning Score (MEWS) Superior to Clinician Judgment in Detecting Critical Illness in the Pre-hospital Environment? *Journal of Emergency Medicine,* 43**,** 404.

TASHAKKORI, A. & TEDDLIE, C. 2003. *Handbook of mixed methods in social and behavioural research,* Thousand Oaks, CA, Sage.

TEDDLIE, C. & TASHAKKORI, A. 2009. *Foundations of mixed methods research,* Thousand Oaks, CA., Sage.

THANGARETNAM, K. P., GOPISETTY, G., RAMANATHAN, P. & RAJKUMAR, T. 2017. A polypeptide from the junction region sequence of EWS-FLI1 inhibits Ewing's sarcoma cells, interacts with the EWS-FLI1 and partner proteins. *Scientific Reports,* 7**,** 7172.

THE KING'S FUND. 2017. *The NHS in a nutshell* [Online]. Available: https://www.kingsfund.org.uk/projects/nhs-in-a-nutshell [Accessed 16/08/2017 2017].

THOMPSON, C. 2003. Clinical experience as evidence in evidence-based practice. *Journal of Advanced Nursing,* 43**,** 230-7.

THOMPSON, C., BUCKNALL, T., ESTABROOKES, C. A., HUTCHINSON, A., FRASER, K., DE VOS, R., BINNECADE, J., BARRAT, G. & SAUNDERS, J. 2009. Nurses' critical event risk assessments: a judgement analysis. *Journal of Clinical Nursing,* 18**,** 601-12.

THOMPSON, C., CULLUM, N., MCCAUGHAN, D., SHELDON, T. & RAYNOR, P. 2004. Nurses, information use, and clinical decision making—the real world potential for evidence-based decisions in nursing. *Evidence Based Nursing,* 7**,** 68.

THOMSON, R., LUETTAL, D., HEALEY, F. & SCOBIE, S. 2007. Safer care for the acutely ill patient: Learning from serious incident. London: National Patient Safety Agency (NPSA).

TIAN, Y., DIXON, A. & GAO, H. 2012. *Data briefing: emergency hospital admissions for ambulatory case-sensitive conditions identifying the potential for reductions* [Online]. London: The King's Fund. Available: https://www.kingsfund.org.uk/publications/data-briefing-emergency-hospital-admissions-ambulatory-care-sensitive-conditions [Accessed 30/07/2018].

TIMMINS, N. 2015. *The practice of system leadership: Being comfortable with chaos* [Online]. London: The King's Fund. Available: https://www.kingsfund.org.uk/publications/practice-system-leadership [Accessed 30/07/2018].

TIMMINS, N. 2017. *Tackling variations in clinical care: Assessing the getting it right first time (GIRFT) oprogramme* [Online]. London: The King's Fund. Available: https://www.kingsfund.org.uk/publications/tackling-variations-clinical-care [Accessed 30/07/2018].

TIRKKONEN, J., OLKKOLA, K. T., HUHTALA, H., TENHUNEN, J. & HOPPU, S. 2014. Medical emergency team activation: performance of conventional dichotomised criteria versus national early warning score. *Acta Anaesthesiologica Scandinavica,* 58**,** 411-9.

TOH LEONG, T., AHMAD, N. S., NASURUDDIN, D. N., ITHNIN, A., KHAIZURIN TAJUL, A., IDA ZARINA, Z. & WAN ZURINAH WAN, N. 2016. CD64 and Group II Secretory Phospholipase A2 (sPLA2-IIA) as Biomarkers for Distinguishing Adult Sepsis and Bacterial Infections in the Emergency Department. *PLoS One,* 11.

TRAPLETTI, A. & HORNIK, K. 2017. tseries: Time series analysis and computational finance. https://cran.r-project.org: The R Project for Statistical Computing.

TROCHIM, W. M. K. 1989. Outcome pattern matching and program theory. *Evaluation and Program Planning,* 12**,** 355-366.

U.S. BUREAU OF THE CENSUS 2010. X-12-ARIMA Seasonal Adjustment Program. Washington, DC.: U.S. Bureau of the Census.

VAN VEEN, M., TEUNEN-VAN DER WALLE, V. F., STEYERBERG, E. W., VAN MEURS, A. H., RUIGE, M., STROUT, T. D., VAN DER LEI, J. & MOLL, H. A. 2010. Repeatability of the Manchester Triage System for children. *Emergency Medicine Journal,* 27**,** 512-6.

VENTURA, S., ARYEE, D. N., FELICETTI, F., DE FEO, A., MANCARELLA, C., MANARA, M. C., PICCI, P., COLOMBO, M. P., KOVAR, H., CARE, A. & SCOTLANDI, K. 2016. CD99 regulates neural differentiation of Ewing sarcoma cells through miR-34a-Notch-mediated control of NF-kappaB signaling. *Oncogene,* 35**,** 3944-54.

VERBAKEL, J. Y., LEMIENGRE, M. B., DE BURGHGRAEVE, T., DE SUTTER, A., AERTGEERTS, B., BULLENS, D. M. A., SHINKINS, B., VAN DEN BRUEL, A. & BUNTINX, F. 2015. Validating a decision tree for serious infection: diagnostic accuracy in acutely ill children in ambulatory care. *British Medicial Journal Open,* 5.

VORWERK, C. & COATS, T. J. 2012. The prognostic value of tissue oxygen saturation in emergency department patients with severe sepsis or septic shock. *Emergency Medicine Journal,* 29**,** 699-703.

WACHIRA, B. W. & TYLER, M. D. 2015. Characterization of in-hospital cardiac arrest in adult patients at a tertiary hospital in Kenya. *African Journal of Emergency Medicine,* 5**,** 70-74.

WALCHER, F., KULLA, M., KLINGER, S., ROHRIG, R., WYEN, H., BERNHARD, M., GRAFF, I., NIENABER, U., PETERSEN, P., HIMMELREICH, H., SCHWEIGKOFLER, U., MARZI, I. & LEFERING, R. 2012. [Standardized documentation in emergency departments with the core dataset of the DIVI]. *Unfallchirurg,* 115**,** 457-63.

WALCHOK, J. G., PIRRALLO, R. G., FURMANEK, D., LUTZ, M., SHOPE, C., GILES, B., GUE, G. & DIX, A. 2017. Paramedic-Initiated CMS Sepsis Core Measure Bundle Prior to Hospital Arrival: A Stepwise Approach. *Prehospital Emergency Care,* 21**,** 291-300.

WALLGREN, U. M., BOHM, K. E. M. & KURLAND, L. 2017. Presentations of adult septic patients in the prehospital setting as recorded by emergency medical services: a mixed methods analysis. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine,* 25**,** 23-23.

WALLGREN, U. M., CASTRÉN, M., SVENSSON, A. E. V. & KURLAND, L. 2014. Identification of adult septic patients in the prehospital setting: a comparison of two screening tools and clinical judgment. *European Journal of Emergency Medicine,* 21**,** 260-265.

WALSHE, C., EWING, G. & GRIFFITHS, J. 2012. Using observation as a data collection method to help understand patient and professional roles and actions in palliative care settings. *Palliative Medicine,* 26**,** 1048-1054.

WANG, H. E., WEAVER, M. D., SHAPIRO, N. I. & YEALY, D. M. 2010. Opportunities for Emergency Medical Services care of sepsis. *Resuscitation,* 81**,** 193-197.

WARD, D., POTTER, J., INGHAM, J., PERCIVAL, F. & BELL, D. 2009. Acute medical care. The right person, in the right setting--first time: how does practice match the report recommendations? *Clinical Medicine* 9**,** 553-556.

WEBER, E. J. 2014. Highlights from the issue. *Emergency Medicine Journal,* 31**,** e1-e1.

WELLS, S., TAMIR, O., GRAY, J., NAIDOO, D., BEKHIT, M. & GOLDMANN, D. 2018. Are quality improvement collaboratives effective? A systematic review. *British Medical Journal Quality and Safety,* 27**,** 226-240.

WEST OF ENGLAND ACADEMIC HEALTH SCIENCE NETWORK. 2016. *Implementing the National Early Warning Score (NEWS)* [Online]. West of England Academic Health Science Network. Available: https://www.weahsn.net/what-we-do/enhancing-patient-safety/the-deteriorating-patient/news/ [Accessed 30/07/2018].

WICKHAM, H. 2017. tidyverse: Easily install and load the 'Tidyverse'. https://cran.r-project.org: The R Project for Statistical Computing.

WILES, E. T., BELL, R., THOMAS, D., BECKERLE, M. & LESSNICK, S. L. 2013. ZEB2 Represses the Epithelial Phenotype and Facilitates Metastasis in Ewing Sarcoma. *Genes and Cancer,* 4**,** 486-500.

WILLIAMS, J. P. 2008. The SAGE Encyclopedia of Qualitative Research Methods. Thousand Oaks, California: SAGE Publications, Inc.

WILLIAMS, M. 2015. Changing and downgrading of 999 calls. *Freedom of information request.* AMB-X NHS Trust.

WILLIAMS, T. A., TOHIRA, H., FINN, J., PERKINS, G. D. & HO, K. M. 2016. The ability of early warning scores (EWS) to detect critical illness in the prehospital setting: A systematic review. *Resuscitation,* 102**,** 35-43.

WILSON, S. J., WONG, D., CLIFTON, D., FLEMING, S., WAY, R., PULLINGER, R. & TARASSENKO, L. 2013. Track and trigger in an emergency department: an observational evaluation study. *Emergency Medicine Journal,* 30**,** 186-91.

WINDLE, J. & WILLIAMS, J. 2009. Early Warning Scores: are they needed for emergency care? *Emergency Nurse,* 17**,** 22-26.

WINDLE, K., ESSAM, N. S., VOS, J., CABALLERO, A. L. G., PHUNG, V. H., SIRDIFIELD, C., SIRIWARDENA, A. N. & MCKAY, S. M. 2014. Admission Avoidance Programme - Final Report. Community and Health Research Unit, University of Lincoln.

WONG, Y. K., LUI, C. T., LI, K. K., WONG, C. Y., LEE, M. M., TONG, W. L., ONG, K. L. & TANG, S. Y. 2016. Prediction of en-route complications during interfacility transport by outcome predictive scores in ED. *American Journal of Emergency Medicine,* 34**,** 877-82.

XIE, J., SREENIVASAN, S., KORNISS, G., ZHANG, W., LIM, C. & SZYMANSKI, B. K. 2011. Social consensus through the influence of committed minorities. *Physical Review E,* 84**,** 011130.

YIN, R. K. 2014. *Case study research: Design and methods 5th edition,* Thousand Oaks, CA, SAGE publications Ltd.

Appendices

Appendix 1: Inter-rater assessment of Mixed Methods Assessment Tool conducted by Souto et al. (2014)

KEY	
Kappa score	Level of agreement
0.21-0.40	Fair
0.41-0.60	Moderate
0.61-0.80	Substantial
0.81-0.99	Almost perfect

	Qualitative studies	
Item	Description	Kappa
1.1	Relevance of sources of data to address question	0.62
1.2	Relevance of data analysis to address question	0.52
1.3	Consideration of how context influences findings	0.36
1.4	Consideration of how researchers influence findings	0.21
	Randomised clinical trials	
Item	Description	Kappa
2.1	Description of the randomisation	0.70
2.2	Description of the allocation concealment	0.58
2.3	Complete outcome data	0.41
2.4	Low withdrawal rate	0.30
	Non-randomised studies	
Item	Description	Kappa
3.1	Recruitment of participants to minimise selection bias	0.86*
3.2	Appropriateness of measurements	0.77*
3.3	Comparison of participants	0.38
3.4	Complete outcome data (80% or above)	0.64
	Mixed methods studies	
Item	Description	Kappa
5.1	Is the mixed methods research design relevant to address the qualitative and quantitative research questions?	0.92*
5.2	Is the integration of qualitative and quantitative data relevant to address the research question?	0.69
5.3	Is appropriate consideration given to the limitations associated with this integration?	**

* Agreement on positive ratings only ** No disagreement between raters $Based on mixed methods section only

319

Appendix 2: Papers excluded from literature review with reasons for exclusion

No	Author	Reason for exclusion
Exclusions related to Prehospital & Early Warning Score search [#1 AND #2]
1	McBride et al. (2005)	Hospital-based research study
2	Naeem and Montenegro (2005)	Hospital-based research study
3	Brown and Bleetman (2006)	EWS not used or evaluated, only recommended
4	Green and Williams (2006)	Hospital-based research study
5	Harrison et al. (2006)	Hospital-based research study
6	Prytherch et al. (2006)	Hospital-based research study
7	Robertson-Steel (2006)	Commentary / Discussion
8	Subbe et al. (2006)	Hospital-based research study
9	Gao et al. (2007)	Systematic review; focuses on the use of track and trigger scores in hospital setting
10	Subbe et al. (2007)	Hospital-based research study
11	Ban et al. (2008)	Paper relates to EWS-FLI1 & Ewing's sarcoma cells not Early Warning Scores
12	Smith et al. (2008a)	Tool development / comparison / validation review – Included studies are not prehospital specific
13	Smith et al. (2008b)	Tool development / comparison / validation review – Included studies are not prehospital specific
14	Ward et al. (2009)	Hospital-based research study
15	Bachmaier et al. (2009)	Paper relates to EWS-FLI1 & Ewing's sarcoma cells not Early Warning Scores
16	Windle and Williams (2009)	Commentary / Discussion
17	Anon (2010)	Commentary / Discussion
18	Challen and Walter (2010)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
19	Chen et al. (2010)	Abstract only / Hospital-based research study (Chinese)
20	Gray et al. (2010)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
21	Kashikar et al. (2010)	Paper relates to EWS-FLI1 & Ewing's sarcoma cells not Early Warning Scores
22	Mitchell et al. (2010)	Hospital-based research study
23	Robb and Seddon (2010)	Hospital-based research study
24	Smith (2010)	Commentary / Discussion
25	van Veen et al. (2010)	Hospital-based research study
26	Albert and Huesman (2011)	Abstract only / Hospital-based research study

Exclusions related to Prehospital & Early Warning Score search [#1 AND #2]		
No	**Author**	**Reason for exclusion**
27	Ban et al. (2011)	Paper relates to EWS-FLI1 & Ewing's sarcoma cells not Early Warning Scores
28	Carmichael et al. (2011)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied / Tool does not include temperature
29	Patel et al. (2011)	Hospital-based research study
30	Robson and Daniels (2011)	Commentary / Discussion
31	Alspach (2012)	Commentary / Discussion
32	Ebrahimian et al. (2012)	Tool does not include oxygen saturations
33	Fullerton et al. (2012)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
34	Parham (2012)	Hospital-based research study
35	Peris et al. (2012)	Hospital-based research study
36	Petrillo-Albarano et al. (2012)	Inter-facility transfer study
37	Portz et al. (2012)	EWS applied to EMS data retrospectively
38	Sun et al. (2012)	Commentary / Discussion
39	Taecker (2012)	Commentary / Discussion
40	Walcher et al. (2012)	Written in German
41	Alrawi et al. (2013)	Hospital-based research study
42	De Meester et al. (2013)	Hospital-based research study
43	Hollenberg et al. (2013)	Commentary / Discussion
44	Seiger et al. (2013)	Hospital-based research study
45	Wiles et al. (2013)	Paper relates to EWS-FLI1 & Ewing's sarcoma cells not Early Warning Scores
46	Wilson et al. (2013)	Hospital-based research study
47	Bradman et al. (2014)	Hospital-based research study
48	Bunkenborg et al. (2014)	Hospital-based research study
49	Corfield et al. (2014)	Hospital-based research study
50	Day and Oxton (2014)	Hospital-based research study
51	Ennis (2014)	Hospital-based research study
52	Moseson et al. (2014)	Hospital-based research study
53	Tirkkonen et al. (2014)	Hospital-based research study

