Interfacility Critical Care Transfers in Saudi Arabia:

Measuring adverse events, mortality comparison and consensus on interventions in adult critical patients transferred by paramedics

By
Abdullah Ahmad Alabdali, MSc, BSEMS

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in Health Sciences

University of Warwick, Warwick Medical School

July, 2017

Table of Contents

List of Figures

List of Tables

Acknowledgements

Firstly, I would like to express my sincere gratitude to my supervisor, Prof. Richard Lilford, for his support of my PhD, for his patience, motivation and knowledge that helped me throughout the PhD study. Secondly, I would like to express my appreciation to my second supervisor, Dr. Chetan Trivedy, for his time and expertise that improved my clinical practice and research. Finally, I would like to thank Dr. Joanne Fisher for her support, knowledge and patience.

Beside my advisors, I would like to thank Dr. Nawfal Aljerian who provided me the access to data and supported me throughout the data collection phase. Without his precious support, it would not have been possible to conduct this research.

Last, but not least, I would like to thank my family, my parents Ahmad and Norah, my brothers and sisters, and my uncle Fahad, for their support throughout the PhD. Words cannot express how grateful I am to my beloved wife, Eman, and our angels, Norah and Ahmad, for all the sacrifices that you have made on my behalf.

Declaration

I hereby declare that this thesis is based on my own research, except when stated otherwise, in accordance with the regulations of the University of Warwick, and has not been submitted elsewhere.

The following is a list of published articles and abstracts presented in conferences:

Part of Chapter 2 has been published in Air Medical Journal:
Alabdali, A., Fisher, J.D., Trivedy, C. & Lilford, R.J. (2017) A Systematic Review of the Prevalence and Types of Adverse Events in Interfacility Critical Care Transfers by Paramedics. *Air Medical Journal*, 36 (3): 116-121.

Part of Chapter 4 has been published in the *Saudi Journal of Health Specialties*.
Alabdali, A., Trivedy, C., Aljerian, N., Kimani, P. & Lilford, R.J. (2017) Incidence and predictors of adverse events and outcomes for adult critically-ill patients transferred by paramedics to a tertiary care medical facility. *J Health Spec*, 2017(5): 206-211.

Part of Chapter 4 has been presented as a poster:
Alabdali, A., Trivedy, C., Aljerian, N., Kimani, P. & Lilford, R.J. (2017) Poster presentation “Incidence and predictors of adverse events and outcomes for adult critically-ill patients transferred by paramedics to a tertiary care medical facility”. Retrieval conference, Glasgow.

Part of Chapter 5 has been presented as a poster:
Alabdali, A., Trivedy, C., Aljerian, N., Kimani, P. & Lilford, R. J. (2017) Poster presentation “In hospital mortality and 30-days survival in paramedic model versus physician model in interfacility transfer of critically-ill adult patient in Saudi Arabia”. Retrieval conference, Glasgow.

List of Abbreviations:

AAGBI: Association of anaesthetists of Great Britain and Ireland

AC: Anterior cubital

ACLS: Advance cardiac life support

AE: Adverse event

AED: Automated external defibrillator

AMI: Acute myocardial infarction

APACHE: Acute physiology and chronic health evaluation

ARDS: Acute respiratory distress syndrome

ATV: Automatic transport ventilator

BiPAP: Bi-level positive airway pressure

BLS: Basic life support

BP: Blood pressure

BVM: Bag-valve mask

cc: Cubic centimetre

CCU: Coronary care unit

CI: Confidence interval

cmH_2O: Centimetre of water

CPAP: Continuous positive airway pressure

CPR: Cardiopulmonary resuscitation

CTCAE: Common terminology criteria for adverse event

CVA: Cerebrovascular accident

ECG: Electrocardiogram

EMS: Emergency medical services

ER: Emergency room

ETCO2: End-tidal CO2/Capnography

ETT: Endotracheal tube

Fio2: Fraction of inspired oxygen

g/dl: Gram per decilitre

GCS: Glasgow coma scale

GI: Gastrointestinal

HR: Heart rate

IABP: Intra-aortic balloon pump

IBP: Invasive blood pressure

ICC: Intra-class correlation coefficient

ICU: Intensive care unit

IRB: Institutional review board

IRR: Inter-rater reliability

IV: Intravenous

KAIMRC: King Abdullah International Medical Research Centre

KAMC: King Abdulaziz Medical City

Km^2: Square kilometre

KPA: Kilopascal

MAP: Mean arterial pressure

mcg: Microgram

MedEvac: Medical evacuation.

mg: Milligram

mm: Millimetre

mmHg: Millimetre mercury

mmol/l : Millimoles per litre

MNG: Saudi Ministry of National Guard

MOH: Saudi Ministry of Health

MTV: Manually trigged ventilator

NCI: United States National Cancer Institute

NG: Nasogastric tube

NHTSA: The US National Highway Traffic Safety Administration

OCEBM: Oxford Centre for Evidence-Based Medicine

OG: Orogastric tube

OR: Odd ratio

PALS: Paediatric advance life support

PEARL: Pupils equal and reactive to light

PEEP: Positive end-expiratory pressure

PHTLS: Pre-hospital trauma life support

PRISMA: Preferred reporting items for systematic reviews and meta-analyses

PRN: As needed

RR: Respiratory rate

RSTP: Risk score for transported patients

RTA: Road traffic accident

SCFHS: Saudi Commission for Health Specialties

SL: Sub-lingual

SOB: Shortness of breath

SPO2: Peripheral capillary oxygen saturation

ST: ST segment

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

TBI: Traumatic brain injury

Temp: Temperature

UK: The United Kingdom

USA: United States of America

WHO: World Health Organisation

Abstract

Introduction: paramedics conducting interfacility transfer of critically-ill patients is one of the existing models in interfacility transfer. The paramedic model is available in multiple countries, including the Kingdom of Saudi Arabia. Paramedics' expanded scope of practice has allowed them to transport, monitor and intervene with complex patients. This PhD thesis is designed to evaluate the safety of the paramedic model in Saudi Arabia conducting interfacility transportation of critically-ill patients.

Method: the PhD thesis is mixed methods. A systematic literature review was conducted to examine literature on the safety of paramedics in interfacility transfers. A retrospective chart review was conducted to examine the incidence, predictors and pattern of adverse events seen in interfacility transfers by paramedics in Saudi Arabia. Following this, a retrospective chart review of interfacility transfers by physicians to the same institution was conducted to compare in-hospital mortality and 30-days survival in both groups. Finally, an expert survey was conducted to examine the consensus of paramedics' intervention to adverse events seen in interfacility critical care transfers.

Results: the literature showed that the frequency of adverse events seen by paramedics in interfacility transfers ranges from 5.1% to 18%. The rate of adverse events in adult critical patients transferred by paramedics to a tertiary care facility in Saudi Arabia was 13.7%, in-hospital mortality was 30.4% and 30-days survival was 68.1%. There is no significant difference regarding in-hospital mortality or 30-days survival between the paramedic and physician models. The paramedics' interventions in interfacility adult critically-ill patients were rated appropriate by the majority of the experts in 86.8% of cases; the probability of an intervention to be appropriate was 84.9%.

Conclusion: paramedics with appropriate training and skill can safely transfer critical interfacility adult patients. The mortality outcomes in the paramedic model are comparable to the physician model.

1 Introduction

1.1 Background

Care regionalisation and specialist care services have increased the demand for moving critically-ill patients between hospitals (interfacility transport) (Fan, et al., 2006). Interfacility transfers carry risks to the patient, especially when the patient's vital functions are dependent on external devices such as ventilators. Advancement in medical technology permits more critically-ill patients to be transported between hospitals, and more equipment necessary for their care can be transported with patients.