Exclusions related to Prehospital & Early Warning Score search [#1 AND #2]		
No	Author	Reason for exclusion
54	Subbe and Sabin (2014)	Commentary / Discussion
55	Bayer et al. (2015)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
56	Borgert et al. (2015)	Hospital-based research study
57	Cameron et al. (2015)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
58	Engelbrecht et al. (2015)	Hospital-based research study
59	Englund and Stuart (2015)	Abstract only / Hospital-based research study
60	Fuijkschot et al. (2015)	Hospital-based research study
61	Hancock (2015)	Focuses on implementation programme. No references of effect/usefulness in ambulance service
62	Silcock et al. (2015)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
63	So et al. (2015)	Hospital-based research study
64	Wachira and Tyler (2015)	Hospital-based research study
65	Anderson (2016)	Commentary / Discussion
66	Anon (2016)	Commentary / Discussion
67	Barrett (2016)	Commentary / Discussion
68	Bunkenborg et al. (2016)	Hospital-based research study
69	Campbell et al. (2016)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
70	Connell et al. (2016)	Systematic review; focuses on the education and use of EWS in hospital setting
71	Flôr da Rocha et al. (2016)	Hospital-based research study
72	Gaumont et al. (2016)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
73	Hoikka et al. (2016)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
74	Kalliomäki et al. (2016)	Abstract only / EWS applied to EMS data retrospectively
75	Leung et al. (2016)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
76	Romero-Ortuno et al. (2016)	Hospital-based research study
77	Ruan et al. (2016)	EWS used by doctors in prehospital emergency care setting
78	Singh et al. (2016)	Inter-facility transfer study
79	Smith et al. (2016)	Tool development / comparison / validation study – Hospital-based study
80	Szakmany et al. (2016)	Hospital-based research study
81	Ventura et al. (2016)	Paper relates to EWS-FLI1 & Ewing's sarcoma cells not Early Warning Scores

	Exclusions related to Prehospital & Early Warning Score search [#1 AND #2]	
No	**Author**	**Reason for exclusion**
82	Williams et al. (2016)	Systematic literature review; focuses on studies comparing and validating EWS tools in prehospital setting. Not all tools and/or studies included, meet inclusion criteria for this review. Those that do have been included.
83	Wong et al. (2016)	Inter-facility transfer study
84	Ahmad and Wood (2017)	Discussion/commentary
85	Broughton (2017)	Abstract only / Hospital-based research study
86	Downey et al. (2017)	Systematic literature review; focuses on strengths and limitations of EWS. Not all tools and/or studies included, meet inclusion criteria for this review. Those that do have been included.
87	Ebrahimian et al. (2017)	Tool development / comparison / validation study – Whilst tool was prospectively piloted, the tool did not include temperature
88	Shang-Kai et al. (2017)	Hospital-based research study
89	Jouffroy et al. (2017)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
90	Le Lagadec and Dwyer (2017)	Hospital-based research study
91	Missen et al. (2018)	Hospital-based research study
92	Mohammed et al. (2017)	Hospital-based research study
93	Nannan Panday et al. (2017)	Literature review; focuses on the use of EWS in the hospital setting
94	Pirneskoski et al. (2017)	Abstract only / Hospital-based research study
95	Salottolo et al. (2017)	Interfacility transfer study
96	Seak et al. (2017)	Hospital-based research study
97	Sekimura et al. (2017)	Abstract only / Relates to Endobronchial Watanabe Spigot (Japanese)
98	Shaw et al. (2017)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
99	Swain (2017)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
100	Thangaretnam et al. (2017)	Paper relates to EWS-FLI1 & Ewing's sarcoma cells not Early Warning Scores
101	Abbott et al. (2018)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
102	Credland (2018)	Commentary / Discussion
103	Najafi et al. (2018)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
104	Osteras et al. (2018)	HEMS based-Study - EWS retrospectively applied
105	Hoikka et al. (2018)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied

Exclusions related to Paramedic Pathfinder search [#1 AND #3]		
No	Author	Reason for exclusion
1	Brooke (2014)	Commentary / Discussion
2	Goulding (2014a)	Commentary / Discussion
3	Goulding (2014b)	Commentary / Discussion
4	Weber (2014)	Commentary / Discussion
5	Bowser et al. (2015)	Paper relates to community health projects supported by Pathfinder International
6	Agarwal et al. (2016)	Paper relates to community health projects supported by Pathfinder International
7	Braun et al. (2016)	Paper relates to community health projects supported by Pathfinder International
8	Gill et al. (2016)	Paper relates to community health projects supported by Pathfinder International
9	Jacinto et al. (2016)	Paper relates to community health projects supported by Pathfinder International
10	Noble et al. (2016)	No reference to the use of EWS
11	Blodgett et al. (2017)	No reference to the use of EWS

Exclusions related to Prehospital & Sepsis Score Tool search [#1 AND #4]		
No	Author	Reason for exclusion
1	Bouza et al. (2005)	Hospital-based research study
2	Adams et al. (2006)	Hospital-based research study
3	Schaaf et al. (2007)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
4	Jones et al. (2008)	Hospital-based research study
5	Bottle and Aylin (2009)	Hospital-based research study
6	Gerovasili et al. (2009)	Hospital-based research study
7	Muller et al. (2010)	Hospital-based research study
8	Wang et al. (2010)	Hospital-based research study
9	Shiuh et al. (2012)	Abstract only / Uses SIRS criteria only / does not include all EWS physiological measures
10	Vorwerk and Coats (2012)	Hospital-based research study
11	Agabiti et al. (2013)	Hospital-based research study
12	Baez et al. (2013)	Retrospective analysis using EMS data
13	Guerra et al. (2013)	Uses Sepsis Alert Protocol screening tool (does not include all EWS physiological measures)
14	Ric (2013)	Abstract only (results still pending) / Search for subsequent papers and full text to no avail

No	Author	Reason for exclusion
	Exclusions related to Prehospital & Sepsis Score Tool search [#1 AND #4]	
15	Burke et al. (2014)	Hospital-based research study
16	Fitzpatrick et al. (2014)	Hospital-based research study
17	Kim et al. (2014)	Hospital-based research study
18	Nunn (2014)	Hospital-based research study
19	Polito et al. (2014)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
20	Wallgren et al. (2014)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
21	Baez (2015)	Discussion / commentary
22	Bailly et al. (2015)	Hospital-based research study
23	Bohm et al. (2015)	Retrospective analysis using EMS data
24	Cone (2015)	Discussion / commentary
25	Halaweish et al. (2015)	Hospital-based research study
26	Macdonald and Brown (2015)	Systematic review related to hospital-based care
27	Polito et al. (2015)	Tool development / Comparison / Validation study – EMS data &/or scores retrospectively applied
28	Verbakel et al. (2015)	The decision tool was used by doctors and does not include all EWS physiological measures
29	Baez (2016)	Discussion / commentary
30	Baez and Cochon (2016)	Hospital-based research study
31	Green et al. (2016)	The Paramedic Sepsis Screening Tool does not include all EWS physiological measures
32	Hunter et al. (2016a)	Discussion / commentary
33	Hunter et al. (2016b)	The Prehospital Screening Tool uses SIRS criteria / does not include all EWS physiological measures
34	Kessler et al. (2016)	Hospital-based research study
35	McGill et al. (2016)	Development of guidelines
36	Smyth et al. (2016)	Systematic review; Not all tools and/or studies included, meet inclusion criteria for this review. Those that do have been included.
37	Toh Leong et al. (2016)	Hospital-based research study
38	Askim et al. (2017)	Hospital-based research study
39	Hsiao-Yun et al. (2017)	Hospital-based research study
40	Morris et al. (2017)	Systematic review; focuses on hospital-based care and aeromedical care
41	Price et al. (2017)	Literature review; focuses on common emergencies related to pulmonary hypertension

Exclusions related to Prehospital & Sepsis Score Tool search [#1 AND #4]		
No	Author	Reason for exclusion
42	Reay et al. (2017)	Systematic Literature review; focuses on communication and handover of patient care
43	Walchok et al. (2017)	Tool development / Comparison / Validation study. Tool does not include all physiological measures
44	Wallgren et al. (2017)	Retrospective analysis using EMS data
45	Charbonneau et al. (2018)	Hospital-based research study
46	Ramasamy et al. (2018)	Hospital-based research study
47	Shu et al. (2018)	Abstract only / Retrospective analysis using EMS data
48	Swan et al. (2018)	Retrospective analysis using EMS data

Appendix 3: Paramedic Pathfinder Medical & Trauma Tool

North West Ambulance Service NHS Trust

Paramedic Pathfinder (Medical) — 8/31/2010 V2

This process does not apply to the following patient categories:
Cerebrovascular Accident (CVA)
Cardiac Related Chest Pain
Patients < 5 Years of Age
Obstetric and Gynaecological Presentations
Mental Health Presentations
Patients Lacking Mental Capacity
PHEW > 4

Legend:
- Red: Transport to Emergency Department
- Yellow: Transport to UCC or access Care Pathway if available
- Blue: Consider non-conveyance guidelines
- Green: Proceed to next priority box

Complete Primary Survey ABCD

Airway Compromise
Progressive or Sudden Worsening of Breathing
Shock
Uncontrollable Bleeding
New Neurological Deficit
Acute Loss of Mobility
Reduced Level of Consciousness
Severe Pain
→ Yes → Stabilise and immediate transportation to ED

No ↓

Headache as Primary Presentation
Purpura/Non Blanching Rash
Vascular Compromise
Tachycardia > 120
Temp ≤ 35 or ≥ 40 Deg C
Vomiting Blood
Abdominal Pain Radiating to Back
Significant PR Bleed
→ Yes → Emergency Department

No ↓

History of Unconsciousness
Temperature ≥ 38.5 Deg C
History of Acutely Vomiting Blood
Hyperglycaemia > 17 mmol (without Ketosis)
Haematuria
Retention of Urine
Abnormal Pulse
Facial/Tongue Oedema
Significant Cardiac History
→ Yes → Consider Transport to Urgent Care Centre (Kitemark 1 Only)

If Patient has a current Care Pathway in situ, please consider referral

No ↓

Fulfils criteria for non-conveyance Guideline
→ Yes → Complete Non-conveyance Process including relevant documentation

No ↓

Transport to Urgent Care Centre (Kitemark 1 Only)

If Patient has a current Care Pathway in situ, please consider referral

Clear and leave Scene

327

North West Ambulance Service NHS Trust

Paramedic Pathfinder (Trauma)	8/31/2010 V2

This process does not apply to the following patient categories:
Cerebrovascular Accident (CVA)
Cardiac Related Chest Pain
Patients < 5 Years of Age
Obstetric and Gynaecological Presentations
Mental Health Presentations
Patients Lacking Mental Capacity
PHEW > 4

Transport to Emergency Department (Red)

Transport to UCC or access Care Pathway if available (Yellow)

Consider non-conveyance guidelines (Blue)

Proceed to next priority box (Green)

Complete Primary Survey
ABCD

Airway Compromise
Progressive Worsening of Breathing
Shock
Uncontrollable Bleeding
New Neurological Deficit
Acute Loss of Mobility
Reduced Level of Consciousness
Severe Pain
Significant Mechanism of Injury

Yes → Stabilise and immediate transportation to ED

No

Penetrating Injury of Head, Neck or Torso
Gross Deformity/Open Fracture
History of Unconsciousness
Vascular Compromise
Critical Skin
Inhalation Injury
Direct Trauma to the Neck or Back
Facial Oedema
Temp ≤ 35 Deg C
Electrical or Chemical Injury

Yes → Emergency Department

No

Fulfils criteria for non-conveyance Guideline

Yes → Complete Non-conveyance Process including relevant documentation

No

Transport to Urgent Care Centre
(Kitemark 1 Only)

If Patient has a current Care Pathway in situ, please consider referral

Clear and leave Scene

Appendix 5: Prehospital Early Warning Score (PHEWS)

Pre- Hospital Early Warning (PHEW) Score								
Parameter / Score	3	2	1	0	1	2	3	Individual scores
Heart Rate (bpm)	<40	41-50	51-59	60-100	101-119	120-129	>130	
Respiratory Rate	>30	20-29		11-19		9-10	<8	
Systolic BP (mmHg)	<80	81-90	91-99	100-170		171-199	>200	
O_2 Sats (%) (with oxygen therapy)				>92	90-92	85-89	<85	
Central Nervous System			New agitation or confusion	Alert	Responds to voice	Responds to pain	Unresponsive	
Temperature Tympanic		>38.5		35.1- 38.4	<35			
BM mmol/l (capillary)		>20	11-19	5- 10.9	4.1- 4.9		<4	
Pain score (0-10)		≥7	5-6	< or = 4				
Any individual shaded parameter or a combination of parameters totaling more than 4 Requires emergency ambulance conveyance							TOTAL	

Appendix 6: Quality assessment of study by Newton et al. (2013)

Methodological quality criteria: MMAT 3 Quantitative non-randomised study				
Title: **Clinical navigation for beginners: the clinical utility and safety of the Paramedic Pathfinder** Study by: **Newton et al. (2013)** Study aim: To evaluate the clinical utility and safety of Paramedic Pathfinder tool using a mixed clinician sample Tool: Medical and Trauma Paramedic Pathfinder - algorithmic tool includes physiological/clinical discriminators				
Criteria met: */4			Score: 25%	
	Yes	No	Can't tell	Comments
a. Are there clear quantitative research questions or objectives?		✓		The authors do not state a research question or objective per se, only a study aim (see above).
b. Do the collected data allow the research question to be addressed?		✓		See item 2 below
1. Are participants (organizations) recruited in a way that minimizes bias?			✓	This cross-sectional evaluation took place over 2-3 days, at 8 sites. Sites either had an urgent care pathway in the locale or one was planned. EMT grade 2 and above invited to participate. Participation was voluntary. Patient/clinical exclusions: FAST+, cardiac chest pain, mental illness, obstetric & gynae, those lacking mental capacity, aged < 5 years & with PHEWS > 4. NHS R&D permission were obtained but NHS ethical approval was not necessary, as this was a service evaluation. **Limitations:** Considering the study aim, no results were provided for the number of clinicians who participated, nor information about their clinical grade. The only information provided was the number of patient report forms collected; these could have been completed by the same small sample of clinicians over the 3 days. In study limitations, the authors state the sample size was lower than originally anticipated.
2. Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention outcomes?		✓		Measurement included ambulance clinicians' responses to question, 'Using the Paramedic pathfinder' what is the most appropriate destination for this patient? Response options included: Emergency care, Urgent care, Community care & Self-care. Responses were compared to Gold Standard. Gold standard was determined by majority decision from expert panel. Expert panel were provided with a set of strict evaluation guidelines that included a minimum recommendation for urgent care level of care. **Limitations:** Methods of proposed analysis were not described. Decisions captured were only for those patients conveyed to ED. No evaluation was undertaken of the tools utility/application on those patients left at scene. At the time of the evaluation, non-conveyance rate was 18.5%. This compromised the studies validity & does not fulfil the

				'safety' aim of the study. In the study limitations, authors state outcomes related to community and primary care referral will be subject to further evaluation. The application of Paramedic Pathfinder is restricted on patients less than 5 years. The pre-hospital EWS figured in the paper appears to be an adult-based score system. There is a) no patient information provided (e.g. average age and SD) and b) no mention of a different EWS being used to assess patients aged 5-16 years. Thus, assessment of validity is limited.
3. In the groups being compared (exposed vs non-exposed; with intervention vs without; cases vs control), are the participants comparable, or do researchers take into account (control for) the differences between these groups?		✓		Results were presented in two 2x2 tables; one for the medical and another for trauma tool comparing Expert (ED & Other) and Clinician (ED & Other) decision outcomes. Medical tool: Experts and Clinicians agreed 221 patients required ED and 77 patients could be diverted to alternative care pathway. Trauma tool: Experts and Clinicians agreed ED = 54 and Other = 35. The Experts were unable to agree amongst themselves the appropriate outcome of 6 (1%) patients. Medical tool: Sensitivity = 94.4% (90.7-96.7%) and Specificity = 57.9% (49.4-65.9%). Trauma Tool: Sensitivity = 96.4% (87.9-99%) and Specificity = 60.3% (47.5-71.9%). Tools inability to discriminate accurately between cardiac and musculoskeletal chest pain was highlighted. Tool was changed so cardiac chest pain was distinguished as 'non-traumatic chest pain'. Further issues related to haematuria, first episode retention and loss of consciousness for those with previous history to ensure outcome determined ED rather than Urgent Care outcome. **Limitations:** There was no mention of analysis methods used in the Methods section, nor which analytical software were used to analyse the data. No area under receiver operating characteristic curve (AUROC) provided to show the tools overall diagnostic/decision-making ability; i.e. the cost/benefit analysis between sensitivity and specificity. This makes comparison with other tools more difficult. The authors acknowledged the changes made to the tools, to improve discriminating ability for chest pain meant the specificity was reduced in favour of sensitivity, but no amended figures were provided. When using the tool, there were 2 trauma patients incorrectly deemed by clinicians to be viable for alternative care pathway; one was believed to have musculoskeletal chest pain but had significant cardiac history and the other was an elderly patient with a fractured hip. No information is provided about the clinical grade/experience of the clinicians. There were also 13 medical patients who would have been incorrectly diverted from ED, but no other information was provided; e.g. neither description nor analysis in respect of the patient's condition/demographics, nor clinicians grade/experience. Similarly, no information was provided about the 56 medical patients, nor the 23 trauma patients incorrectly deemed by the clinicians to need ED. Again, this lack of information/analysis compromises the study aim. Owing to the lack of data related to

				patients in general, as well as those not conveyed, it is difficult to determine whether the analysis methods are representative and generalisable in relation to the study aims and outcome measures.
4.	Are there complete outcome data (80% or above), and when applicable, an acceptable response rate (60% or above), or an acceptable follow-up rate for cohort studies (depending on the duration of follow-up)?	✓			538 data forms gathered; 57 (11%) forms in total were either excluded or could not be traced. As the sample group only explored those patients conveyed, and not those left at scene, the authors claim the eligible group represented 79% of the total patients.

Appendix 7: Physiological-social Modified Early Warning Score (PMEWS)

Date:

Time:

Patient ID label:

	Physiological data (MEWS)						
Score	3	2	1	0	1	2	3
Resp. rates	≤8			9–18	19–25	26–29	≥30
O2 Stats.	<89	90–93	94–96	>96			
Heart rate	≤40	41–50		51–100	101–110	111–129	≥130
Systolic BP	≤70	71–90	91–100	>100			
Temp.			≤35	35.1–36 36.1–37.9	38–38.9	≥39	
Neuro.				Alert	Confused/agitated	Voice	Pain unconscious

Patient data: Score 1 for each factor

Age > 65

Social isolation (lives alone, no fixed abode)

Chronic disease (respiratory, cardiac, renal, immunosuppressed, and DM)

Performance status	Score	
Normal activity without restriction	0	**MEWS:**
Strenuous activity limited, can do light	1	**Patient data score:**
Limited activity but capable of self-care	2	**Total PMEWS:**
Limited activity, limited self-care	3	Name of assessor:
Confined to bed/chair, no self-care	4	Grade:

Appendix 8: Quality assessment of study by Ebrahimian et al. (2014b)

Methodological quality criteria: MMAT 3 Quantitative non-randomised study				
Title: **Physiological-social Scores in predicting outcomes of prehospital internal patients** Study by: **Ebrahimian et al. (2014b)** Study aim: To investigate the feasibility of using the PMEWS for the identification of patients that needed prehospital emergency care. Tool: Physiological-social Modified Early Warning Score (PMEWS) – includes measures of physiological parameters & social norms				
Criteria met: **/4				Score: 50%
	Yes	No	Can't tell	Comments
a. Are there clear quantitative research questions or objectives?		✓		No research questions or objectives specified, only a study aim (see above).
b. Do the collected data allow the research question to be addressed?	✓			Data collected would address the research aim.
1. Are participants (organizations) recruited in a way that minimizes bias?			✓	The prospective (cross-sectional) diagnostic accuracy study took place over 2 months at two randomly selected sites. All medical patients conveyed to hospital were invited to participate. There is no mention of whether EMTs' participation was voluntary or not. Patient/clinical exclusions included patients with traumatic injury, < 12 years of age, pregnant or mentally ill. **Limitations:** This study did not seek participation from patients attended and left at scene. The only data captured related to those conveyed to hospital, not those not conveyed. No explanation/description was provided regarding the 'two sites' where the study was conducted. It is unclear whether the 'sites' relate to ambulance stations, or hospitals. This would compromise replicability of the study.
2. Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention outcomes?	✓			Data were collected from patient report form and the PMEWS form completed by the EMT. The form included information related to physiological measures, the total PMEWS, patients age, whether they were socially isolated, had chronic disease and level of physical ability/activity. The EMT was also required to provide their name and grade. EMTs, provided with the PMEWS tool were required to classify patients into two groups: patients who really required transfer to hospital and patients who did not require the EMS response **Limitations:** No statement is provided regarding ethical considerations or need for approval; e.g. anonymity and storage of patient records. Also, the EMTs were required to provide their name and grade, but there is no mention of whether records would be retrospectively anonymised.

334

| 3. | In the groups being compared (exposed vs non-exposed; with intervention vs without; cases vs control), are the participants comparable, or do researchers take into account (control for) the differences between these groups? | | ✓ | | Emergency Medicine Specialist clinical judgement was deemed to be the gold standard. Area under receiver operating characteristic curve (AUROC) was used to demonstrate sensitivity and specificity of the PMEWS. Average patient age = 50.58 (±22.15). Majority (55.3%) of patients conveyed were women. Mean physiological score = 1.97 (±2.86). Mean social score = 0.75 (± 1.16). Mean PMEWS = 2.71 (± 3.55). 68.4% were deemed by EMT to need emergency care. PMEWS ≥ 4 = 97.6% needed emergency care. Physiological score AUROC = 0.692 (95% CI: 0.660-0.724). Social score AUROC = 0.667 (95% CI: 0.635-0.699). PMEWS AUROC = 0.738 (95% CI: 0.708-0.767). Results were comparable to those found by Challen and Walter (2010) = 0.710 and Duckitt et al. (2007) = 0.74 and slightly lower than Fullerton et al. (2012) = 0.799. **Limitations:** Authors did not mention what statistical software was used to analyse the data. Because of the lack of data related to those patients not conveyed, it is difficult to determine whether the analysis relates to a representative sample that can be generalised. There was also no analysis undertaken regarding clinical grade of EMTs using the tool, despite the authors gathering this data and acknowledging in the discussion that the skills of prehospital EMTs may vary. It was not clear how many Emergency Medicine Specialists were involved in the study, whether more than one rated each patient and, if so, whether inter-rater reliability was calculated. |
| 4. | Are there complete outcome data (80% or above), and when applicable, an acceptable response rate (60% or above), or an acceptable follow-up rate for cohort studies (depending on the duration of follow-up)? | ✓ | | | 2305 patient reports forms collected and 2157 (93.6%) were analysed. |

Appendix 9: Quality assessment of study by McClelland (2015)

Methodological quality criteria: MMAT 3 Quantitative non-randomised study				
Title: **A retrospective observational study to explore the introduction of the National Early Warning Score in NEAS**				
Study by: **McClelland (2015)**				
Study aim: Explore the introduction of NEWS into North East Ambulance Service (NEAS)				
Tool: National Early Warning Score - Physiological measurement tool				
Criteria met: */4				Score: 25%
	Yes	No	Can't tell	Comments
a. Are there clear quantitative research questions or objectives?	✓			The author's objectives included: - Develop a method of collecting data on suitable cases - Establish the number of calls that may be suitable for NEWS - Establish the prevalence of NEWS usage - Establish the completeness of data set in terms of NEWS variables - Describe the sample population according to NEWS - Explore any changes to practice that may result from linking pre-alerts to NEWS ≥7
b. Do the collected data allow the research question to be addressed?	✓			Data collected included 999-call data (e.g. chief complaint), patient demographics (e.g. age and gender), total NEWS and associated physiological and outcome (e.g. transported (Y/N) and pre-alert (Y/N)).
1. Are participants (organizations) recruited in a way that minimizes bias?		✓		Study compared data from two 24-hour periods. The first time-period (T1) being Monday 8th July 2013; a date randomly generated. The second time-period (T2) Tuesday 1 April 2014 was purposefully selected to ensure the data gathered were acquired from staff trained to use NEWS (see limitations). The 10th case (from the included data set) was selected, providing a 10% sample. Patient/clinical exclusions included paediatrics, maternity and cardiac arrests. NHS R&D permissions were obtained. NHS ethical approval was not necessary. **Limitations:** The T1 sample was acquired when NEWS training was still being implemented. Only 38% of clinicians had been trained to use NEWS by this date (8th July). The author is therefore unsure whether data captured were from crews using NEWS or not. Data collection method was adjusted at T2 to ensure data acquired were from crews who had been trained. The data collection method adopted compromised the study, as the T2 data sample was too small to effectively analyse certain outcomes; T1 sample = 894 patient records in total, 88 were excluded leaving 806 records for analysis versus T2 sample = 91 patient records in total, 8 were excluded leaving 83 patient records. The author acknowledged the use of this simple exclusion criteria also led to a sample population, which may not be representative of where

		✓		NEWS would be used or would be of value in practice (e.g. traumatic injuries, chest pain, stroke etc). Ideally, more data should have been collected and then reanalysed. However, in the discussion the author states, *'The lack of a reliable method of automating data collection process hampers the repeatability of the study due to the time-consuming nature of the data collection and limits the ability to repeat the study and examine longitudinal patterns in NEWS usage.'* However, the time taken to collect the data (as described in the Methods) did not seem unduly excessive, just 37.5 hrs.
2. Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention outcomes?		✓		The NEWS tool used in this study has been found to outperform many other EWS, e.g. AUROC = 0.873 in the ability to discriminate those at risk of cardiac arrest, unanticipated ICU admission and death within 24-hours of observation (Smith et al., 2013). Outcomes to be measured included: - The number of calls that may be suitable for NEWS - The prevalence of NEWS usage - Completeness of the data set in terms of NEWS variables - Describe the population according to NEWS - Explore changes to practice that may result from linking pre-alerts to **Limitations:** It is unclear whether the 'number of calls' relates to all emergency calls received by the Trust (See & Treat and Hear & Treat) or just those attended by ambulance crews (See & Treat only). From the results it would seem to be the latter, but this needs clarification. The author does not specify whether there is any protocol/policy regarding the recording of NEWS on the patient report forms. Therefore, it is difficult to determine whether 'prevalence of NEWS usage' can be measured effectively via this method. The data collection to explore changes to practice that may result from linking pre-alerts to NEWS ≥7 was also deemed to be compromised by the issues related to data collected at T1 and the small sample (n=4 patients) at T2.
3. In the groups being compared (exposed vs non-exposed; with intervention vs without; cases vs control), are the participants comparable, or do researchers take into account (control for) the differences between these groups?		✓		The author states, *'Due to the inclusion of mixed independent and dependent data and the large amounts of missing data, the findings are reported using primarily descriptive statistics'.* The analysis was conducted using Excel. In the results, the author states three different analysis methods were used to analyse and describe the sample populations according to NEWS. These methods included 1) mean imputation 2) listwise deletion and 3) mean imputation combined with listwise deletion, each chosen to adjust for the missing data. Option 1 replaced missing values with the mean derived from existing values for that observation. Option 2 deleted any set of observations with one or more missing elements. Option 3 mean imputation was applied where 1 or 2 observations were missing, or the data

				was deleted for those with > 2 missing observations. Fisher's exact test was used to analyse conveyance, although no significant difference was found. Of all (100%) of patients conveyed at T1, 15% had a high NEWS, 13% had a medium NEWS and 72% had a low NEWS; compared to T2, 11% had a high, 11% had a medium and 78% had a low NEWS. Then comparing all (100%) patients NOT conveyed at T1, 5% had a high NEWS, 14% had a medium and 81% had a low NEWS; whereas at T2, 12% had a medium NEWS and 88% had a low NEWS. There were no patients with a high NEWS left at scene. The descriptive comparison of pre-alerting practice at T1 & T2, found patients having a high NEWS did not influence or change clinical practice to pre-alert. Although, the conclusion drawn from this study was NEWS was not actually being used for reasons unknown. Some PRFS were found to have had no physiological observation, but these were not quantified. All physiological measures at T1 and T2 were 85% or above, except for the measurement of temperature. At T1 temperature was recorded 22% of the time and at T2 this had increased to 48%. Other than temperature and recording of supplemental oxygen, the incidence of recording physiological measures were less than at T1. **Limitations:** There is no description of whether any quality checks were undertaken of the data e.g. the upper range for T1 respiratory rate was 60 breaths per minute, this could relate to patient's heart rate. Similarly, T1 heart rate lower range was 14 beats per minute which could indicate the figures has been entered incorrectly (e.g. numbers inversed). Any remaining anomalies within the data such as these would compromise validity of results. There was also a difference of 10% in the administration of supplemental oxygen, but there is no breakdown provided relating to clinical complaint, even though this information was gathered. It is difficult to deduce whether the clinical cases at T1 and T2 were similar. Pre-alert analysis at T2 included only 7 patients. Similarly, the analyse of conveyance rates for T2 were conducted on a small sample. Results were also presented in a stacked bar graph which made results difficult to comprehend and figures difficult to discern. The validity, reliability and generalisability of the study was compromised by questionable data quality & sample size. The sample size was acknowledged by the author but collecting additional data and repeating the analysis was deemed to be too time-consuming.
4. Are there complete outcome data (80% or above), and when applicable, an acceptable response rate (60% or above), or an acceptable follow-up rate for cohort studies (depending on the duration of follow-up)?	✓			Overall, analysis was conducted on 90.25% of the data collected.

Appendix 10: NEAS' Sepsis Screening Tool

DOES THE PATIENT HAVE ANY OF THE TWO FOLLOWING SYSTEMIC INFLAMMATORY RESPONSE CRITERIA?

☐ Temperature >38.3°C or <36°C
☐ Respiratory rate >20 breaths per minute
☐ Heart rate >90 beats per minute
☐ Acute onset confusion or a reduced conscious level
☐ Glucose >7.7 mmol/lL(unless diabetes mellitus)
☐ WCC >12 x 10°/L or <4 x 10°/L (if available)

These are signs and symptoms of systemic inflammatory response syndrome (SIRS)

If two or more are present in the context of an acute infection it could mean SEPSIS

Please check yellow box.

DOES THE PATIENT HAVE AN INFECTION OR IS AT RISK OF AN INFECTION?

☐ Chest infection
☐ Urinary tract infection
☐ Abdominal pain or distension
☐ Meningitis
☐ Indwelling medical device
☐ Cellulitis/septic arthritis/infected wound
☐ Chemotherapy <6 weeks ago
☐ Recent organ transplant

Two or more signs and symptoms of SIRS (see green box)
+
suspected or at risk of infection
= possible SEPSIS

If possible SEPSIS please check red box for SEVERE SEPSIS

If NOT SEVERE SEPSIS evaluate the need to transfer to the acute hospital or ensure patient is reviewed by medical professional in primary care within 24 hours.