International data show variety in the composition of the transferring team. Many international organisations, such as the Association of Anaesthetists of Great Britain and Ireland (AAGBI), have recommended that an experienced physician should be the primary provider in critical care interfacility transfers. On the other hand, a cross-sectional survey in the United States of America (USA) concluded that paramedics are frequently the primary critical care providers in such transfers (Raynovich et al., 2013). The standard practice in interfacility transfer is to utilise a transferring team that is led by a medical doctor. Nurses, respiratory therapists, paramedics and, in rare cases, perfusionists are allied healthcare personnel that can be utilised in such teams.

Interfacility transport is a component of the Emergency Medical Services (EMS) system. There are generally two types of transfers for which EMS systems are responsible: scene transfers (primary) and interfacility transfers (secondary). The scene transfer is a provider transferring a medical emergency from a scene (private resident, road traffic accident scene, etc.), and secondary transfer is defined as moving a patient from one medical facility to another (usually to a higher level of care). In general, there are two common EMS systems: the Anglo-American EMS system and the European EMS system. The main difference between these two systems is the EMS provider.

The Anglo-American system relies on paramedics (Pozner et al., 2004). On the other hand, the European EMS system depends on medical doctors as the primary pre-hospital providers (Dick, 2003).

Paramedics are the designated pre-hospital (out of hospital) care providers in many countries (Health Careers, 2015). There is no international standard or consensus on the scope of practice, education and skill competencies that paramedics must have prior to practice. This lack of standardisation and agreement has created variation in paramedics' clinical practice across the globe. For example, the title paramedic is protected in some countries, such as the United Kingdom (UK) (HCPC, n.d.), Australia and New Zealand (ANZCP, 2016). The protection of a title means that a healthcare provider can legally practise and use all procedures approved in his/her profession when he/she is registered with the appropriate regulatory body. This protection can provide standardisation of the clinical and educational requirements to practise as a paramedic. On the other hand, most states in the United States recognise paramedics as an extension to the medical doctor and they work under the medical doctor's license (NHTSA, 2008). This extension role of paramedics can create a diversity in both clinical practice and education requirement in EMS systems.

Interfacility transfer of a critically-ill patient by paramedics needs a different scope of practice compared to pre-hospital care. Interfacility critical care transfer requires a different set of knowledge, training and skills (NHTSA, 1998). Critically-ill patients undergoing interfacility critical care transfer are vulnerable to adverse events during the transfer process (Gray, Bush and Whitely, 2004; Arthur et al., 2013). Critical care interfacility transfer by paramedics is evolving as an extended scope of practice in EMS (Celia, Paluck and Smith, 1995; Kupas and Wang, 2014). The expansion of paramedics' scope of practice has allowed them to deal with complicated patients who are usually managed under inter-disciplinary teams in a stable environment, such as an Intensive Care Unit (ICU). The paramedic model in interfacility transfer is utilised in multiple countries, including high-income countries (Robinson et

al., 2009). In such cases, the paramedics are utilised as the primary clinical provider in such transfers.

The increment in the frequency of interfacility critical care transfers is global, supported by numerous international data. For example, a Canadian study showed an increment of 40% in the frequency of interfacility transfers in Ontario provenance between 2005-2008 (Robinson et al., 2009). In addition, healthcare cost and shortage in medical personnel, including doctors, is a major concern. The World Health Organisation (WHO) addressed this issue in 2002, discussing possible solutions to both cost-effectiveness and skill shortage. They argued that, to control skill shortage, it might be applicable to implement skill substitution (Buchan and Dal Poz, 2002). Most of the skill substitution literature has analysed the doctor/nurse skill mix. Also, most of these studies were conducted in North American systems (Antunes and Moreira, 2013). The literature supports the idea of utilising different models in interfacility transfer. To assure a transfer model is functional and appropriate, it is essential to examine its safety to patients.

Patient safety is defined by WHO as “the prevention of errors and adverse effects to patients associated with health care” (WHO, n.d.). An early study, commonly known as “The Harvard Medical Practice Study”, analysed incidence of adverse events (AE) and errors in hospitals. The study results showed that most identified incidence was caused by errors (Leape et al., 1991). Following the Harvard study, a report, “To Err is Human: Building a Safer Health System”, was published in 1999. The report highlighted that errors with significant sequences are more likely to occur in ICU, operating theatres and ER; the report also suggested strategies to improve patient safety that included enhancing knowledge of patient safety and identifying errors and their causes in the healthcare system (Kohn, Corrigan and Donaldson, 2000). Patient safety dramatically moved up to the top of the healthcare systems’ agenda, but the question remained as to whether ambulance services followed the same agenda.

A recent report published by Fisher et al. discussed patient safety in ambulance services and concluded that UK ambulance services are focusing on service targets more than patient safety, recommending that ambulance services should emphasise patient safety as a priority (Fisher, 2015). In 2012, a systematic review by Bigham et al. (2012) analysed patient safety in EMS, including interfacility transfers, and concluded that there is insufficient data and evidence on patient safety and recommended further research to understand patient safety in EMS (Bigham, 2012). The question needed to be addressed is: "can a paramedic safely manage and handle critically-ill patients during interfacility transfer?" To tackle such a massive question, neither a single PhD thesis nor a single clinical study will be able to provide sufficient evidence to change current clinical practice. However, it is crucial to start exploring the paramedics' ability in transferring critically-ill patients. This PhD thesis will analyse the safety of utilising paramedics in adult interfacility critical care transfers in Saudi Arabia.

1.2 Research significance

Evidence-based medicine is an important tool in healthcare decision-making. Healthcare decision-makers and EMS managers are challenged to select the appropriate team configuration that can maximise patient safety in interfacility transfer. EMS research is considered relatively new compared to other healthcare professions. Multiple international EMS organisations have addressed the deficiency in EMS research. For example, the USA National Highway Traffic Safety Administration (NHTSA) issued an EMS agenda for the future in 1998 (NHTSA, 1998). The document confirmed the deficiency of EMS research and highlighted that most EMS research and practices were adopted from hospital-based research projects. The updated version of the agenda, published in 2010, emphasised the slow progress in EMS research. Similarly, the national Canadian EMS research agenda stressed the urgent need to develop evidence-based protocols and practices in EMS, especially with the extended scope of paramedics' practice (Jensen et al., 2013).

This PhD thesis will focus on the interfacility transfers conducted by paramedics. It is an interfacility research that will follow patients throughout their transfer process and up to 30-days post discharge. This research is the first interfacility paramedics research that is designed to report the incidence of AEs and patient outcomes including 30-days survival, with an in-depth analysis of the transfer process exploring paramedics' attitudes towards AEs, and the paramedics' ability to intervene safely in response to these AEs.

Literature has shown a gap in investigating the safety of the paramedics interfacility model. Most of the published literature has discussed in-transit AE or measured limited physiological parameters to evaluate model efficacy and safety. Moreover, it has failed to analyse the paramedics' competencies to recognise and intervene with the patient's AEs (see Chapter 2). This PhD thesis is expected to fulfil this gap by analysing the paramedics' competencies and safety in transferring adult critically-ill patients. It will utilise multiple resources to measure and detect AEs, including AEs that were not documented by paramedics, by reviewing all stages of the transfer process (pre, during and post-transfer records). All safety events detected will be evaluated by clinical experts to analyse the safety of paramedics' interventions in such patients.

This research will provide a valuable contribution to existing literature on the paramedics' model in interfacility transfer, which is expected to inform current clinical practice. It will provide an evaluation of the paramedics' competencies in transferring such patients. This evaluation will help build sufficient clinical evidence to inform decision-makers and EMS managers to rigorously use paramedics in interfacility transfers. This transition in care can be of great assistance to currently overwhelmed healthcare systems, as the shortage of healthcare providers and the demand for transfers have increased.
Paramedics can be utilised to fulfil this task. Paramedics and the EMS systems can transfer patients quicker (they are trained to function on a 24-hour basis in their daily operations), and they can also relieve the pressure on doctors in hospital acute care departments, by enabling them to function in their

inundated units. On the other hand, while the cost efficacy and economic evaluation is beyond the scope of this thesis, the paramedic model in interfacility transfers might be a cost-effective process by decreasing the cost of interfacility care providers. Assuming that all other variables in the transfer process remain constant (equipment, vehicle, supplies, etc.), the paramedic cost is less than that of doctors and nurses (especially highly trained acute-care doctors and nurses).

Ambulance (including air ambulance) vibration and noise throughout the transfer process impose a special challenge to providers in detecting equipment alarms or even performing procedures. In addition, the paramedics' competencies that are designed to fulfil the pre-hospital care can be challenged in terms of patient care in interfacility transfers. This research is designed to explore whether paramedics' competencies will be sufficient to manage AEs in such circumstances. Moreover, the paramedics' care will be translated into medical scenarios to be discussed with experts, to examine experts' opinions regarding paramedics' intervention. This qualitative approach to interfacility transfer will provide valuable data to EMS researchers.

First, the scenarios translated are obtained from real EMS interfacility transfers, which can be utilised in paramedics' medical education. Second, the common interventions performed during transfers and, consequently, patient outcome can be utilised in future clinical trials design. Finally, experts' opinions on possible procedures or advance critical care that could have been administered to patients can be utilised by EMS medical directors to review current clinical protocols, and possibly enhance these protocols to ensure that patients experiencing AEs can be managed properly during transfer.

Locally, this PhD thesis will be the first medical research exploring the utilisation of paramedics in interfacility transfers in Saudi Arabia. Additionally, it is the first Saudi EMS research exploring interfacility AEs. Research findings will be vital in exploring the Saudi interfacility transfer environment. It is an opportunity for the Saudi interfacility transfer system to examine its

performance and to evaluate the paramedic model in interfacility critical care transfers.

The PhD thesis will be reflected on local Saudi practice in many ways:

- It will explore paramedics' competencies in interfacility transfers
- It will enhance patient safety in interfacility transfers by providing data on AEs and consequent paramedic interventions to these AE
- It will analyse paramedic intervention (through experts' opinions) to improve patient care and provide analysis on current paramedics practice
- It will identify areas of weakness in local paramedic practice, accordingly identifying areas of focus to paramedics' continuing education
- It will provide recommendations to support developing national interfacility medical guidelines (currently no national recommendations or guidelines exist in Saudi interfacility transfers)

1.3 Research questions

The PhD thesis is expected to answer the following questions:

- What is the incidence of AE in interfacility critical care transfers led by paramedics in Saudi Arabia? Are there any predictors of AE in population under investigation?
- Can paramedics involved in the interfacility transfer of critically-ill patients, safely manage AE in Saudi Arabia?
- Does the paramedic model in interfacility transfer of critically-ill patients in Saudi Arabia have the same frequency of in-hospital mortality and 30-days survival compared to the physician model?
    - Hypothesis: Patients transferred by paramedics in interfacility critical care transfers have the same frequency of in-hospital mortality and 30-days survival compared to physicians
        - Null hypothesis: H0: P1= P2
        - Alternative hypothesis: H1: P1≠ P2

Where P1 is the proportion of in-hospital mortality and 30-days survival in patients transferred by paramedic compared with P2, which is the proportion of in-hospital mortality and 30-days survival in patients transferred by physician.

1.4 Objectives

- To undertake a systematic review of safety and AE in adult critical interfacility transfers by paramedics
- To undertake a retrospective chart review to compare in-hospital mortality and 30-days survival between the paramedic model and the physician model
- To undertake a retrospective chart review exploring the incidence of AE in the paramedic model
- To undertake expert survey to examine consensus on root causes of AEs and paramedics' intervention in interfacility transfers

1.5 Overview of the research methodology

The PhD thesis design is a mixed method divided into three work streams. Each work stream represents a distinct study. Figure 1 illustrates the study design:

- Work stream 1: Systematic literature review of AE seen by paramedics in adult critical interfacility transfers
- Work stream 2a: characteristics and predictors of AE in interfacility transfers
- Work stream 2b: comparison of in-hospital mortality and 30-days survival between a paramedic group and a physician group transferred to the same tertiary centre
- Work stream 3: expert survey on the consensus of AE/safety events and paramedics' interventions

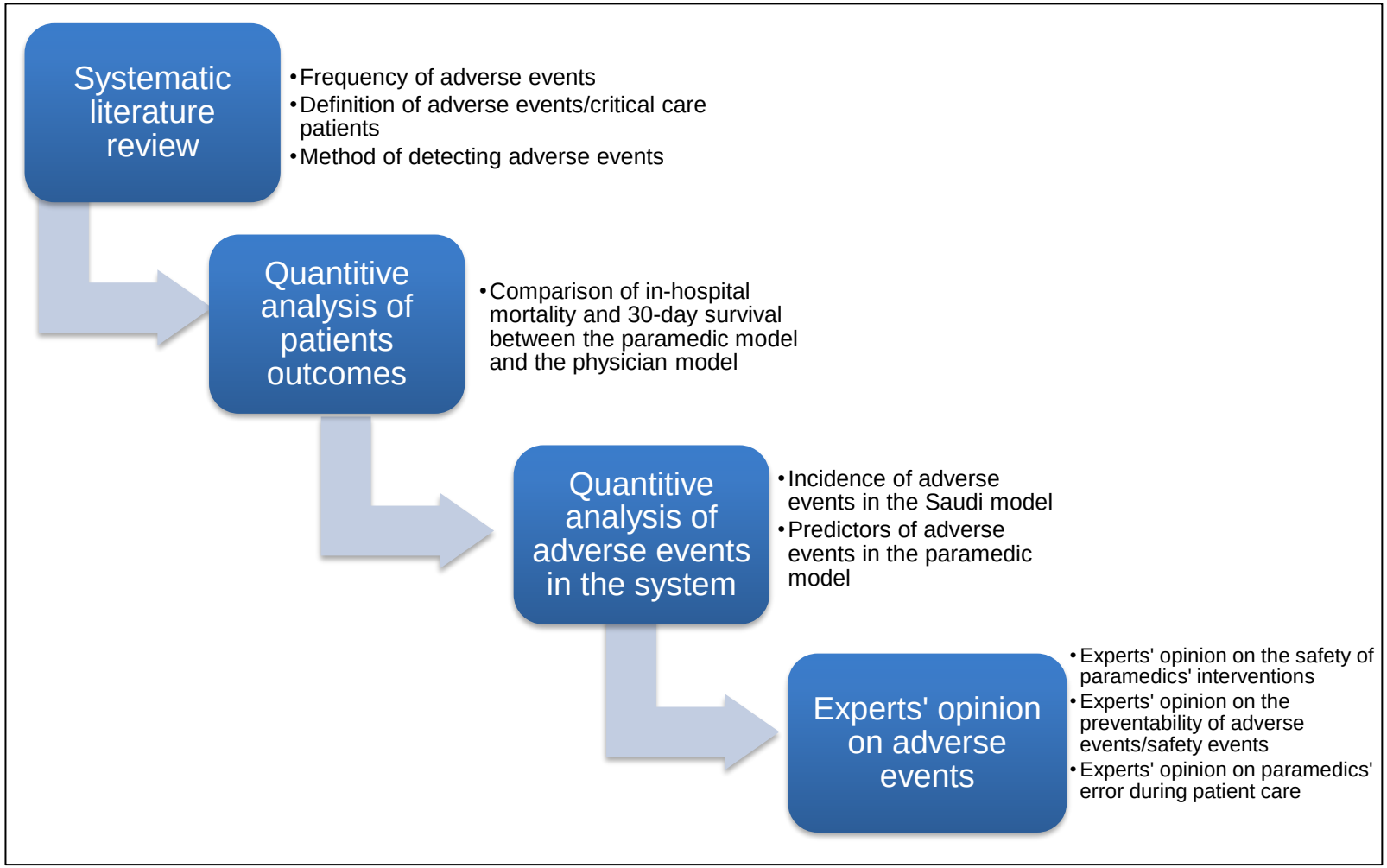
1.6 Ethical approval

The initial ethical approval was submitted through the Biomedical and Scientific Research Ethics Sub-Committee at Warwick University. A full ethical approval was granted on 14/08/2014 (Ref: REGO-2014-1023), a substantial amendment application was also granted on 03/06/2016 (Ref: REGO-2014-1023 AM01) in order to conduct the expert survey. A copy of the ethical approval is provided in Appendix 1. A second 'local' ethical approval was obtained from King Abdullah International Medical Research Center (KAIMRC) Institutional Review Board (IRB) (Ref: IRBC/154/15).