CHECK FOR SEVERE SEPSIS:

☐ Systolic BP <90 mmHg or MAP <65 mmHG or decrease in patient's normal systolic BP >40 mmHG
☐ Capillary refill >3 seconds
☐ Purpuric rash
☐ Mottled/cold peripheries
☐ Lactate >2 mmol/L (if available)
☐ Need for oxygen to keep SpO_2 >90%

Give oxygen 15 L/min via reservoir mark (may still be appropriate in COPD)

250 ml bolus IV crystalloid, reassess and repeat bolus as per response (maximum 1500 ml)

Transfer patient to nearest emergency department

339

Appendix 11: Quality assessment of study by McClelland and Jones (2015)

Methodological quality criteria: MMAT 3 Quantitative non-randomised study				
Title: **A pilot study exploring the accuracy of prehospital sepsis recognition in the North East Ambulance Service** Study by: **McClelland and Jones (2015)** Study aim: To investigate sepsis recognition and the use of the Sepsis Screening Tool (SST) in a UK regional ambulance service Tool: Sepsis Screening Tool (SST) – Includes measurement of temperature, respiratory rate, heart rate, acute onset of confusion or a reduced conscious level, systolic blood pressure & (indirect measure of) oxygen saturation				
Criteria met: ***/4				Score: 75%
	Yes	No	Can't tell	Comments
a. Are there clear quantitative research questions or objectives?	✓			How accurate is prehospital sepsis recognition by NEAS staff?
b. Do the collected data allow the research question to be addressed?	✓			Outcomes measured: - Sensitivity of NEAS recognition of sepsis and severe sepsis - Specificity of NEAS recognition of sepsis and severe sepsis - Explore the use of SST in NEAS - Explore NEAS treatment of sepsis and severe sepsis
1. Are participants (organizations) recruited in a way that minimizes bias?	✓			This was a cross-sectional retrospective (audit-based) observational study of diagnostic accuracy covering a one-month period (January 2014) post-training and implementation of SST at NEAS. NEAS trained all clinical staff in sepsis recognition using the SST between April 2012 and March 2013. NHS permissions were acquired from participating NHS establishments; NEAS and James Cook University Hospital. A sample of data related to patients (aged >16 years), attended by NEAS clinicians, with a documented suspicion of sepsis was collected. This sample was combined, and cross referenced with a sample of data collected from one local tertiary hospital. The hospital data included a patient sample of patients conveyed by NEAS ambulance crews and subsequently diagnosed by a hospital clinician as having sepsis; identified by ICD code A41 sepsis. **Limitation:** Data collected did not include ICD code A40 (streptococcal sepsis) and no reason was provided of why this was not included.

2.	Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention outcomes?			✓	NEAS data were sourced from electronic and paper patient report forms (PRFs). PRFs were auto and manually searched for the keyword 'sepsis'. Hospital data were sourced via monthly sepsis reports. **Limitations:** No summary was provided of the actual data that were extracted from the patient report forms and how this would be used to measure outcomes. This would make replicability of the study difficult.

3.	In the groups being compared (exposed vs non-exposed; with intervention vs without; cases vs control), are the participants comparable, or do researchers take into account (control for) the differences between these groups?	✓			The data sample analysed related to 49 patients; Mean age = 68.5yrs (SD 14.4, range 26-93). Male patients = 33 (67%), mean age 68.9, SD 12.4, range: 26-89. Female patients = 16 (33%), mean age 67.9, SD 16.8, range: 40-93. Patient demographics appear to be comparable to other studies which show higher incidence in males and mean age range from 60-71 years, as cited within Seymour et al. (2012) and Nasa et al. (2012). Out of the 49 patients, the hospital diagnosed 42 (57%) patients as having sepsis; 15 (31%) with sepsis and 27 (55%) with severe sepsis. Of the 42 patients, NEAS clinicians recorded sepsis on 24 PRFs; 18 were correctly recognised as having sepsis to some degree and 6 incorrectly; Sensitivity = 43% (95% CI: 28-58) and specificity 14% (95% CI: 0-40). 8 patients were recognised by NEAS as having severe sepsis; Sensitivity = 30 (95% CI: 12-47) and specificity = 77 (95% CI: 60-95). Of the 24 patients, NEAS clinicians pre-alerted ED on 13 occasions. The use of SST by NEAS clinicians: Reports where sepsis was documented (DS) = 24 and non-documented sepsis (NDS) = 25 cases*…
					    1. ≥2 SIRS Criteria: DS = 16[$] (67%) vs NDS = "?"
					    2. Sepsis Criteria: DS = 12 (75%)[$$] vs NDS = 10 (40%)**
					    3. Severe sepsis Criteria: DS = 6 (?) vs NDS = 3 (?)
					    4. Severe sepsis criteria (SST+): DS = 10 (?) vs NDS = 5(?)
					Limitations: No methods of analysis were proposed in the methods section. All results provided were descriptive, because of the small sample. The results section was written in a manner that makes interpretation difficult for the reader. For example, the small paragraph presenting results of the use of SST does not provide proportions for all measures and those that are, have been calculated from different 'totals' i.e. Sepsis Criteria DS proportions (see [$$]) seem to be calculated from ≥2 SIRS Criteria DS (see [$]), whereas Sepsis Criteria NDS proportions (see **) were calculated based on total number of non-documented cases (see *). It is also unclear how many patients with severe sepsis were identified by NEAS clinicians. For instance, the abstract and Table 1 suggests there were 8 cases identified, whereas in the section presenting results of prehospital treatment the authors commence the paragraph with "Of the 13 patients identified by NEAS as having severe sepsis…"

4. Are there complete outcome data (80% or above), and when applicable, an acceptable response rate (60% or above), or an acceptable follow-up rate for cohort studies (depending on the duration of follow-up)?	✓			60 patients were identified, although 11 were excluded, leaving 49 (81.7%) patient data for analysis.

Appendix 12: Scottish Ambulance Service Sepsis Tool

SEPSIS PRE ALERT

COULD THIS BE SEVERE INFECTION?

Is one Red Flag present?

- AVPU   = V, P or U
- BP systolic   ≤ 90
- Heart rate   > 130
- Resps   ≥ 25
- O_2 to keep SpO_2 ≥92% (Non COPD)
- Hypothermia   < 35 C
- Non-blanching rash/mottled/cyanotic
- No urine last 18hr
- Recent Chemotherapy ≤ 10 days

No

(PTO)

Yes

PRE ALERT ED: RED FLAG SEPSIS

1.?Sepsis 2.?Source 3.V sign 4.Allergy

SEPSIS PRE ALERT (cont'd)

Is one Amber Flag present?

- Immunosuppressed
- Trauma/surgery/procedure ≤ 6 wks
- Resps   21 – 24 OR breathing hard
- BP systolic   91 - 100
- Heart rate   91 -130 OR new arrhythmia
- No urine last 12 - 18hr
- Temp   <36
- Clinical signs wound/device/skin infection

Sepsis Likely

Transfer to designated destination

Communicate "Sepsis Likely" at handover

Appendix 13: Quality assessment of study by Carberry and Harden (2016)

Methodological quality criteria: MMAT 3 Quantitative non-randomised study				
Title: **A collaborative improvement project by an NHS emergency department and Scottish ambulance paramedics to improve the identification and delivery of sepsis 6** Study by: **Carberry and Harden (2016)** Study aim: To demonstrate a 20% improvement in the time taken to identify potentially septic patients (as measured by the time to triage) and treat them (as measured by the time to antibiotics) within 12-months, through Scottish Ambulance Service paramedics pre-alerting the ED of potentially septic patients. Tool: Scottish Ambulance Service (SAS) Tool				
Criteria met: **/4				Score: 50%
	Yes	No	Can't tell	Comments
a. Are there clear quantitative research questions or objectives?	✓			No research questions or objectives per se, but the research aim includes a quantitative measure of improvement to be achieved for two defined measures i.e. time to triage and time to antibiotics.
b. Do the collected data allow the research question to be addressed?	✓			Data collected/measured: - Time from ambulance pre-alert to arrival at ED - Time of triage - Time to first antibiotic (start time = arrival at ED) - Time to completion of sepsis 6 (all components of care bundle delivered) - Percentage of sepsis 6 delivery within 60 minutes - Number of false sepsis pre-alerts - Perceived increase in workload (questionnaire)
1. Are participants (organizations) recruited in a way that minimizes bias?		✓		T0 = 50 patients and T1 = 50 patients diagnosed with Sepsis. Paramedics = 10, located at one station were trained to use the tool and the pre-alerting process. Doctors, nurses and paramedics were invited to complete a paper-based questionnaire to evaluate additional workload. Participation was voluntary, and responses were anonymised. **Limitations:** No information is provided of how patient sample was selected or comparability (e.g. did both data samples include septic patients attended by the participating paramedics pre- vs post?). The geographical location of the station from which paramedics were recruited was in relative proximity to the ED test site. The authors acknowledge this would have had some effect on the outcomes being measured (e.g. time to first antibiotic). Ideally, the study should be replicated using a sample from the wider population. No statement is provided regarding ethical considerations or need for approval; e.g. anonymity and storage of patient records.

2.	Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention outcomes?	✓			Data were extracted retrospectively from patients' hospital case notes. Data were checked for accuracy and quality assured by the consultant ED physician. Data excluded included: Non-septic patients, records with significant data missing or pre-alert from non-participating paramedics. **Limitations:** Some inadvertent contamination of tool use and processes within Scottish Ambulance Service occurred; i.e. paramedics not formally trained began pre-alerting. Authors acknowledge this may have resulted in some bias and therefore these data were removed from data analysis.
3.	In the groups being compared (exposed vs non-exposed; with intervention vs without; cases vs control), are the participants comparable, or do researchers take into account (control for) the differences between these groups?			✓	T-test was conducted to test for differences in mean time to triage. Post intervention 43 patients (86%) had a MEWS ≥ 4; i.e. the inclusion criteria of severe sepsis. 36 (72%) patients were diagnosed with chest sepsis, 9 (18%) = urinary sepsis, 1(2%) = chest and urinary sepsis, 1 (2%) = neutropenia and 3 (6%) = unknown origin. Time to triage (identify sepsis): reduced by 82% (from 17 minutes to 3 minutes), p= 0.01. Time to antibiotic: reduced by 39% (49 minutes to 30 minutes), p=(?). Percentage of Sepsis 6 within 60 minutes: increased from 78% to 98%, p=(?) - 78% of pre-alerts received care bundle within 60 minutes. False pre-alerts: No figures provided, just described as minimal and decreasing over-time. Perceived increase in workload: There were 38 questionnaire responses; doctors n=14, nurses n = 18 and paramedics n=6. No significant increase in workload was reported by any staff group with 34 (89%) reporting the alerting process improved care for sepsis patients. **Limitations:** No patient demographic breakdown was provided for T0 sample. Other than time to triage, no further statistical analyses of differences pre- versus post-intervention were undertaken. It is unclear why 'time to antibiotics' was not also analysed using t test when this measure was one of the primary aims. To determine comparability between pre- vs post and to accommodate for time variance incurred because of variance in geography (as highlighted in limitations above), the paramedics T0 leaving scene time to arrival at ED could have been analysed and compared to time from ambulance pre-alert to arrival at ED; pre-alerts are most frequently made just prior or at the time of leaving scene.
4.	Are there complete outcome data (80% or above), and when applicable, an acceptable response rate (60% or above), or an acceptable follow-up rate for cohort studies (depending on the duration of follow-up)?	✓			86% of the sample at T1 was included in the analysis.

Appendix 14: Quality assessment of study by McClelland and Haworth (2016)

Methodological quality criteria: MMAT 1 Qualitative study				
Title: **A qualitative investigation into paramedics' thoughts about the introduction of the National Early Warning Score** Study by: **McClelland and Haworth (2016)** Study aim: To investigate what NEAS paramedics think about using the National Early Warning Score. Tool: National Early Warning Score - Physiological measurement tool				
Criteria met: **/4				Score: 50%
	Yes	No	Can't tell	Comments
a. Are there clear quantitative research questions or objectives?	✓			To achieve the research aims the authors stated they would explore the thoughts and opinions of paramedics about NEWS, identify reasons for the low level of use (evidenced in pervious paper) and explore the presence of barriers and/or facilitators to the sue of NEWS.
b. Do the collected data allow the research question to be addressed?	✓			Qualitative data.
1. Are participants (organizations) recruited in a way that minimizes bias?	✓			Of the 700 paramedics employed by NEAS, 13 paramedics volunteered, and 8 were purposefully selected. Purposeful selection was undertaken to ensure those recruited represented a range of locations, roles and length of service. Participation was voluntary; however, a £20 voucher was given to those who participated as an appreciation for involvement. Semi-structured interviews were conducted using a topic guide developed based on literature and discussions with NEAS' based clinical team. Interviews were conducted between May-August 2015 (2 years post-implementation of NEWS at NEAS). Interviews were recorded and then transcribed. Data saturation was determined by consensus between both researchers. As practitioner-researchers, with an interest in the subject, the authors acknowledge the potential risk of bias. They were mindful of their involvement and views during the interviews, and aware of potential to lead participants. Data collection and analysis were conducted in parallel to inform the development of the interview schedule as unanticipated topics arose. NHS permissions were acquired from NEAS R&D department.
2. Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention outcomes?		✓		**Limitations:** A five-stage framework analysis method was applied. Whilst this method was referenced, the initial coding framework was not described. No mention is made explicitly of how the data were analysed; i.e. no reference to whether any specific analysis tools or software were used (e.g. NVIVO or MAXQDA). From the results, it would seem the data were thematically analysed using a grounded theory, as the authors state… *"Three overarching themes emerged from the data…"*. There is however, little information on whether one or

				both researchers analysed the data, and if both, how the researchers agreed on the themes that emerged. There were no results provided regarding those who participated, to provide evidence that the sample was representative. Whilst the researchers were aware of researcher bias, they do not seem to have implemented any strategy to assess bias post-analysis e.g. sharing their results with a sample of participants and inviting feedback regarding their interpretation.
3.	In the groups being compared (exposed vs non-exposed; with intervention vs without; cases vs control), are the participants comparable, or do researchers take into account (control for) the differences between these groups?		✓	**Limitations:** Some interviews were conducted by one researcher (i.e. one researcher and one participant), whereas others were conducted by both interviewers (i.e. two researchers to one participant). The authors acknowledge this may have introduced some variation in questioning… However, they did not acknowledge that this may have introduced some variation to overall context of the interview (power imbalance) and subsequent response from the participants. No information was provided about when and where the interviews were conducted e.g. on or off NEAS premises; in private in an office, or the staff mess room with people coming and going and frequent interruptions; whether staff were on or off duty etc. No consideration was given of other factors that may be influencing clinical or cultural practice at the time e.g. other policy changes, operational demands etc.
4.	Are there complete outcome data (80% or above), and when applicable, an acceptable response rate (60% or above), or an acceptable follow-up rate for cohort studies (depending on the duration of follow-up)?	✓		A reflexive journal was kept by the authors detailing pre- and post-interview thoughts. This was done to promote reflection in the authors role and influence in the interview and to help minimise researcher bias. The researchers were known to the participants, which they state allows shared experiences to be discussed, but also admit familiarity can lead to certain aspects being missed or not being explored, and subsequently not captured. Neither researcher held managerial positions at NEAS; therefore, it was assumed by the researchers (maybe wrongly) that participants felt able to share their honest thoughts and experiences.

NHS

Health Research Authority

NRES Committee ███████████

04 January 2012

███████████

Dear ███████████

Study title:	Modified Early Warning Scores (MEWS) to support ambulance clinicians' decisions to transport or treat at home: time series study
REC reference:	11/EM/0459

The Research Ethics Committee reviewed the above application at the meeting held on 19 December 2011. Thank you for attending to discuss the study.

Ethical opinion

- The committee queried the training of the ambulance clinicians. You informed the committee that the importance of this study is placed with the training. The training will be delivered by clinical team leaders who will pass on the information to groups of 12 or 13 ambulance clinicians. It will be reinforced that the MEWS tool is to assist them in making clinical decisions and they will also be encouraged to integrate usual practice with the MEWS tool.

- You were asked when the MEWS tool will be used. You responded that the MEWS tool will be used at the same time the patient is being checked. If the patient has low severity and the clinician is planning on leaving the patient at home, the MEWS tool may either support their decision or make them consider more carefully and possibly think again. The emphasis is always on safety and if participants are unsure then clinicians will be encouraged to transport to hospital.