1.7 Statistical support

Statistical support of the PhD study was sought through the "statistics clinic" (Dr. Peter Kimani) at Warwick Medical School. The student performed all the statistical entries and analysis, and the statistical clinic was utilised to validate results and assure statistical tests utilised in this PhD are appropriate. There were two statistical software utilised in this PhD: IBM SPSS® version 22 and R software.

Figure 1 Illustration of the PhD methodology



1.8 Setting

The Kingdom of Saudi Arabia was established in 1932, occupying a land area of approximately 2,000,000km^2. In 2015, the Saudi population, according to the Saudi General Authority for Statistics, was 31,015,999 with the majority of population between 15-69 years (General Authority for Statistics, 2015). The Saudi healthcare services can be considered as national healthcare services provided by multiple governmental agencies, the majority of which are provided by the Saudi Ministry of Health (MOH); it is estimated that 60% of the Kingdom's health services are provided by the MOH (Sebai, Milaat and Al-Zulaibani, 2001). The MOH adopts the referral system from primary care to, finally, tertiary specialised services. The Saudi hospitals bed ratio is 2.2 per 1,000 population (MoH, 2017).

King Abdulaziz Medical City-Riyadh (KAMC) was established by a royal decree in 1983, a university tertiary medical facility, located in Riyadh, Kingdom of Saudi Arabia. The medical facility operates under the Ministry of National Guard (MNG), and all Saudi citizens with valid medical referral can be accepted. KAMC has more than 1,500 beds, 21 general ICU beds, eight Trauma ICU beds, nine Surgical ICU beds, four Burn ICU beds, eight Neurological ICU beds and 14 intermediate care unit beds. The ER has a total of 85 adult beds, including 15 critical care ER beds. KAMC is one of the biggest hospitals in the Middle East.

KAMC, as a tertiary academic facility, accepts referred critically-ill patients on a daily basis, and their ground ambulance service is available 24 hours a day to retrieve such patients. Patients are retrieved from different sites; the most common site is Dirab medical facility, a National Guard healthcare emergency centre, located approximately 50km south-west of KAMC. An off-peak journey can take more than 50 minutes. Another common site is the Saudi Medevac (MedEvac) base, located approximately 28km west of KAMC. In off-peak hours, the journey can be completed in 25 minutes. However, in most cases, due to heavy traffic, such journeys may exceed an hour. Interfacility transfer is usually conducted with lights and sirens (except between 2300–0700). Most

interfacility transfers are scheduled in advance through an ambulance service dispatch centre, operated by qualified emergency medical technicians. The paramedic receives a full medical report from the referring hospital via dispatch, then, the required equipment is prepared in advance.

Patients transferred from other hospitals to KAMC ICU constitute 8% of all ICU admissions (Rishu et al., 2013). Patients referred to KAMC have two pathways. The first is to be transported by a medical doctor, usually an anaesthetist or an intensivist and critical care nurse, using ground mode provided by the referring facility. The second pathway is to retrieve referred patients by the KAMC EMS department with two paramedics. The selection of a specific transfer pathway is dependent on the transfer time, availability of the transporting team and mode of transfer. KAMC reserves ICU beds for a maximum of 24 hours, and the availability of transferring crew is the main determination of crew level selection in interfacility transfers.

The EMS department at KAMC is a division under emergency medicine. Appendix 2 lists EMS resources at KAMC. Medical oversight and consultation are available 24 hours a day, 365 days a year under an on-duty critical care area ER consultant. Minimum manpower shift requirements include one advance life support unit operated with at least one paramedic in addition to an ambulance driver, two basic life-support units operated with at least one basic emergency medical technician and an ambulance driver. The KAMC EMS department is a diverse department, and heterogeneity in paramedic training exists due to the diversity of EMS personnel. However, minimum skill competency is granted through the Saudi Commission for Health Specialties (SCFHS) paramedic license requirements.

All paramedics involved in interfacility transfer of critical patients have received advanced training on operating ventilators and syringe pumps; they are also Advance Cardiac Life Support (ACLS), Basic Life Support (BLS), Pre-Hospital Trauma Life Support (PHTLS) and Paediatric Advance Life Support (PALS) providers.

The competencies of paramedics involved in interfacility transfer were obtained from an interview with the EMS medical director. The competencies are divided into main categories with specific skills to each category. A complete list of paramedics' competencies is provided in appendix 2.

The interfacility transfer is conducted via a type 3 ambulance (box fitted on cut-a-way chassis of a van). The type 3 ambulances are one of the largest types available. There are multiple devices available in interfacility critical care transfer:

- Lifepak® 12 monitor and defibrillator
- Crossvent® portable ventilator
- Alaris® syringe pump

Interfacility transfer is usually operated with two paramedics. In the rare cases where two paramedics are not available, a registered nurse from the receiving hospital unit may support the transfer, but, as per the hospital's policies and procedures, the paramedic is the designated primary provider of clinical care. Paramedic protocols utilise a wide range of medications, including advanced life-support medications and Rapid Sequence Intubation (RSI) medications. The following list is the medications available to paramedics:

Activated Charcoal	Dextrose 50%
Adenosine	Diazepam (Valium)
Adrenaline 1:1000 Adrenaline 1:10000	Diltiazem (Cardizem)
Albuterol	Diphenhydramine
Amiodarone	Dopamine
Aspirin	Etomidate
Atropine	Fentanyl
Calcium Chloride	Furosemide (Lasix)
Glucagon	Naloxone (Narcan)
Haloperidol (Haldol)	Nitroglycerin
Ipatropium (Atrovent)	Oxygen
Lidocaine	Rocuronium bromide

Magnesium Sulfate	Sodium Bicarbonate
Methylprednisolone	Succinylcholine
Midazolam	Thiamine
Morphine	Ketamine

The following list is medications NOT approved to be initiated by paramedics, but paramedics are approved to maintain it.

Amrinone	Norepinephrine
Anti-infectives: Anti-biotics/Anti-virals/Anti-fungals/Anthelmintics	Phenytoin
Blood products	Propofol
Dobutamine	Racemic Epinephrine
Heparin	Thrombolytics
Insulin	Vecuronium
Mannitol	Drugs familiar to the paramedic

If a medication is not common or familiar to the paramedic, an on-line medical direction is required.

1.9 PhD chapters

The PhD is divided into eight chapters. The first chapter represents the background, framework and methodology overview of this thesis, while the last chapter discusses the conclusion and the research findings. Six chapters were designed as separate papers, of which two have been published in peer-review journals and two presented in a scientific conference. The following are the PhD chapters:

Chapter 1: Introduction.

Chapter 2: A systematic review on the prevalence and types of AE in interfacility critical care transfers by paramedics.

Chapter 3: Feasibility study on incidence of AE in adult critical patients transferred to a tertiary hospital by paramedics.

Chapter 4: Incidence and characteristics of AE in adult critical patients transferred to a tertiary hospital by paramedics.

Chapter 5: In-hospital mortality and 30-day survival in the paramedic model versus the physician model in interfacility transfers of critically-ill adult patients in Saudi Arabia.

Chapter 6: A pilot study on expert survey of paramedics' interventions in adult critical patients transferred to a tertiary hospital in Saudi Arabia.

Chapter 7 Adverse events preventability, paramedics' errors and proportion of care in which the paramedics' interventions were appropriate in adult critical patients transferred to a tertiary hospital in Saudi Arabia.

Chapter 8: Discussion and summary of the research.

2 Systematic review on the prevalence and types of adverse events in interfacility critical care transfers by paramedics

2.1 Abstract

Objectives: To investigate whether paramedics can safely transfer interfacility critically-ill adult patients, also to determine the prevalence and types of adverse events when paramedics lead interfacility critical care transfers.

Methods: MEDLINE, Web of Science, Embase and CINAHL databases were searched from 1990 up to February 2016. Eligibility criteria were adult patients (16 years or older), interfacility transfer (between two healthcare facilities), quantitative or qualitative description of adverse events and paramedic as primary care provider or sole healthcare provider.

Results: Seven publications had paramedics as the sole healthcare provider conducting interfacility critical care transfers. All seven studies were observational studies published in the English language. Five studies were retrospective, while the other two studies were prospective. The study duration ranged from 14 months to ten years. Three studies examined paramedics' safety in interfacility transfers. Paramedics' safety in transporting cardiac patient on intra-aortic balloon pump (IABP) was examined in two studies, while a single study examined paramedics' safety to transport patients from different clinical categories. The frequency of adverse events seen by paramedics in interfacility transfers ranged from 5.1% to 18%. All published literature was Level 3 Oxford Centre for Evidence-Based Medicine (OCEBM).

Conclusion: There is a gap found in the literature on the safety and adverse events in interfacility transfers by paramedics. The prevalence of in-transit adverse events is well-established; however, due to the weakness of published literature in lacking longitudinal monitoring of patients and only reporting in-transit events, we believe that further research in this area might provide the basis of paramedics' safety in interfacility transfers.

2.2 Introduction

In cases of critical illness and injury, it is sometimes necessary to transfer patients between healthcare facilities, either by land or air ambulance (Shelton et al., 2000). Interfacility transfer carries risks to the patient, especially when the patient's vital functions are dependent on external devices such as ventilators. Advancement in medical technology permits more critically-ill patients to be transported between hospitals, also more sophisticated equipment can be transported with patients (Uusaro, 2002). During interfacility transfers, critically-ill patients are vulnerable to adverse events; these are "unfavorable and potentially harmful occurrence during or after the course of patient care. Adverse events are due to circumstances that may or may not be preventable" (MacDonald, Banks and Morrison, 2008). Critically-ill patients are also at higher risk of in hospital mortality and other adverse outcomes following interfacility transfer (Durairaj et al., 2003).

There are concerns of patient safety during interfacility transfers, specifically whether a specialised transport medical personnel improves hospital outcomes, and the efficacy of utilising a specialised transporting team remains debatable (Belway et al., 2006). The paramedic, as the lead interfacility critical care transfer provider, is a proposed model. Paramedics are the designated pre-hospital (out of hospital) care providers in many countries (Health Careers, 2015); interfacility transfer of a critically-ill patient needs a different scope of practice compared to pre-hospital care; it requires a different set of knowledge, training and skills (NHTSA, 2006). Some scholars argue that paramedics' skills are sufficient and that is inefficient to deploy a medical doctor, but the question remain as to whether paramedics can provide care of the same quality as other healthcare personnel under the difficult circumstances involved in such transfer, such as ambulance noise, limited ambulance space and the lack of support from other medical specialties.

Literature and evidence in EMS are largely adopted from hospital-based research and findings (NHTSA, 1998); however, in interfacility transfer

conducted by providers other than paramedics, the accuracy and applicability of reported results can be generally challenged, based on the fact that paramedics' knowledge, skills and environment are absolutely different than would be found in a hospital setting. This review was conducted to answer whether paramedics can safely transfer interfacility critically-ill patients and to examine the prevalence and types of adverse events when paramedics lead such transfers.

2.2.1 Objectives

This systematic review was conducted to answer:

1) Can paramedics safely transfer interfacility critically-ill adult patients?
2) What is the prevalence and types of adverse events when paramedics lead interfacility critical care transfers?

2.3 Methods

This systematic review was undertaken using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009).

2.3.1 Eligibility criteria

Results of the search were screened for the following criteria:

- Adult patient 16 years or older
- Interfacility transfer
- Quantitative or qualitative description of adverse events
- Paramedic as primary care provider or sole healthcare provider

Full text reviewed studies were excluded if they were:

- Exclusively paediatric and/or neonatal population
- Pre-hospital or military transfers
- Interfacility transfers done by a healthcare provider other than paramedics

- Non-quantitative or qualitative description of adverse events

2.3.2 Information sources

A specialised medical librarian was consulted prior to this review. Four electronic databases were searched. These were: MEDLINE (OVID 1990 to February week 1 2016), Web of Science (1990–2016) (Appendix 3), Embase (Embase classic+Embase 1990 to 2016 week 6) (Appendix 4) and CINAHL (1990–2016) (Appendix 5). Reference lists of included papers were also screened for further citations. No restriction was applied to language, but the date was limited to studies conducted after 1990 because authors agree that results prior to this are outdated. All non-English publications will be translated to the English language.

2.3.3 Search

The following search terms were used to search sources: allied health, paramedic, emergency medical services, emergency medical technicians, ambulance, air ambulance, pre-hospital care, helicopter emergency medical services, interfacility transfer, inter-hospital transfer, hospital transfer, patient transfer, transportation of patient and critical care. The MEDLINE full search strategy (OVID 1990 to February week 1 2016) is listed below:

1	exp Patient Transfer/ or patient transfer*.mp.
2	transportation of patients.mp. or exp "Transportation of Patients"/
3	(inter-hospital trans* or interhospital trans* or inter hospital trans*).mp.
4	(interfacility trans* or interfacility trans* or inter facility trans*).mp.
5	critical care trans*.mp.
6	1 or 2 or 3 or 5 or 6
7	critical care.mp. or exp Critical Care/
8	intensive care.mp. or exp Intensive Care/
9	intensive care units.mp. or exp Intensive Care Units/
10	7 or 8 or 9
11	6 and 10
12	(paramedic* or paramedic practitioner* or specialist paramedic* or consultant paramedic* or critical care paramedic* or advanced paramedic practitioner* or ambulance clinician* or emergency paramedic*).mp.
13	paramedic*.mp.
14	ambulance clinician*.mp.

15	exp Emergency Medical Technicians/ or exp Emergency Medical Services/ or exp Allied Health Personnel/
16	ambulance*.mp. or exp Ambulances/
17	(helicopter emergency medical service* or HEMS).mp.
18	(aeromedical or aero-medical).mp.
19	12 or 13 or 14 or 15 or 16 or 17 or 18
20	11 and 19
21	limit 21 to (humans and yr="1990 -Current")

2.3.4 Study selection

After duplicates were removed, the titles of included studies were screened to determine eligibility and to manually identify duplicates. After that, all included papers abstracted were screened, and, finally, all included studies were reviewed by two independent reviewers (the student and an independent reviewer), and disagreement between reviewers was to be discussed with a third person (Dr. Joanne Fisher, a senior research fellow at health sciences, Warwick Medical School).

2.3.5 Data collection:

The search strategy was applied to all electronic databases. An OVID MEDLINE search with the assistance of a specialised medical librarian was conducted (1946 to February week 1 2016). Search results were saved electronically in EndNote®, a reference management software. Terms in all databases were searched separately with the assistance of a medical librarian, when available, Medical Subject Heading (MeSH) terms were exploded. After conducting the main search, Endnote® was utilised to automatically identify duplicates, then a second manual process was conducted to assure all duplicates were excluded. Irrelevant titles and abstracts were excluded, when uncertainty about the content of an article existed, then a full article was reviewed. A data extraction sheet was developed by the authors, and was pilot-tested on 15 articles (Appendix 6). One reviewer (the student) and independent reviewer filled data extraction sheets, disagreement (if existed) was planned to be resolved by another author, and all data sheets filled by reviewers were collected and matched.