- The committee asked how you will decide which ambulance stations will be involved. You informed the committee that they will be selected due to anticipated participation, some sites may be more agreeable than others to participation. If there is low participation then you may need to broaden the amount of stations. You informed the committee that you wish to involve two rural and two urban stations in ██████ and ██████ with broadly comparable transportation rates of about 70%.

- The committee then asked whether you had any idea of the number of unnecessary transports to hospital, you informed the committee that they did not have that information but it would be difficult to make a decision on whether a transport was

A Research Ethics Committee established by the Health Research Authority

348

necessary or unnecessary depending on whose viewpoint was taken.

The members of the Committee present gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

Ethical review of research sites

NHS Sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations

1. Question 6 and 8 on the MEWS Survey Questionnaire need punctuating correctly for ease of reading.

It is responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

You should notify the REC in writing once all conditions have been met (except for site approvals from host organisations) and provide copies of any revised documentation with updated version numbers. Confirmation should also be provided to host organisations together with relevant documentation

Approved documents

The documents reviewed and approved at the meeting were:

Document	Version	Date
Covering Letter		28 November 2011
Investigator CV		24 November 2011

Letter from Sponsor		28 November 2011
Letter of invitation to participant	1	18 November 2011
Other: MEWS-ADstudy flow chart	1	18 November 2011
Other: Gantt Chart	1	15 November 2011
Participant Consent Form	1	08 November 2011
Participant Information Sheet	1	08 November 2011
Protocol	5	18 November 2011
Questionnaire: MEWS-ADsurvey	1	18 November 2011
REC application		28 November 2011
Referees or other scientific critique report		29 November 2011

Membership of the Committee

The members of the Ethics Committee who were present at the meeting are listed on the attached sheet.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

Feedback

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

Further information is available at National Research Ethics Service website > After Review

With the Committee's best wishes for the success of this project

Yours sincerely

PP ▓▓▓▓▓▓

Chair

Email: ▓▓▓▓▓▓▓▓▓pct.nhs.uk

Enclosures: List of names and professions of members who were present at the meeting and those who submitted written comments
"After ethical review – guidance for researchers"

Copy to: Care organisation/sponsor - ▓▓▓▓▓▓▓▓▓▓
Ambulance Service NHS Trust

Appendix 16: NHS permission for pilot study using a Modified Early Warning Score to support ambulance clinician's decision making

███ Ambulance Service **NHS**

NHS Trust
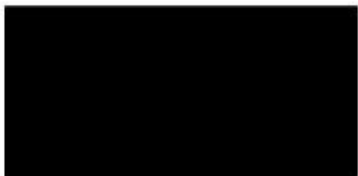
25 January 2012

Project Title: Modified Early Warning Scores (MEWS) to support ambulance clinicians' decisions to transport or treat at home: time series study
REC Number: 11/EM/0459
Chief Investigator: █████████

I am pleased to inform you that NHS permission has been granted for the above named project on the basis of the information provided in the application form, protocol and supporting documentation.

The following documents were reviewed:

Document Title	Version Number	Date
Protocol	V5	18.11.2011
Consent Form	V1	08.11.2011
Participant Information Sheet	V1	08.11.2011
Survey	V2	24.01.2012
Study Flow Chart	V1	18.11.2011
Invitation Letter	V1	18.11.2011
Gantt	V1	15.11.2011
CV ████		24.11.2011
CV ████		January 2011

Permission is granted on the understanding that the study is conducted in accordance with the Research Governance Framework, ICH GCP if applicable, the ████ policies and procedures and is subject to the following conditions:

Favourable ethical opinion and local approvals
This permission is subject to the favourable opinion of the Research Ethics Committee all other related regulatory approvals (if appropriate).

Legislation

You must adhere at all times to the principles and standards of the Department of Health's *Research Governance Framework*. You are also reminded of your obligation to collect, use, store and protect all research data in accordance with the Data Protection Act 1998, the Human Rights Act 1998 and all other legislation that applies to your project.

Circumstances to notify to the Clinical Governance, Audit and Research office

You must inform the Clinical Governance, Audit and Research office immediately:

- If your research deviates from that laid out in the approved protocol/proposal for any reason, at any time.
- Of any adverse incidents or near misses arising from the project. These will be dealt with according to current ███ policies and procedures.

Adverse Events

- You should ensure that incidents are reported in accordance with the Trust's current Untoward Incident Reporting Policy.
- You should notify all regulatory authorities including the REC and MHRA (where applicable) using the processes and templates set out by these authorities.
- You should also comply with the reporting processes for adverse events set out by your sponsor.
- The research sponsor or the Chief Investigator, or the local Principal Investigator at a research site, may take appropriate urgent safety measures in order to protect research participants against any immediate hazard to their health or safety. The R&D office should be notified that such measures have been taken. The notification should also include the reasons why the measures were taken and the plan for further action. The R&D Office should be notified within the same time frame of notifying the REC and any other regulatory bodies

Amendments

You should inform the Clinical Governance, Audit and Research office of any changes to the protocol before implementing the changes locally. You should do this by forwarding the amendment correspondence with the REC to the Research & Development Administrator. You should also inform the Research & Development Administrator if there are any changes to the membership of the research team or changes to the project status. Any amendments should be submitted in accordance with the guidance in IRAS.

Monitoring and Auditing

Please note that the ███ is required to monitor research to ensure compliance with the Research Governance Framework and other legal and regulatory requirements. You are required to comply with the Trust's monitoring arrangements. You should also ensure that you send copies of any interim and final reports to the Research & Development Administrator.

Sponsorship and Supervision

The sponsor for the research is ███ *Ambulance Service* and they have confirmed in writing that they will fulfil their responsibilities under the Research Governance Framework.

Your ███ Ambulance Service supervisor is ███ The supervisor responsible for the day to day supervision of the research and should be contacted in the first instance should you require any advice or assistance.

Finally, we would like to wish you every success with the project and look forward to seeing the results.

Yours sincerely

Ambulance Service **NHS**

NHS Trust

Nadya Essam
Using National Early Warning Scores to support paramedic decision-making: Modelling and improving effectiveness of prehospital ambulance transport to hospital

Principles	Indicators	Meets indicator Yes / No / NA	Comments
Is the aim of the project justified and compatible with local priorities and requirements?	A written project plan exists?	Yes	A full project plan has been submitted with the application. (Final v2 – 07/04/2014)
	Evidence of directorate / division / service support for project?	Yes	The project is fully supported by the Trust. The results from the project will provide evidence for the ongoing use of NEWS within the Trust.
Is the proposed project underpinned by an appropriate evidence base?	Evidence is presented/sourced in a written project plan?	Yes	The plan gives a detailed background to support the undertaking of the project and clearly defines the aims, objectives and scope.
Have ethical requirements regarding the identification and recruitment of participants been met?	Processes should be in place (and described in the project plan) to address: •First contact with potential participants •Consideration of vulnerability •Right to refuse •Right to withdraw •Process for obtaining consent/ agreement where appropriate •Justification for not seeking consent (with reference to relevant policies or guidance).	Yes	Participation in the project is voluntary. staff will be made aware of the project through general advertisements (email, posters and flyers). Participant information sheets have been developed for both the qualitative and observation elements of the study. The sheets clearly define the right to refuse participation and withdrawal from the project. There is a process for obtaining written consent from participants and separate consent forms have been developed for the interview/focus groups and observation elements.
The roles and responsibilities of any participants (patients / / relatives / staff) are agreed between the project lead and relevant participants.	Have the roles and responsibilities of the participants been outlined in the project plan?	Yes	The participant information sheets clearly define the involvement of participants and what is expected of them. The project plan lists each member of the project team and their respective roles and responsibilities throughout.
The participants privacy should be	Does the project plan comply with the NHS	Yes	The project plan and participant information sheets explain that any

Principles	Indicators	Meets indicator Yes / No / NA	Comments
respected and confidentiality should be maintained.	Code of Cofidentiality? *(Caldicott Guardian / Data Protection Officer should be consulted in complex situations)*		information gathered by the project team will be kept in confidence and all data used will be anonymous.
Data collection tools such as interview schedules and questionnaires are appropriately phrased. *(existing validated tools should be used e.g. from NRES)*	What is the appropriateness of the data collection tools?	Yes	The project team will be using semi structured self-administered questionnaires based on the Normalisation Process Theory framework (a validated analytical framework and toolkit).

The interview schedule (Project Plan - Appendix 7) gives an overview of the questions and discussions likely to take place during the interviews/focus groups. No contentious or sensitive issues can be identified in this document

The observation study record sheet (Project Plan – Appendix 10) shows the type of information to be collected during this part of the project. A guide has been produced to ensure that the team member considers the same issues during each observation and records only relevant information and details for the purpose of the project. |
Where a proposal involves an invasive procedure an independent review of ethical implication should be made by an appropriate clinician.	Is there evidence of independent ethical review by appropriate clinician?	N/A	
Findings are disseminated to / shared with areas of the organisation that will learn from them.	Will the project be entered into a local project database?	Yes	Details of the project will be kept locally on an project database.
	Will the projects findings be disseminated locally, regionally, nationally (where appropriate) through newsletters publication websites	Yes	The findings from the project will be disseminated locally (within the Trust), nationally and internationally to relevant professional bodies and organisations. Dissemination of the findings has been considered well in the project plan. It is hoped that the

Principles	Indicators	Meets indicator Yes / No / NA	Comments
			learning and outcomes are easily accessible to decision makers in the future.
Participant involvement is accurately presented in reports and shared in a way that is easily understood.	Is there evidence of Patient and Public Involvement (PPI) input into reports (if relevant)?	Yes	The project has good involvement from patient and public representatives and clearly demonstrates the ongoing PPI input throughout the project. (Project plan – patient and public involvement p41)
Staff should be skilled and competent to undertake project tasks and should be in receipt of appropriate clinical and or academic supervision.	Is there evidence of the necessary skills and competencies in the following: • Project staff CVs • Training records • Competency assessment records • Supervisors statement. (Necessary skills might include data collection, data analysis, project management, time management, communication etc.)		Project staff CVs have been submitted. The PhD student is adequately supervised by qualified staff and has an internal manager/supervisor. All project staff have the relevant the skills and experience for data collection and analysis.
Resources (including time and money) required to complete the project are available	Is there evidence that the project is appropriately resourced?	Yes	Local management are in support of the project and are named on the project team. This will ensure that there is continued engagement and support for use of resources for the project.
	Is there support for the project from local management to ensure resources are appropriate?	Yes	
Appropriate risk assessments and have been conducted. (The risk assessment might consider what to do if patients reveal information that would indicate clinical need or intervention, malpractice	Does the proposal address areas of potential risk offering management strategies?	Yes	The project is evaluating a decision making tool that are already implementing. The risks involved in evaluating this tool are minimal.
	Is there evidence of organisational support?	Yes	Local management are in support of the project and are named on the project team. This will ensure that

Principles	Indicators	Meets indicator Yes / No / NA	Comments
is identified, the project disrupts normal care or routines, non-compliance with policy/guidelines is identified which results in patient care being compromised)	Is there evidence of adhering to the Trusts guidance on disclosure?		there is continued engagement and support for use of resources for the project.
	Has a risk-benefit evaluation been undertaken to address the likelihood of harm and or distress and has an appropriate equality impact assessment been carried out?	N/A	This indicator is not applicable to the project. The intervention will be implemented in the Trust with or without this evaluation taking place. There are no additional risks associated with carrying out this project.

Appendix 18: NHS permission for the NEWS case study

███ Ambulance Service **NHS**

NHS Trust

Nadya Essam
████ Ambulance Service NHS Trust
████
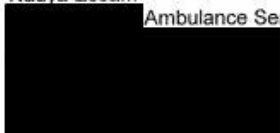
09 April 2014

Dear Nadya,

Project Title: Using National Early Warning Scores to support paramedic decision-making: Modelling and improving effectiveness of prehospital ambulance transport to hospital

I am pleased to inform you that ████ Ambulance Service has granted approval for the above named project on the basis of the information provided in the application.

The following documents were reviewed:

Document Title	Version Number	Date
Project Plan	Final v2	07/04/2014

Permission is granted subject to the following conditions:

Legislation - You are reminded of your obligation to collect, use, store and protect all data in accordance with the Data Protection Act 1998, the Human Rights Act 1998 and all other legislation that applies to your project.

Amendments - You should inform the Clinical Governance, Audit and Research office of any changes to the protocol, membership of the project team or changes to the project status before implementing the changes locally. You should do this by forwarding details of the amendment to the Research & Development Administrator.

████ **Supervision** - Your ████ Ambulance Service supervisor is ████ The supervisor responsible for the day to day supervision of the project and should be contacted in the first instance should you require any advice or assistance.

Finally, we would like to wish you every success with the project and look forward to seeing the results.

Yours sincerely

Appendix 19: Approval from University of Lincoln Research Ethics Committee for the NEWS Case Study

UNIVERSITY OF LINCOLN

School of Health and Social Care Ethics Committee
College of Social Science
Bridge House
Brayford Pool
Lincoln
LN6 7TS

Telephone 01522 882000

29th April 2014

Title: Implementing the National Early Warning Scores (NEWS) in pre-hospital emergency care setting using the Normalisation Process Theory framework, as detailed in the attached project plan (see page 21) only (Supervisor: ▮▮▮▮▮▮

▮▮▮▮▮▮▮▮

Dear Ms Essam

Congratulations on behalf of the Ethics Committee. I am pleased to confirm a favourable ethical opinion of the above research, on the basis described in the application form, protocol and supporting documentation.

Regards

▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮

National Early Warning Scores (NEWS) in prehospital emergency setting: a qualitative study

We would like to invite you to take part in an evaluation study. Before you decide whether to participate it is important that you understand why the evaluation is being done and what it would involve for you. Please take time to read the following information carefully. You might like to talk to others about it at this stage.

Purpose
The purpose of the study is to better understand the barriers and facilitators for the use of National Early Warning Scores (NEWS) in prehospital emergency care.

Why have I been selected?
You have been invited because we are working in collaboration with staff employed by AMB-X who have the understanding and experience of delivering emergency patient care.

Do I have to take part?
It is entirely up to you to decide. When you have read this sheet, if you would like our researcher to explain the study in more detail you can contact Nadya Essam by phoning: [number] or by emailing her at nadya.essam@AMB-X.nhs.uk

If you decide to take part, we will ask you to sign a consent form to show you have agreed to take part. You can of course withdraw from the study at any time without giving us a reason. It is important that if you would like to take part, you let our research team know, either by telephoning or emailing Nadya.

What will happen if I take part?
A researcher will contact you to inform you of the date, time and location of the focus group/interview discussion. If you have chosen to participate in a focus group, about seven other people will be in the discussion with you. Interviews will last about 30 minutes. Focus group discussion will last about an hour. The discussion will be audio recorded; this will be written up without your name, so you cannot be identified as having taken part. The original audio recordings will be kept securely and destroyed at the end of the study period.

What will I have to do?
We want to know about your experiences of providing emergency patient care and your views about the introduction of NEWS in the emergency prehospital setting. The researcher will ask you several questions about this. As well as answering these questions you will also be given the opportunity to talk about any other issues which you feel may be important to the study.

What is a National Early Warning Score (NEWS)?

The Royal College of Physicians has recommended for the assessment of acute-illness severity to be standardised. They recommend NEWS to be adopted across all health care settings (primary, prehospital and acute) to enable severity to be measured, tracked and clinical teams alerted to any clinical deterioration ensuring an optimal clinical response. Further information can be found here: http://www.rcplondon.ac.uk/resources/national-early-warning-score-news

What if I have no experience or understanding of NEWS?

We will be hosting focus groups discussion and conducting interviews both before and after NEWS has been implemented. If you have not heard or been trained to use NEWS it may be because the awareness and training programme has not yet commenced. Don't worry our Researcher will ensure you have sufficient understanding before you begin your discussion. Your thoughts and views will be of value to this study.