2.3.6 Data items

Each included study was reviewed to extract: (1) characteristics of included patients (age, reason of transfer, mode of transfer and patient diagnosis) and inclusion and exclusion criteria of the selected studies were also reviewed; (2) healthcare providers conducting the interfacility transfer (critical care paramedics, doctors and nurses) or a combination of providers; (3) main outcome measured (frequency of adverse events, types of adverse events or safety of transfer using paramedics); (4) method of reporting adverse events (pre-defined list, all types of adverse events).

2.3.7 Risk of bias

We examined each study quality first and found that all studies included were observational studies. These studies were later divided into prospective or retrospective. We also recorded study size in recognition of the fact that adverse events in general and poor outcome in particular, and small studies, will be emphasised. We also assessed whether adverse events were defined, since this definition can vary from case to case. The definition we size above is broad and we anticipated that some authors might focus on specific adverse events. Since reviewers may differ in discrimination and their recognition of adverse events, we also noted whether multiple reviewers were selected; where two or more reviewers were used we observed whether inter-observer variation was measured.

2.4 Results

2.4.1 Study selection

A total of 8,082 citations were identified, comprised of MEDLINE (1517 publications), Embase (5147 publications), CINAHL (754 publications) and Web of Science (664 publications). After adjusting for duplicates, the total number of publications was 6,318. There were three abstracts found in French

language which were translated and were irrelevant. After reviewing titles and abstracts, within the relevant publications were 91 articles. Ninety-one publications were retrieved and reviewed by two reviewers (the student and an independent reviewer who is a PhD student with a nursing qualification), and, of 91 publications, nine were excluded for not being interfacility transfers (including scene responses and military population), six publications were excluded because they were exclusively concerning paediatrics and the neonatal population, 39 publications were excluded because paramedics were not the sole healthcare professionals conducting patient transportation, and 30 articles were excluded because of the lack of adverse events or patient safety (Table1). Seven publications had paramedics as the sole healthcare provider conducting interfacility critical care transfers (Figure 2).

Table 1 Papers excluded with reason

Author, Year	Reason for excluding paper
Dorlac et al., 2009	Military population
Franco et al., 2012	Military population
Gerhardt et al., 2014	Military population
Lairet et al., 2013	Military population
Lamb, D., 2010	Military population
Lehmann et al., 2009	Military population
Andrew et al., 2015	Emergency scene
Flabouris et al., 2003	Emergency scene
Norton et al., 1996	Emergency scene
Asaithambi et al., 2014	Non quantitative or qualitative description of adverse events
Bigham et al., 2012	Non quantitative or qualitative description of adverse events
Billeter et al., 2014	Non quantitative or qualitative description of adverse events
Blakeman, T. C. & Branson, R. D., 2013	Non quantitative or qualitative description of adverse events

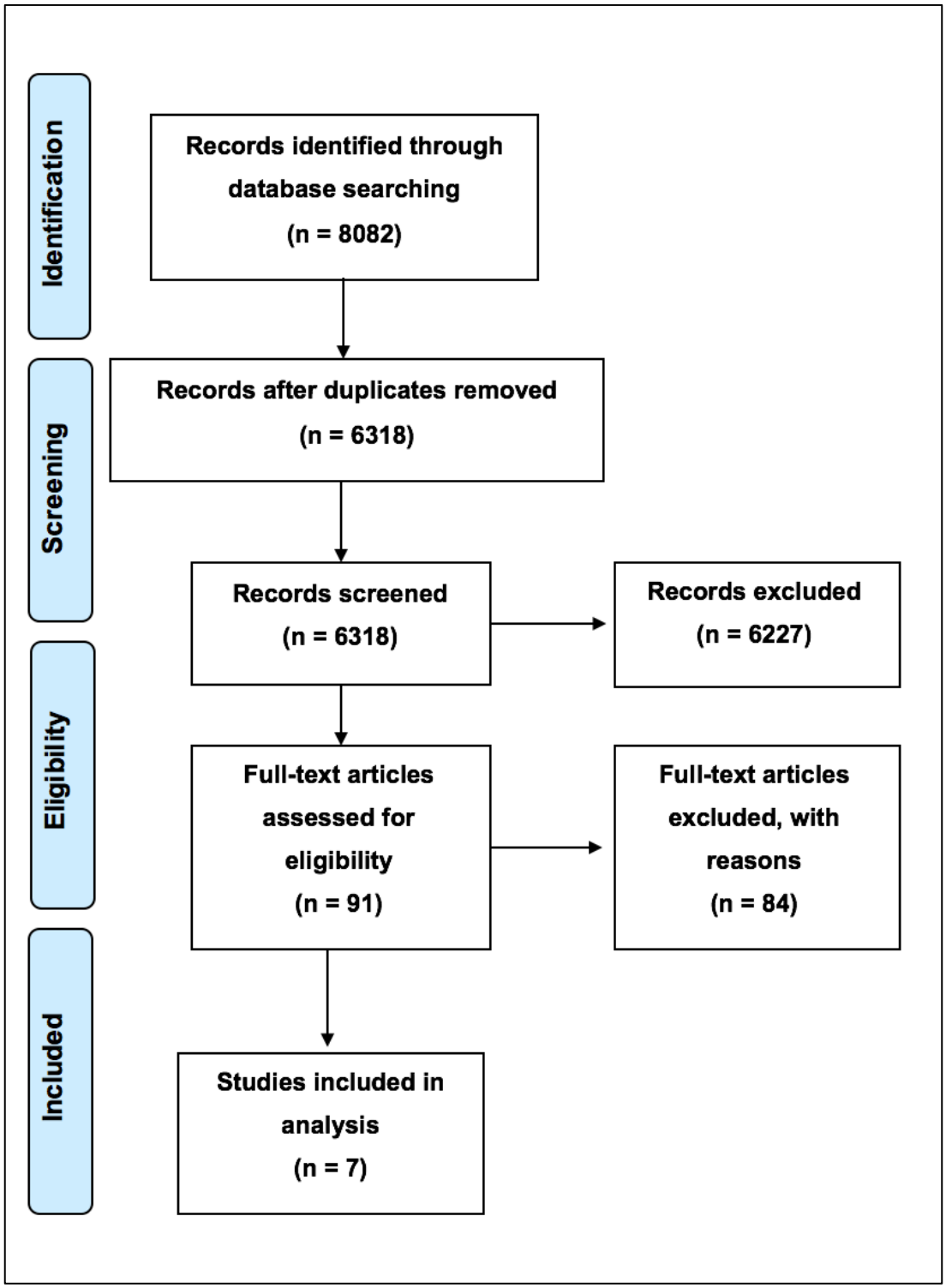
Author, Year	Reason for excluding paper
Brown et al., 2011	Non quantitative or qualitative description of adverse events
Byrne et al., 2008	Non quantitative or qualitative description of adverse events
Catlano et al., 2012	Non quantitative or qualitative description of adverse events
Duke, G. J. & Green, J. V., 2001	Non quantitative or qualitative description of adverse events
Durairaj et al., 2003	Non quantitative or qualitative description of adverse events
Eckstein et al., 2014	Non quantitative or qualitative description of adverse events
Flabouris, A., 1999	Non quantitative or qualitative description of adverse events
Flabouris et al., 2008	Non quantitative or qualitative description of adverse events
Flabouris et al., 2008	Non quantitative or qualitative description of adverse events
Flabouris et al., 2012	Non quantitative or qualitative description of adverse events
Hatlestad, D. & Van Horn, J., 2003	Non quantitative or qualitative description of adverse events
Kupas, D. F. & Wang, H. E., 2014	Non quantitative or qualitative description of adverse events
Lambert, S. M. & Willett, K., 1993	Non quantitative or qualitative description of adverse events
Muchembled et al., 2012	Non quantitative or qualitative description of adverse events
Nyquist, P., 2012	Non quantitative or qualitative description of adverse events
Ranasingh et al., 2012	Non quantitative or qualitative description of adverse events
Raynovich et al., 2013	Non quantitative or qualitative description of adverse events
Reiss et al., 1996	Non quantitative or qualitative description of adverse events
Rishu et al., 2013	Non quantitative or qualitative description of adverse events
Runcie et al., 1990	Non quantitative or qualitative description of adverse events
Santry et al., 2011	Non quantitative or qualitative description of adverse events
Shelton et al., 2000	Non quantitative or qualitative description of adverse events
Singh, J. M. & MacDonald R. D., 2009	Non quantitative or qualitative description of adverse events

Author, Year	Reason for excluding paper
Stephens et al., 1995	Non quantitative or qualitative description of adverse events
Stone et al., 1994	Non quantitative or qualitative description of adverse events
Walcott et al., 2011	Non quantitative or qualitative description of adverse events
Bellingan et al.,2000[1]	Health provider other than paramedic
Belway et al., 2006	Health provider other than paramedic
Burney et al., 1992	Health provider other than paramedic
Burns et al., 2013	Health provider other than paramedic
Burns et al., 2011	Health provider other than paramedic
Caldow et al., 2005	Health provider other than paramedic
Cliff, D. & Loh, N. H. W., 2012	Health provider other than paramedic
Deasy et al., 2007	Health provider other than paramedic
Dewhurst, C. & Sullivan, I., 2001	Health provider other than paramedic
Donnelly et al., 1995	Health provider other than paramedic
Droogh et al., 2012	Health provider other than paramedic
Elliott et al., 1996	Health provider other than paramedic
Fan et al., 2006	Health provider other than paramedic
Flabouris et al., 2006	Health provider other than paramedic
Frakes, M. A., 2002	Health provider other than paramedic
Fried et al., 2010	Health provider other than paramedic
Gilligan et al., 1999	Health provider other than paramedic
Giovanetti et al., 2011	Health provider other than paramedic
Gray et al., 2003	Health provider other than paramedic
Harris, E. M., 1996	Health provider other than paramedic
Hartke et al., 2010	Health provider other than paramedic

Author, Year	Reason for excluding paper
Hui et al., 2012	Health provider other than paramedic
Jaynes et al., 2002	Health provider other than paramedic
Klein et al., 2007	Health provider other than paramedic
Kreeftenberg et al., 2000	Health provider other than paramedic
Lees et al., 2008	Health provider other than paramedic
Lightenberg et al., 2005	Health provider other than paramedic
Linden et al., 2001	Health provider other than paramedic
Lovelace et al., 2008	Unspecified health care provider
Maloney Jr, G. E. & Pakiela, J. A., 2008	Health provider other than paramedic
Oberg et al., 1998	Health provider other than paramedic
Seymour et al., 2008	Health provider other than paramedic
Sinclair, T. D. & Werman, H. A., 2009	Health provider other than paramedic
Strauch et al., 2015	Health provider other than paramedic
Thomas et al., 2010	Health provider other than paramedic
Uusaro et al., 2002	Health provider other than paramedic
Wiegersma et al., 2011	Health provider other than paramedic
Youngquist et al., 2010	Health provider other than paramedic
Zalstein et al., 2010	Health provider other than paramedic
Barry et al., 1994	Exclusively paediatric and/or neonatal population
Britto et al.,1994	Exclusively paediatric and/or neonatal population
Chen et al., 2006	Exclusively paediatric and/or neonatal population
Clement et al., 2010	Exclusively paediatric and/or neonatal population
Goldman et al., 1995	Exclusively paediatric and/or neonatal population

Author, Year	Reason for excluding paper
Wolf et al., 2010	Exclusively paediatric and/or neonatal population

Figure 2 PRISMA chart



2.4.2 Study characteristics

A descriptive summary of seven selected publications is provided in Table 2. A critical critique is provided in Table 3.

Table 2 Demographics of selected studies

Author, n, country, design	Mode of transport	Age (Years)	Clinical category	Transfer providers	Type of adverse events reported	Prevalence of adverse events	Study duration (months)	Comments
Allendes et al. n=140, Canada, Retrospective review	Air/Ground	Adult mean 62.7 (SD +/- 13.9)	Cardiac	Paramedics	Hypotension, tachycardia, malfunction, vehicle problems	25% (35/140 patients)	September 2003 to January 2013 (112 months)	Descriptive statistic was utilised to report results.
Domeier et al. n=111, USA, Prospective observational study	Ground	All ages	Mixed	Paramedics	Clinical deterioration based on modified Acute Physiology and Chronic Health Evaluation APACHE score	18%(20/111 patients)	September 1991 to December 1992 (15 months)	Descriptive statistic was utilised to report results.
MacDonald et al. n=29, Canada, Prospective case series	Air/Ground	Adult mean 63.4 (SD +/- 10.4)	Cardiac	Paramedics	Hypertension, bleeding at insertion site, intra-aortic balloon pump (IABP) malfunction, trigger loss, power loss, chest pain, nitroglycerin or pain control,	37.9% (11/29 patients)	Fall 2002 the first 24 months of the programme (24 months)	Descriptive statistic was utilised to report results.

Author, n, country, design	Mode of transport	Age (Years)	Clinical category	Transfer providers	Type of adverse events reported	Prevalence of adverse events	Study duration (months)	Comments
					tachycardia, vehicle problems			
MacDonald et al. n=680, Canada, Retrospective observational study	Air	Adult mean 43.9	Mixed	Paramedics	Aviation-related, communication, equipment, patient management, clinical performance related	11.53 for every 1,000 flight	January 2002 to June 2005 (41 months)	Descriptive statistic was utilised to report results.
Singh et al. n=19228, Canada, Retrospective cohort study	Air	Adult median 53.0	Mixed	Paramedics	Death, major resuscitative procedure, haemodynamic deterioration, extubation, respiratory arrest	5.1% (981/19228 patients)	January 2004 to May 2006 (28 months)	Descriptive statistic was utilised to report results.
Singh et al. n=1735, Canada, Retrospective cohort study	Air/Ground	Adult median 58	Mixed	Paramedics	Hypotension, requiring vasopressor, SPO2<88,death, major resuscitative procedure	17.1 % (297/1735 patients)	January 2004 to May 2006 (28 months)	Descriptive statistic was utilised to report results.
Singh et al. n=5144, Canada, Retrospective cohort study	Ground	Adult mean 59.2 (SD+/- 17.3)	Mixed	Paramedics	Haemodynamic instability, respiratory complication, death	6.5% (333/5144 patients)	January 2005 to December 2010 (72 months)	Descriptive statistic was utilised to

Author, n, country, design	Mode of transport	Age (Years)	Clinical category	Transfer providers	Type of adverse events reported	Prevalence of adverse events	Study duration (months)	Comments
								report results.

Table 3 Critique of selected studies

Study Authors	Study Design	Study Size	Method of detecting adverse events	Criteria for selecting patients	Definition of adverse events
Domeier et al.	Prospective observational study	111 patients	Changes in APACHE score	*Patients with a mechanical ventilator and/or medication not approved for use by non-mobile intensive care unit paramedics. *Supervisor will determine the need of extra staffing	Changes in patient's condition based on three parameters of Acute Physiology and Chronic Health Evaluation (APACHE) score.
MacDonald et al.	Prospective case series	29 patients	Two reviewers	All patients transported on intra-aortic balloon pump (IABP)	Not specified
Allendes et al.	Retrospective observational study	149 patients	Two reviewers	All patients transported on intra-aortic balloon pump (IABP)	Not specified
MacDonald et al.	Retrospective observational study	58,956 flights	Two reviewers	Adverse events web-based reporting system for stakeholders	An adverse event is an unfavourable and potentially harmful occurrence during or after the course of patient care. Adverse events are due to circumstances that may or may not be preventable. An error is a preventable adverse event.
Singh et al.	Retrospective observational study	19,228 patients	Chart review	All air–medical transports of patients 18 years of age or older in the province of	Death, major resuscitative procedures, haemodynamic deterioration (systolic blood pressure< 80mm Hg, mean arterial