Are there any benefits in taking part?

We cannot promise the study will help you personally but the information we collect *before* NEWS has been implemented will be used to inform the implementation programme, and the information collected *after* will be combined with patient clinical data to evaluate the benefits of using NEWS for staff and patients.

The insight and understanding we gain from this study will be shared with other ambulance services who may be considering adopting NEWS.

What if there are any problems?

We don't expect there to be any problems, but if there are, we will deal with these promptly. If you have any complaints about the way you have been dealt with during the study, these can be forwarded to AMB-X Complaints Department on [telephone number].

Will my taking part in the study be kept confidential?

As researchers we will follow ethical and legal practice to handle information about you in confidence. All data will be anonymous.

National Early Warning Scores (NEWS) in prehospital emergency setting: observational study

We would like to invite you to take part in an evaluation study. Before you decide whether to participate it is important that you understand why the evaluation is being done and what it would involve for you. Please take time to read the following information carefully. You might like to talk to others about it at this stage.

Purpose

The purpose of the study is to better understand the barriers and facilitators for the use of National Early Warning Scores (NEWS) in prehospital emergency care.

Why have I been selected?

You have been invited because we are working in collaboration with staff employed by AMB-X who have the understanding and experience of delivering emergency patient care.

Do I have to take part?

It is entirely up to you to decide. When you have read this sheet, if you would like our researcher to explain the study in more detail you can contact Nadya Essam by phoning: [number] or by emailing her at nadya.essam@AMB-X.nhs.uk

If you decide to take part, we will ask you to sign a consent form to show you have agreed to take part. You can of course withdraw from the study at any time without giving us a reason. It is important that if you would like to take part, you let our research team know. Please contact Nadya, either by telephone or email.

What will happen if I take part?

- A researcher employed by AMB-X will contact you to arrange a convenient date to observe you at work.
- The researcher will watch and ask you questions throughout the shift to gain an understanding how you make decisions about patient care.
- The researcher will use an observational guide to record aspects which influence, support or hinder you during your work.

What will I have to do?

You should deliver patient care as you have been trained and usually would do. The researcher will observe you whilst you work and will ask you questions about the care you provide and the decision you make after each incident. As well as answering these questions you will be given the opportunity to ask questions and to talk about any other issues which you feel may be important to the evaluation.

What is a National Early Warning Score (NEWS)?

The Royal College of Physicians has recommended for the assessment of acute-illness severity to be standardised. They recommend for National Early Warning Scores (NEWS) to be adopted across all health care settings (primary, prehospital and acute) to enable severity to be measured, tracked and clinical teams alerted to any clinical deterioration ensuring an optimal clinical response. Further information can be found here: http://www.rcplondon.ac.uk/resources/national-early-warning-score-news

What if I have no experience or understanding of NEWS?

We will be undertaking an observational study both *before* and *after* NEWS has been implemented. Don't worry if you have not heard or been trained to use NEWS it may be because the awareness and training programme has not yet commenced.

Are there any benefits in taking part?

We cannot promise the study will help you personally but the information we collect *before* NEWS has been implemented will be used to inform the implementation programme, and the information collected *after* will be combined with patient clinical data to evaluate the benefits of using NEWS for staff and patients.

The insight and understanding we gain from this study will be shared with other ambulance services who may be considering adopting NEWS.

What if there are any problems?

We don't expect there to be any problems, but if there are, we will deal with these promptly. If you have any complaints about the way you have been dealt with during the study, these can be forwarded to AMB-X Complaints Department on [telephone number].

Will my taking part in the study be kept confidential?

As researchers we will follow ethical and legal practice to handle information about you in confidence. All data will be anonymous.

Appendix 22: Interview study consent form (v2, April 2014)

███████████ Ambulance Service **NHS**

NHS Trust

Participant Identification Number for this study:

CONSENT FORM

National Early Warning Scores (NEWS) in prehospital emergency care setting: qualitative study

Please initial box

1. I confirm that I have read and understand the information sheet version 2 dated 04/04/2014 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. ☐

3. I understand that the data collected during the study will be anonymised and may be looked at by individuals from the research project team or from the relevant NHS Trust. I give permission for these individuals to have access to this data. ☐

4. I understand that anonymised quotes from the data may be used for written publications and I consent to this. ☐

5. I consent to being audio recorded during the focus group/interview ☐

6. I agree to take part in the above study. ☐

_____ _____ _____
Participant   Date   Signature

_____ _____ _____
Study team member   Date   Signature

Appendix 23: Observation study consent form (v2, April 2014)

Ambulance Service **NHS**

NHS Trust

Participant Identification Number for this study:

| CONSENT FORM |

National Early Warning Scores (NEWS) in prehospital emergency care setting: observational study

Please initial box

1. I confirm that I have read and understand the information sheet version 2 dated 14/04/2014 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.

3. I understand that the data collected during the study will be anonymised and may be looked at by individuals from the research project team or from the relevant NHS Trust. I give permission for these individuals to have access to this data.

4. I understand that anonymised data and quotes from the study may be used for written publications and I consent to this.

5. I agree to take part in the above study.

_____   _____   _____
Participant   Date   Signature

_____   _____   _____
Study team member   Date   Signature

Appendix 24: Interview topic guide for Paramedics (v1, July 2015)

Thank you _____ for agreeing to participate in this evaluation study. I just need to ask you some questions to ensure you understand your rights as a participant and to clarify your willingness to continue participating in the study.

 ➢ Can I confirm that you have read and understood the information sheet that I sent to you?

 ➢ Do you understand your continued participation is voluntary and you are free to withdraw at any time without giving reason?

 ➢ Do you understand that the data collected will be anonymised and may be looked at by individuals from the research team? Do you give permission for these individuals to have access to this data?

 ➢ Do you also understand that anonymised quotes from the data may be used for written publication and do you consent to this?

 ➢ Do you consent to this interview being audio recorded?

Thank you. So, moving on…

<u>ICE BREAKER</u>

 ➢ Could you describe your clinical career path for me?

Prompts:

 ➢ How long have you been trained as a frontline clinician?

 ➢ Did you come straight in as a paramedic or were you a technician first?

 ➢ What did you do next?

 ➢ What is your current role?

 ➢ How have things been for you 'work-wise' over the last year?

So, my overarching study aim is to investigate the feasibility, usefulness and effectiveness of NEWS to support paramedics' decision-making. Just to recap the Royal College of Physicians has recommended the assessment of acute-illness severity to be standardised. They recommend National Early Warning Scores (NEWS) to be adopted across all health care settings (primary, prehospital and acute).

➢ Have you visited the RCP website using the link we provided previously?

➢ Have you done any other research on NEWS (e.g. read any papers)?

As you know, AMB-X has been introducing NEWS in association with Paramedic Pathfinder. When answering the questions, I would like you to focus on NEWS as much as possible, rather than Paramedic Pathfinder.

➢ Is that okay? Does that make sense?

INTERVIEW

1. **Have you been trained how to use the NEWS tool yet?**

➢ When did you complete the training?

➢ What did you think of the training?

Prompts:

➢ Was the presentation and material delivered so that it was easy to follow and understand?

➢ Did you understand what you were required to do?

➢ Did you feel confident in how to use and interpret NEWS?

➢ Do you think further any training should be provided? If so, what other training do you think is needed?

2. **Could you tell me a little bit more about the purpose of National Early Warning Scores?**

Prompts:

> Why do you think AMB-X decided to introduce NEWS?

> Have you used NEWS?

> Could you give me an example of why and when you have used it?

> Did have any difficulties with the tool?

> Do you use it because you have to, or because you choose to?

> Have you used it to support your decision-making? If so, did you use it to 'form' a decision i.e. prospectively? Or did you use it to 'confirm' your decision i.e. retrospectively?

> How often do you use it?

> How is it different from other triage tools you may use?

> Have you ever used the score to support communication with other HCPs or with the patient themselves? Could you tell me about this? How was it received?

3. **Thinking about the task itself, could you describe the process?**

Prompts:

> How do you get a NEW Score?

> How do you gather the vital signs necessary? Have you ever experienced any problems with this?

> How do you identify the individual parameter score? Have you ever experienced any problems with this?

> Who is responsible? For example, do you take responsibility, or is it down to your crew-mate, first person on scene, transporting crew etc?

> How often do you calculate a NEW score for each job? If more than once, which score do you record on your PRF? Which score do you use during handover?

4. Do you find NEWS easy or difficult to use?

Prompts:

> ➢ If easy, why is it easy?
>
> ➢ If not, why do you find it difficult and what difficulties have you experienced?
>
> ➢ How did you overcome those difficulties?
>
> ➢ How easy or difficult have others found it to use?

5. Do you find NEW scores easy or difficult to understand?

Prompts:

> ➢ If easy, could you tell me why or what makes it is easy to understand?
>
> ➢ If difficult, why do you find it difficult to understand?
>
> ➢ How could it be made easier to understand?
>
> ➢ When you speak with other people, and refer to the patient's NEWS, do other people understand?
>
> ➢ Have you used NEWS during communications with the patient? If so, how did you do that, could you explain? Did the patient understand?

6. Do you find NEWS helps or hinders?

Prompts:

> ➢ How does it fit with your roles and responsibilities?
>
> ➢ How does it fit with other tasks you have to do?
>
> ➢ If it helps, how does it help? Can you give me an example?
>
> ➢ If it hinders, in what why does it hinder you? Can you explain in a little more detail?
>
> ➢ How does it fit with organisationally, with other working practices, policies, procedures etc?

7. **Under what circumstances do you think NEWS should be used?**

Prompts:

➢ So, you provided the example earlier of using NEWS do you think NEWS should be used in that circumstances all the time? Could you explain?

➢ Are there other circumstances when you think NEWS should be used? If so, could you provide me with some examples and why you think it should be used?

➢ Are there circumstances when you think NEWS should not be used?

8. **Do you think NEWS has made any difference since it was introduced?**

Prompts:

➢ If so, can you tell me what those differences are?

➢ Do you think NEWS provides any benefits or not? If so, what benefits do you think NEWS provides and to whom? If not, why not?

9. **In 3 years', how do you perceive NEWS may be being used?**

Prompts:

➢ Do you think clinicians will be using it more or less? Why do you think that?

➢ Do you think it will be being used differently? Why do you think that?

  ➢ Do you think it will influence other changes or will modify how you currently work? If so, how and why?

Appendix 25: Interview topic guide for Paramedic Pathfinder Leaders (v1, July 2015)

Thank you _____ for agreeing to participate in this evaluation study. I just need to ask you some questions to ensure you understand your rights as a participant and to clarify your willingness to continue participating in the study.

- ➢ Can I confirm that you have read and understood the information sheet that I sent to you?

- ➢ Do you understand your continued participation is voluntary and you are free to withdraw at any time without giving reason?

- ➢ Do you understand that the data collected will be anonymised and may be looked at by individuals from the research team? Do you give permission for these individuals to have access to this data?

- ➢ Do you also understand that anonymised quotes from the data may be used for written publication and do you consent to this?

- ➢ Do you consent to this interview being audio recorded?

Thank you. So, moving on…

ICE BREAKER

- ➢ Could you describe your clinical career path for me?

Prompts:

- ➢ How long have you been trained as a frontline clinician?

- ➢ Did you come straight in as a paramedic or were you a technician first?

- ➢ What did you do next?

- ➢ What is your current role?

- ➢ How have things been for you 'work-wise' over the last year?

So, my overarching study aim is to investigate the feasibility, usefulness and effectiveness of NEWS to support paramedics' decision-making. To achieve this, I am evaluating the implementation and adoption of NEWS at AMB-X, which as you know is being implemented in association with Paramedic Pathfinder.

INTERVIEW

1. **Can you provide me with a brief description of your role and responsibilities in leading the implementation of NEWS and Paramedic Pathfinder?**

Prompts:

➢ Have you perceived that your role to have changed since you came into post?

➢ If so, could you tell me briefly how your role has changed?

➢ Why do you think this change was necessary?

2. **Can you quickly tell me about the project/training programme, and how this has progressed?**

Prompts:

➢ What methods have been used?

➢ How many staff (number/percentage) have been trained so far?

➢ How many staff are there still to do?

➢ Do you perceive that you will be able to complete the training of all staff?

➢ If so, when do you think the training will be completed?

➢ If not, why do you think you won't be able to complete the training (e.g. your role has changed, there are different priorities across the trust etc)?

➢ Have there been any problems? If so, how did you overcome these?

3. **Can you tell me a little about how you are assessing/measuring change?**

Prompts:

- ➢ Are you assessing the use of NEWS separately from Paramedic Pathfinder?

- ➢ What are you measuring (e.g. conveyance rates, time on scene, referrals, revisits, accuracy of NEWS calculations)?

- ➢ How are you sampling data (e.g. all staff or a random representative sample, by sector, by sector on rotational basis etc)?

- ➢ How frequently are you auditing the data?

- ➢ Who is responsible for conducting the audits?

- ➢ What do you do with the findings?

- ➢ Do you provide staff with any feedback? If so, how do you do this? How do the staff respond?

4. **Could you tell me a little about the findings from your audits?**

Prompts:

- ➢ What has uptake and rate of uptake been like?

- ➢ Were the findings different from those that you expected?

- ➢ If so, how did they differ?

- ➢ What do you perceive influenced that difference?

- ➢ Did the findings influence any changes to training or roll-out?

5. **Do you think Paramedic Pathfinder has made any difference since it was introduced, can you explain?**

Prompts:

- ➢ If so, can you tell me what those differences are?

- ➢ What do you think is the most important difference and why?

6. And what about NEWS, do you think NEWS has made any difference?

Prompts:

➢ If so, can you tell me what those differences are?

➢ What do you think is the most important difference and why?

7. How compatible is NEWS/Pathfinder with existing working practices?

Prompts:

➢ Have you perceived that behaviours or working practices have changed?

➢ If so, what changes have you seen?

➢ Why do you think these changes occurred?

➢ Are the changes those that were desired or anticipated?

➢ If not, why do you think there has been little change? What are the consequences?

8. Have you had any feedback from staff, about the implementation of NEWS/Pathfinder into everyday practice? If so, can you give me some examples?

Prompts:

➢ Do you perceive staff to have adopted it willingly, or not?

➢ Have they experienced any difficulties? If so, can you give some examples?

9. Have you experienced any barriers implementing Paramedic Pathfinder? If so, what were those barriers? How were they overcome them?

Prompts:

➢ If so, what barriers did you experience (e.g. getting training in place and delivered in time; individuals being able to take time off to attend the training; lack of support from strategic and operational staff)?

➢ How did you overcome those barriers?

10. Likewise, did you experience any barriers implementing NEWS? If so, could you tell me about those barriers and how you overcame them?

Prompts:

➢ Have broken or lack of resources had any impact (e.g. pulse oximeters, thermometers)? If so, how frequently does this occur?

11. Have there been any difference in uptake of Paramedic Pathfinder across the trust? If so, what do you think has influenced this difference?

Prompts:

➢ Has there been anything specific that has supported or dissuaded adoption of Paramedic Pathfinder? For example, has uptake been better in localities where there are greater number of referral pathways, and where referral pathways are easily accessible?

12. Likewise, have there been any difference in uptake of NEWS across the trust? If so, what do you think has influenced this difference?

Prompts:

➢ Has there been anything specific that has supported or dissuaded its adoption? For example, has uptake been better in localities where A&Es are familiar and use NEWS than in those where it has not been used?

13. Do you perceive any specific benefits to have been realised?

Prompts:

➢ If so, can you tell me a little more? For example, what benefits do you think have been achieved, by whom?

➢ If not, why not?

14. What has helped or facilitated you most as Paramedic Pathfinder Lead?

Prompts:

➢ What support have you had organisationally (e.g. by CAT, comms, operational support, education, PMIT, or from peers)? How did this help?

➢ What else has supported you?

15. Have there been any unintended consequences?

Prompts:

> ➢ If so, what unintended consequences occurred and why?

> ➢ Where any changes instigated? If so, what changes were made? Has this made any difference?

16. Knowing what you know now, is there anything you would have done differently?

Prompts:

> ➢ What advice would you give another Trust/Pathfinder Lead who is planning implementing Paramedic Pathfinder

17. In 3 years' time how do you perceive NEWS/Pathfinder may be being used?

Prompts:

> ➢ Do you think clinicians will be using it more or less? Why do you think that?

> ➢ Do you think it will be being used differently? Why do you think that?

> ➢ Do you think it will influence other changes or will modify how you currently work? If so, how and why?

Appendix 26: Observation guide (v1, April 2014)

Guide:

1. **Time and date of incident** – make a note of the date and time of the incident.

2. **Incident number** – this will be used to obtain an anonymised copy of the patient report form (PRF). The PRF will be used to support the analysis, for example the comments, physiological measures and clinical impression/diagnosis recorded by the paramedic will be used in conjunction with the observational notes to gain a better understanding of how clinical-decisions are made.

3. **Influencers** (pre) – Try to make a note before arriving at scene of factors that may influence decisions. For example, how is the paramedic feeling (well, happy, relaxed or tired, stressed, headache)? How has the description of the incident been received/perceived by the attending paramedic? Are there excessive demands on ambulance? What is the weather like or traffic conditions? How far is the incident from current location or distance to hospital? What is the state of play with the hospital – are there delays? Have the crew had or due their meal break? Is the end of shift approaching?

4. **Physiological assessments/observations** – A note will be made of mechanism of injury or any obvious physical influencing factors (e.g. fracture, head injury) that would warrant hospital assessment or treatment. The physiological assessments undertaken (or not) by the paramedic should be noted along with the measures recorded. If not measured, try to ascertain from the paramedic why (e.g. patient refused) and make a note. Record the individual measures and calculate a total aggregate NEWS based on the last physiological assessment.

5. **Communication/interaction** – Observe and take note of the communication and interaction that takes place between paramedic and patient, the paramedic and significant others (e.g. relative, carers etc.) and the patient and significant others. Consider emotions, attitudes, concerns, beliefs.

6. **Treatment provided and outcome** - Make a note of any treatment provided at the scene by the attending paramedic and the outcome of that treatment.

7. **Environmental factors** – Make a note of influencers within the environment for example, has the incident occurred in a public place, are there signs which suggest it is unsafe to leave the patient at home etc.

8. **Influencers (post) –** Consider other factors at scene that may influence decisions (see 3 above), standard operating procedures etc. that may influence the decisions made.

9. **Decision-making** - Ask the paramedic after the incident how they came to the decision to transport or leave their patient at home. What factors do they believe influenced their decision? Which factors influenced their decision most strongly? Did they use any decision support tools? Was the decision easy or difficult to make?

10. **Reflexivity** – Make a note of how the paramedic felt before and after. Did they think the job went well? Would they have managed it differently under different circumstances? Were they confident about the decisions they made? What would have made it easier?

11. **Additional notes** – Make a note of any other interesting observations, behaviour, comments.

12. **Clinical experience** – Include information of length of service within prehospital care, experience of other care settings or similar organisations, previous experience of similar incidents or conditions etc.

Appendix 27: Observation record sheet (v1, April 2014)

1. Time & Date:

2. Incident number:

3.   Influencers   (pre):
_____
_____
_____
_____
_____
_____
_____
_____

4.   Physical   assessment/observations:
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Respiratory rate: _____ [   ]

Oxygen saturations: _____ [   ]

Supplemental Oxygen: _____ [   ]

Temperature: _____ [   ]

Systolic Blood pressure: _____ [   ]

Heart rate: _____ [   ]

Level of Consciousness: _____ [   ]

                                              NEWS [   ]

5. Communication/interactions:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

6. Treatment provided at scene & outcome:

_____
_____
_____
_____
_____
_____
_____
_____
_____

7. Environmental factors:

_____
_____
_____
_____
_____
_____
_____
_____
_____

8. Influencers (post):

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

9. Decision-making:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

10. Reflexivity:

_____
_____
_____
_____
_____
_____
_____

11. Additional notes:

_____
_____
_____
_____
_____

12. Clinical experience:

_____
_____
_____
_____

Appendix 28: Number of NHS 111 calls resulting in an ambulance being dispatched

NHS 111

— Number of ambulance dispatched
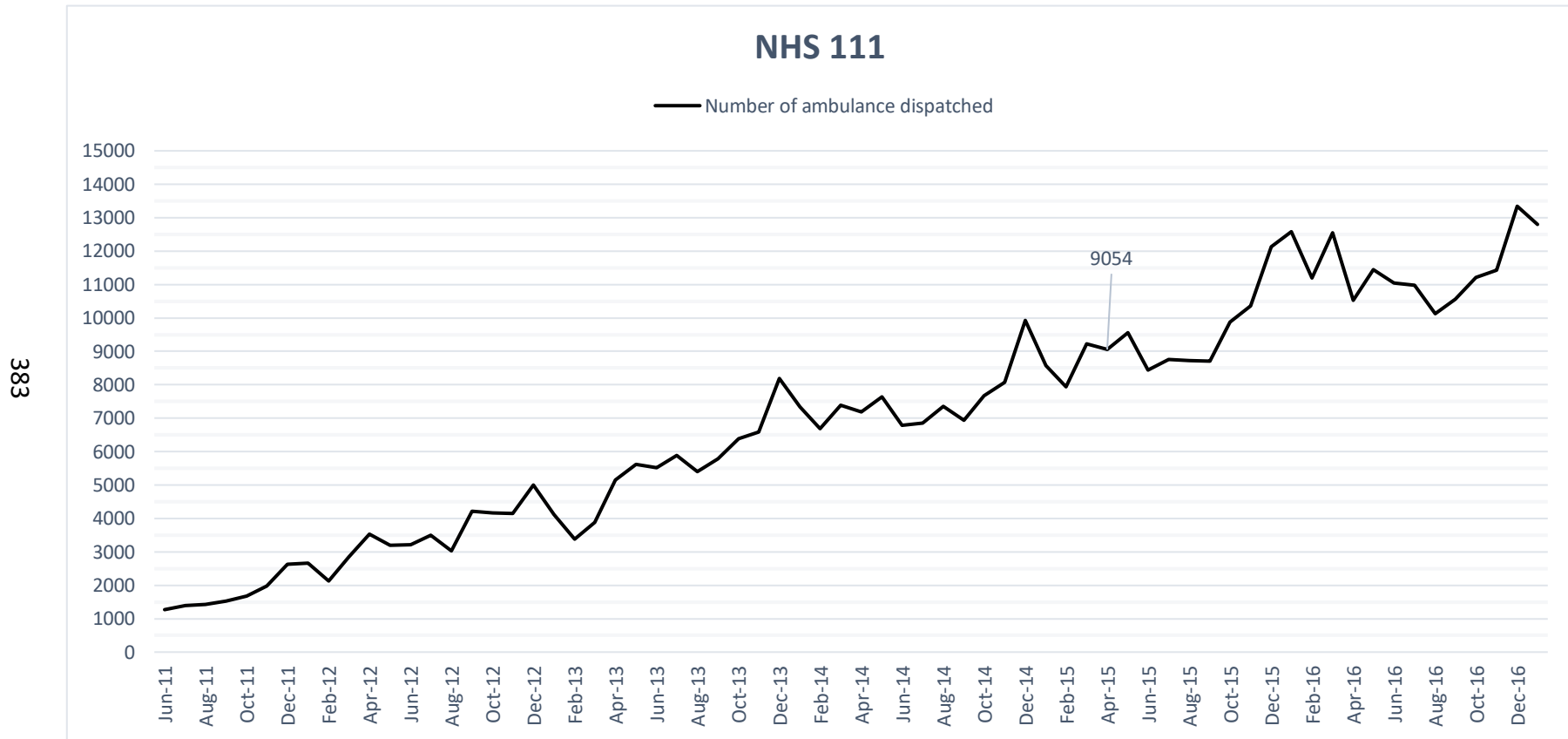
Appendix 29: Percentage of NHS 111 calls resulting in an ambulance being dispatched

NHS 111

—— % Amb Dispatch
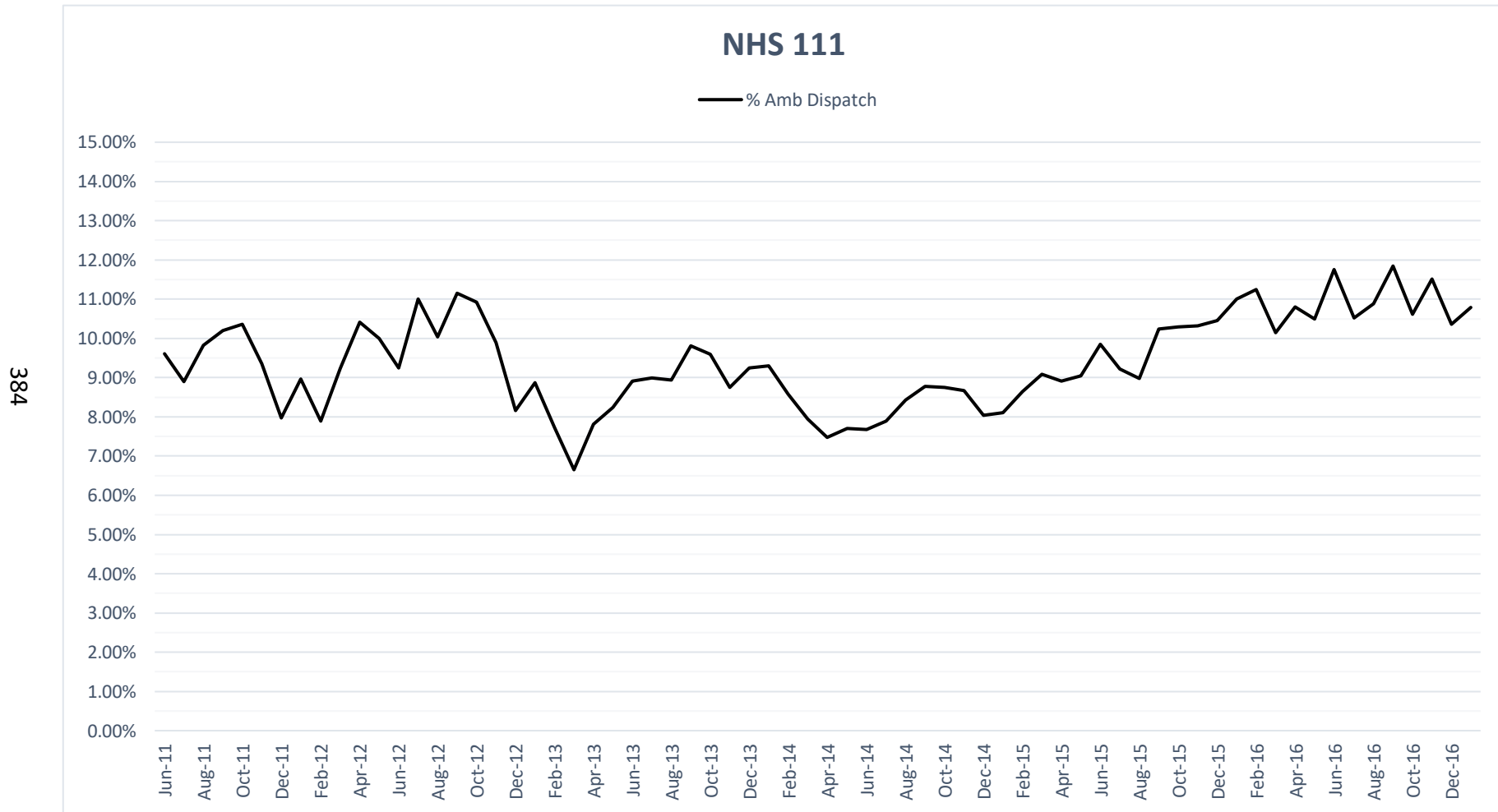
Appendix 30: Summary of observations, decision-making and outcomes

<u>Key to shading</u>   Clinical complaint: `Green` = non-blue light response (priority Green 1-4 call & ECP assessment unit) & `Red` = emergency blue light response (priority Red 1 or 2 category A call)

Physiological measurements: Shading reflects individual parameter NEW score: `Grey` = 0, `Green` = 1, `Amber` = 2 and `Red` = 3 (*Patient report forms missing: shading and measures are based on the measures obtained during observation)

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
P3/1	M	65	*Loss of consciousness. Sustained injury to the forehead and an abrasion to bridge of nose during fall.*	20	96	No	37	128	72	A			No	No		C	*Reoccurring episodes of unconsciousness necessitating further assessment. Patient was confused on arrival and recovery was slower than desired. ECG showed abnormalities, but unable to determine whether this was a pre-existing problem already being treated owing to patient's confusion. Incident had occurred in public place, but even if at home the clinician would have recommended the patient go to hospital for further assessment.*	*Back-up crew requested and conveyed patient to ED.*

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
			Patient details									**NEWS & Paramedic Pathfinder**					**Decision-making & outcomes**	
P3/2	F	86	*Chest pain. Post-fall. Uncertain of fall frequency, as patient had dementia. Pain non-radiating. Worse on palpation and movement. Visibly in pain, but unable to provide pain score.*	16	94	No	36.4	157	68	A			No	No		C	*Patient required pain relief. Entonox not appropriate because of dementia and difficulty with self-administration. Clinician provided morphine which meant conveying patient to ED. Further assessment and X-ray were needed to determine cause of pain; possible causes included pulmonary embolism or fractured rib.*	*Back-up crew requested and conveyed patient to ED.*
P3/3	F	66	*Allergic reaction; Lignocaine administered IM by dental surgeon 1-hour previous. Feeling drowsy. Had similar reaction before. Usually goes home and sleeps it off. Slower recovery than normal.*	14	98	No	36.7	166	72	A			No	No		NC	*Patient's observations were all normal. Patient had history of similar reactions and had recovered normally. Patient was primary carer for a disabled relative and did not want to go to ED.*	*Escorted patient home and assisted indoors. Patient left at home in care of relative.*

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
P3/4	M	80	*Minor injury fall.* Patient had Alzheimer's and reduced mobility. No loss of consciousness. Able to mobilise post-fall. No obvious pain. Skin tear to elbow.	14	97	No	36	124	80	A			No	No		NC	*Patient's relative who has lasting power of attorney did not wish patient to go to hospital.*	*Wound dressed. GP contacted. District Nurse visit arranged for following day. Patient left at home in care of relative.*
P4/5	F	83	*Inner ear infection.* Dull ache behind ear, with whooshing sound, radiating deeper into the head.	18	99	No	36.6	172	82	A	0	✓	No	No	-	NC	*Contacted GP. GP advised the patient is already receiving antibiotic treatment and would continue monitoring patient.*	*Advice provided. Patient left at home in care of relative.*
P4/6	M	44	*UTI.* Generally unwell. Had hernia operation one month previous. Experiencing a change in taste - therefore has not been eating or drinking. Patient is perspiring. Jaundiced; head and face, but not torso. Urine has strong odour. Possible sepsis.	20	96	No	38.2	103	106	A	3	✓	No	No	+	C	*Had originally planned treating patient closer to home (i.e. arranging GP visit) but patient was tachycardic, had a raised temperature and was slightly jaundiced raised concerns regarding post-surgery UTI & sepsis. Patient was dehydrated. Intravenous fluids administered at scene by clinician. Patient would need to be assessed, treated and monitored in hospital.*	*The attending paramedic requested back-up crew to convey the patient to ED. Followed ambulance to ED to provide the clinical handover.*

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
																	Patient details — **NEWS & Paramedic Pathfinder** — **Decision-making & outcomes**	
P6/7	M	80	*UTI. Had Cystoscopy earlier in the week. Felt dizzy and fell. Had been on the floor for 2 hours. Would normally be able to get up unassisted.*	16	94	Yes	36.3	135	88	A	0	X	No	Yes	-	NC	*Clinician's primary consideration was for the patient's safety. Patient lived alone and was experiencing reduced mobility and instability when standing. Patient had not eaten for two days. Nearest relative lived 2 hours away.*	*Attending paramedic requested back-up crew to convey patient to the local UCC, who refused to accept patient. Patient subsequently conveyed to main ED by back-up crew.*

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
P6/8	M	79	*Elbow injury. Possible dislocation/subluxation with contusion and haematoma. Able to articulate arm. No pain or visual discomfort. Patient has dementia.*	16	97	No	36.5	168	73	A	0	✓	No	No	-	NC	*UCC would be able to manipulate elbow under local anaesthetic and then immobilise.*	*Conveyed to UCC by attending clinician, in FRV. UCC refused to accept because general anaesthetic would be required. Patient conveyed to ED. ED nursing staff questioned why patient had been conveyed there; they would use a local anaesthetic not general*
P6/9	F	27	*Exacerbation of Hydrocephalus. Left sided arm and neck pain.*	16	100	No	37	130	91	A			No	No		C	*Patient was in a public place. Extremely anxious and distressed. Experienced similar symptoms 4-weeks prior, which had been treated with a lumbar puncture to release pressure. Hospital assessment*	*Automatic back-up arrived on-scene 5-minutes after FRV. Back-up crew*

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
																	considered necessary because of previous medical history.	conveyed patient to ED.
P9/10	M	47	*Loss of consciousness. Patient collapsed whilst training at local Gym. Unresponsive for 1-2 minutes. Alert, chatty, pink and perfused when assessed. No pain. Patient currently receiving treatment for a chest infection from GP.*	18	99	No	36	126	74	A			No	No		NC	*Whilst Pathfinder states the patient should be conveyed because of a neural deficit/ loss of consciousness. ED was unnecessary, as the patient had fully recovered. The collapse was believed to be caused by over-exertion combined with a chest infection, which had reduced oxygen transfer. The clinician believed the patient just needed antibiotics from their GP to treat the chest infection.*	*Advised to make an appointment with GP. Patient discharged at scene.*

Patient details — **NEWS & Paramedic Pathfinder** — **Decision-making & outcomes**

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
			Patient details									**NEWS & Paramedic Pathfinder**					**Decision-making & outcomes**	
P9/11	M	51	*Chest pain. Patient has heart disease and Lymphoma. Been experiencing pain for 90-minutes. Pain worse on palpation and inspiration, with numbness in left arm. Patient had self-administered a friend's GTN spray which had no effect*	83*	97	No		109	82	A			No	No		C	*Patient refused pain relief when offered and was reluctant to go to hospital. The attending paramedic was unable to complete full assessment, as patient was in a public place and was intoxicated. Whilst the paramedic did not believe the pain to be cardiac-related, a full assessment including bloods would be required to determine cause.*	*Back-up crew conveyed patient to ED.*
P10/12*	M	89	*Severe breathing difficulties. GP visited day before. Diagnosed a chest infection and prescribed antibiotics. Patient's condition has since worsened. Condition was visibly deteriorating rapidly.*	34	87	Yes	36.4	171	186	A	?	?	No	No	?	C	*Based on the patients breathing pattern and being apyrexic, the clinician believed the patient to be suffering left ventricular heart failure rather than a chest infection; although they acknowledged they did not check if the patient had been given paracetamol, which would have reduced patient's temperature.*	*Oxygen, GTN and furosemide administered. Patient conveyed on blue lights and sirens to resuscitation unit at local ED.*

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
P11/13	F	68	*Toe injury. Bruising, but no swelling, deformity or broken skin. Full range of movement. Pain score = 4/10.*			No				A			No	No		NC	*Good pedal pulse and capillary refill. Patient was mobile and weight-bearing, without difficulty. Injury restricted to the toe. No further treatment required.*	*Advice provided. Discharged at scene.*
P11/14	F	53	*Foot blister. Blister located on dorsum of foot above big toe. Cause = ill-fitting footwear. Pain score: 1/10.*			No				A			No	No		NC	*Minor injury. No further treatment necessary.*	*Blister de-roofed and dressed. Self-care advice provided. Discharged at scene.*
P11/15	F	26	*Musculoskeletal hip pain. Pain score = 2/10 without analgesia.*			No				A			No	No		NC	*Patient not fallen or experienced any trauma. No swelling or bruising. Normal capillary refill and dorsal pedal pulse. Was fully weightbearing, had normal gain and full range of movements. No back pain or incontinence. Pain believed to be musculoskeletal cause by carrying niece on hip.*	*Advice provided. Discharged at scene.*

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Patient details								NEWS & Paramedic Pathfinder						Decision-making & outcomes	
			Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
P11/16	F	40	_Ankle injury. Patient is paraplegic. Injury sustained from severe muscle spasm. Evidence of swelling and redness, but no bruising or deformity._										No	No		NC	_Paramedic recommended the patient attend the local UCC for an X-ray. Ankle may be fractured, as there was swelling and inflammation, but assessment was difficult owing to the patient having no sensation or movement in lower limbs._	_Patient refused paramedics advice, stating they would prefer to see their own GP when they returned home the following day (was on holiday). Self-care advice provided. Discharged at scene._

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
P14/17	M	94	*Chest pain; sudden onset. Carer found patient bent double in pain. Decrease breath sounds on left side of chest, accompanied by sharp pain on inspiration. No cough, but patient taking steroids for recent chest infection/pneumonia.*	22	100	No	36.3	161	79	A			No	No	-	NC	*Chest pain believed to be respiratory in origin, not cardiac. Patient described the pain as 'sharp'. Pain was experienced on inspiration. There was consolidation of lung. Had recently been treated for pneumonia. Clinician considered risks of pleurisy or hole in the lung and whilst unlikely, pericarditis could not be ruled-out. Patient needed an X-ray and blood tests to identify cause. Whilst these could have been arranged via the patient's GP, the clinician felt it more appropriate (because of patients age and recent pneumonia) to arrange transport to ED, so treatment could be commenced sooner.*	*Back-up crew requested and conveyed patient to ED.*

Observation ID	Patient details										NEWS & Paramedic Pathfinder						Decision-making & outcomes	
	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
P14/18	F	98	*UTI.* Retention of urine. Weeping blisters on lower leg. Unable to mobilise. Been sat in chair for 3 days. Patient lives at home alone. Carers visited four times daily.	18	94	No		125	48	A			No	No		NC	*Patient was slurring her words and behaving abnormally. Stroke was considered as possible clinical impression, but over-ruled as the patient was not FAST+. Based on the fluid accumulation in patient's legs, immobility and strong smell of urine, the attending paramedic believed the patient had a UTI. Hospital assessment was considered necessary because of low blood pressure. Paramedic thought it unlikely that the patient would be accepted directly to a ward, because of comorbidities.*	*Back-up crew requested and conveyed patient to ED.*
P14/19	M	51	*Overdose; intentional with alcohol.* Patient had not vomited. No pain. History of depression and attempted suicide.	18	98	No	36	95	105	A			No	No		C	*Combination of drugs and alcohol, plus mental well-being would need to be formally assessed at ED.*	*Back-up crew requested and conveyed patient to ED.*

Observation ID	Patient details										NEWS & Paramedic Pathfinder						Decision-making & outcomes	
	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
P14/20	M	72	*Loss of consciousness. Patient's hernia had been problematic earlier. Felt drowsy so went to bed. Got up, felt clammy and sweaty then collapsed. Was unconscious for 5-minutes. Unable to stand; dizzy/light-headed. Been on floor for 60-minutes.*	18	99	No	36.5	177	68	A			No	No		C	*Patient was still on the floor and experiencing 'funny episodes' 60-minutes after collapsing. Patient turned grey and was shaking when assisted up off the floor. Unsafe to leave the patient at home. The cause of the collapse needed to be explored.*	*Back-up crew requested and conveyed patient to ED.*

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
																	Patient details →	**NEWS & Paramedic Pathfinder** / **Decision-making & outcomes**
P14/21	F	58	*Chest pain. Gradual on-set. Sharp stabbing pain between shoulder blades, radiating to left side of chest. Being treated for bridging fibrosis, but pain felt different. Pain score = 6/10 increasing to 8/10. Regular crescendos and dull heavy sensation in left arm and tingling in jaw. Tired and lethargic. Was being treated with steroids for chest infection.*	20	97	No	36.4	176	86	A			No	No		C	*Pain eased with GTN and aspirin. Symptoms described were cardiac in nature and whilst the patient's ECG showed normal sinus rhythm, a small myocardial Infarction could not be ruled out without a blood test.*	*Back-up crew requested and conveyed to ED. On arrival at hospital patient had a seizure lasting 2-3 mins. Patient had history of pseudo non-epileptic seizures. Patient taken into Resus.*

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Patient details								NEWS & Paramedic Pathfinder						Decision-making & outcomes	
			Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
P14/22*	M	17	*Dislocated knee. Patient had fallen outside at school.*	16	98	No	36		88	A	?	?	No	No	?	C	*Further assessment and X-ray necessary. Joint needed to be stabilized/immobilized.*	*Patient self-administered Entonox whilst the attending paramedic straightened the patient's leg. Knee relocated back into the joint during manipulation. Back-up crew requested, and patient conveyed to ED.*

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Patient details								NEWS & Paramedic Pathfinder					Decision-making & outcomes		
			Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
P17/23	F	86	_UTI._ Being treated by GP for bladder problem. Experiencing suprapubic non-radiating pain (score: 7/10 pre-pain relief). Nausea and vomiting. Slightly jaundiced. No haematuria, but urine has a strong odour. Abdomen slightly swollen, possibly because of retention of urine.	20	98	No	37.4	177	78	A	1	X	No	No	+	C	Patient was given the option to remain at home and for a GP visit arranged, but the patient declined. Pain score was also Paramedic Pathfinder positive. The patient was slightly jaundiced, which combined with urine retention, offensive odour, led the paramedic to believe the underlying infection had reached the kidneys. Further assessment at hospital was necessary.	Patient conveyed to ED by attending paramedic and crew-mate (DCA).
P17/24	M	49	_Knee injury._ Fell previous day. Ambulance attended but the patient refused to travel to ED. Signs of oedema to left knee. Unable to weight bare. Pain score pre-treatment: 10/10 with pain relief: 2/10.	22	98	Yes	37.5	122	88	A	6	X	No	No	+	C	Patient lives alone. Had comorbidities and significant recent medical history (pancreatitis, necrosis of left hip, arthritis of spine, admitted earlier in the year with PE leading to cardiac arrest). X-ray would be necessary to determine whether leg/knee was fractured. Patient also believed to have a chest infection, which would need further assessment and treatment.	Patient conveyed to ED by attending paramedic and crew-mate (DCA).

Observation ID	Sex of patient: M=Male/F=Female	Age of patient	Clinical Complaint	Respiratory Rate	Oxygen Saturations	Supplementary Oxygen	Temperature	Systolic Blood Pressure	Heart Rate	Level of Response (AVPU)	Last NEWS recorded on PRF	Accuracy of NEWS: ✓=Correct/X=Incorrect	Use of NEWS Tool observed	NEWS verbalised during clinical handover	Paramedic Pathfinder recorded on PRF	Decision-made: C=convey/NC=Not convey	Rationale	Outcome
																	Patient details	
																	NEWS & Paramedic Pathfinder	
																	Decision-making & outcomes	
P17/25	M	70	_Ankle injury._ Evidence of oedema. Pain score pre-treatment = 10/10 and with pain relief = 6/10.	16	100	No	36.3	132	56	A			No	No		C	This was a back-up call made by another paramedic working solo on FRV. The Paramedic I was observing agreed with the attending paramedic's decision. Patient would need assessment and treatment at ED, as the local MIU would not accept traumatic injury with obvious deformity.	Patient conveyed to ED by attending paramedic and crew-mate (DCA).

Appendix 31: Summary of wider context and potential influencing factors

Observation ID	Shift	Day of the week	Month	Weather	Location	Sector	Response vehicle	Paramedic's sense of well-being	Traffic	Handover at ED	999-call demand	Other factors
P3/1-4	07:00-15:30 (4th shift in a run of seven)	Monday	September	Rain	Semi-rural/ rural	1	FRV	Good; despite having only 2 hours sleep the night before because of own children.	Okay	Okay	Okay	Nothing to report.
P4/5-6	07:00-19:00 (4th shift in a run of six)	Thursday	August	Sunny	Urban	3	FRV	Physically well. Morosely discontented at/with work. Seeking employment opportunities elsewhere.	Okay	Okay	Okay	Finished previous shift 3-hours late, claims this was becoming the norm. Paramedic in neighbouring county had committed suicide the night before; found hanging in the ambulance station garage. All stations in sector were being 'Quality Task Force' inspected the following Monday, in preparation for the CQC inspection due in the next month or so.

Observation ID	Shift	Day of the week	Month	Weather	Location	Sector	Response vehicle	Paramedic's sense of well-being	Traffic	Handover at ED	999-call demand	Other factors
P6/7-9	12:00-Midnight (2nd shift in a run of three)	Friday	July	Sunny	Coastal urban/ semi-rural	2	FRV	Physically well. Stated work had become increasingly stressful. Public demand was increasing but there were less paramedics because they are leaving at an increasing rate. Personally, unhappy with the way FRVs were being utilised to attended low category calls.	Busy initially, easing throughout the shift.	Okay	Okay	Finished shift 2-hours late the day before.
P9/10-11	07:00-19:00 (1st shift in a run of two shifts)	Monday	April	Overcast and cold	Urban	2	FRV	Good; happy and well. Had recently applied and been appointed the new position as Clinical Team Mentor. Also, had recently completed his BSc in Autonomous Practice.	Okay	Okay	Okay	Nothing to report.
P10/12	11:00-19:00 (1st shift in a run of three)	Monday	August	Overcast.	Large urban	1	DCA	Happy. Paramedic stated she liked this shift-pattern as she was able to get a lie-in and had no traffic to contend with when getting to work.	Okay	Okay	Quiet	Ambulance 'off road' for 30 minutes at beginning of shift whilst vehicle re-kitted and restocked
P11/13-16	08:00-18:00 (overtime)	Sunday	August	Sunny	Coastal urban/ semi-rural	2	ECP assessment unit)	Good. Shift would be repaid with time off in lieu. Had recently been seconded to senior management position for 3-month period but was not comfortable/settled in new position and was considering relinquishing post.	Okay	Okay	Okay	Nothing to report.

Observation ID	Shift	Day of the week	Month	Weather	Location	Sector	Response vehicle	Paramedic's sense of well-being	Traffic	Handover at ED	999-call demand	Other factors
P14/17-22	07:00-19:00 (3rd shift in a run of three)	Wednesday	March	Rainy & cold	Large urban	1	FRV	Good; happy and well. Had swapped and worked this shift on behalf of a colleague who needed the day off. Previous 2 shifts had worked on DCA.	Okay	Delayed: 60-minutes turnarounds because of 48-hour strike by junior doctors. Whilst ED was unaffected, patient flow through ED was slow because of difficulties getting patients on/off wards.	Quiet	Staff had received internal comms advising the CEO would be leaving the Trust. This had unsettled frontline staff. The paramedic being observed commented the CEO had been good for the organisation and was sorry she was leaving. The finance director was also leaving. CQC had assessed the organisation in the autumn and the report was due any day.
P17/23-25	06:00-14:00 (an overtime shift)	Tuesday	September	Showery	Rural/ Semi-rural	1	DCA	Good; happy and well. Really enjoys the job. Believes it is a valued and respected profession by the public, although less so by other healthcare professionals. She likes working both on DCA and FRV. When working alone on the FRV, she felt it develops your skills - "It can be difficult, but it makes you think a little bit more" of whether people really do need to go to hospital. Recently completed her BSc in Paramedic Science was pleased with her grade.	Okay	Okay	Okay	Nothing to report.

404