				Ontario, excluding non-urgent transports of patients to a convalescent facility or home, scheduled transports for medical appointments, treatments or repatriation and transports related to organ donation.	pressure < 60mm Hg or in-flight administration of a vasopressor), inadvertent extubation, or respiratory arrest.
Singh et al.	Retrospective observational study	1,735 Patients	Chart review	Patients 18 years of age or older and received mechanical ventilation during transport	The occurrence of major resuscitative procedures or any one of 1) in-transit mortality, 2) major resuscitation procedure, 3) new in-transit hypotension (systolic blood pressure< 80mm Hg, mean arterial pressure < 60mm Hg) or new vasopressor medication, or 4) new hypoxia defined by oxygen saturation (SpO2)<88%.
Singh et al.	Retrospective observational study	5,144 patients	Chart review	All land transports of patients aged 18 years or older	A critical event as any of (1) new haemodynamic instability (new record of systolic blood pressure <80mm Hg, mean arterial pressure <60mm Hg, new in-transit administration of a vasopressor, or a cardiovascular resuscitation procedure); (2) new respiratory instability (new hypoxemia (SpO2 <88%), respiratory arrest or respiratory resuscitation procedure); or (3) in-transit death.

Study Authors	Results (95% CI)	Interfacility adverse event reviewer	Comments
Domeier et al.	18%(11.6%-26.7%*)	The agency medical director	*Three parameters of APACHE score were monitored (HR, MAP and RR)[+] *Programme medical director was the only reviewer *Exclusion criteria excluded many critical patients who are transferred regularly by EMS
MacDonald et al.	37.9%(21.3%-57.6%*)	Programme manager and programme medical director	*Small sample size *Lack of longitude monitoring *Risk of bias is high, no anonymisation to data despite the fact that reviewers were programme officers
Allendes et al.	25% (17.1%-31.2%*)	Not specified	*Small sample size *Lack of longitudinal monitoring * It is not clear whether the two reviewers were same agency employees or independent reviewers
MacDonald et al.	11.58 per 1000 flights (10.7 to 12.4)	Not specified	* Lack of longitudinal monitoring *Result reported is specific to air transport systems *The study was designed to analyse reporting system entries, unreported adverse events might not be included *It is not clear whether the two reviewers were same agency employees or independent reviewers

Singh et al.	5.1%(4.8%-5.4%*)	NA	*In-transit events only * Result might be limited to air transport environment *Paramedics working in air transfer are usually more experienced than ground paramedics, which might affect the small number of events reported
Singh et al.	17.1% (15.3%-18.9%*)	NA	*In-transit events only *Only intubated patients are included *Study focused on ventilation practice in and out of hospital environment * Case definition has limited the number of adverse events measured
Singh et al.	6.5% (5.8%-7.1%*)	NA	*In-transit events only *Lack of longitudinal monitoring * Case definition has limited the number of adverse events measured

2.4.3 Description of studies

All seven studies were observational studies published in the English language (Domeier, Hill and Simpson, 1996; MacDonald and Farquhar, 2005; MacDonald, Banks and Morrison, 2008; Singh et al., 2009a; Singh et al., 2009 b; Allendes and MacDonald,2013; MacDonald and Ahghari, 2014). Five studies were retrospective (MacDonald, Banks and Morrison, 2008; Singh et al., 2009a; Singh et al., 2009 b; Allendes and MacDonald, 2013; Singh, MacDonald and Ahghari, 2014) while the other two included studies were prospective (Domeier, Hill and Simpson, 1996; MacDonald and Farquhar, 2005). The study duration varies significantly between studies, and ranges from 14 months to ten years.

2.4.4 Population/setting

All seven studies were conducted in the North American settings (Domeier, Hill and Simpson, 1996; MacDonald and Farquhar, 2005; MacDonald, Banks and Morrison, 2008; Singh et al., 2009a; Singh et al., 2009 b; Allendes and MacDonald, 2013; Singh, MacDonald and Ahghari, 2014). Two were specifically designed for cardiac patients transported while on an intra-aortic balloon pump (IABP) (MacDonald and Farquhar, 2005; Allendes and MacDonald, 2013).

A total of 169 adult cardiac patients on IABP were included and the other 26,898 adult patients were transported by paramedics for different clinical diagnoses. The modes of transport identified in this literature review were ground, air or both. Two studies (Domeier, Hill and Simpson, 1996; Singh, MacDonald and Ahghari, 2014) (29%) utilised only ground ambulances to transport critically-ill patients while another two studies (MacDonald, Banks and Morrison, 2008; Singh et al., 2009a) (29%) were only about air transportation. Three studies (MacDonald and Farquhar, 2005; Singh et al., 2009 b; Allendes and MacDonald, 2013) (42%) utilised both air and ground transportation.

2.4.5 Studies outcomes

The outcomes of studies included differ significantly. The heterogeneity of the included studies prevented the authors performing meta-analysis. The cardiac studies: Allendes and MacDonald (2013) evaluated the safety of paramedic transporting IABP-dependent patients by analysing adverse events, while the MacDonald and Farquhar (2005) study was a description of paramedic experience in transporting IABP-dependent patients.

Of the mixed clinical category studies, the main outcome of Domeier, Hill and Simpson (1996) was to determine whether paramedics can monitor and treat patients usually transported by other healthcare providers. The outcomes of Singh et al. (2009a) were to determine in-transit critical events and factors associated with it in an air-based ambulance service. Singh et al.'s (2009b) outcomes were to determine ventilation practices outside hospital (by paramedics), administration of sedation and paralytics and analysing of critical events seen by paramedics. Another outcome (Singh, MacDonald and Ahghari, 2014) was to determine in-transit critical events in a ground-based ambulance service.

2.5 Discussion

All included studies were observational studies. To ensure the accuracy of reporting such studies, Strengthening The Reporting of Observational Studies in Epidemiology (STROBE) guidelines was utilized to analyse the studies included (Von Elm et al., 2007). The literature review included seven publications wherein paramedics were the sole healthcare providers conducting interfacility transfer. This section discusses literature on adverse events seen in adult critical care transferred by paramedics. It is important to note that six of these studies were conducted in Canada. Paramedics in the included studies were utilised in both air and ground ambulances to be the primary healthcare provider to transfer critically-ill patients (see Table 2).

2.5.1 Paramedic safety in interfacility transfers

Three studies examined paramedics' safety in interfacility transfers (Domeier, Hill and Simpson, 1996; MacDonald, Banks and Morrison, 2008; Allendes and MacDonald, 2013) Paramedics' safety in transporting cardiac patient on IABP was examined in two studies (MacDonald and Farquhar, 2005; Allendes and MacDonald, 2013) while Domeier, Hill and Simpson (1996) examined paramedics' safety to transport patients from different clinical categories.

Types of adverse events reported in cardiac studies were similar, both examined few clinical-adverse events (hypotension and tachycardia) and logistics-adverse events (malfunction and vehicle problems), in contrast, the frequency of adverse events reported in both studies was very high compared to other clinical categories found in these systematic literature review studies. Allendes and MacDonald (2013) found that 35 patients out of 140 had an adverse event (25%) and MacDonald and Farquhar (2005) found that 11 patients out of 29 had an adverse event (37%). Both cardiac studies concluded that paramedics could safely transfer interfacility critically-ill patients on IABP to a definitive care facility.

Studies available on paramedics' safety in transporting critically-ill cardiac patients on IABP cannot be generalised (external validity) to other EMS systems for many reasons. First, the total number of included patients (169 patients) was relatively small to draw a firm conclusion regarding the safety of paramedics transferring critically-ill cardiac patients on IABP. Second, both cardiac studies are classified as Level 4 Oxford Centre for Evidence-Based Medicine (OCEBM) (The Oxford Levels of Evidence 2, n.d.), which supports the fact that no definite conclusion can be drawn from either study on paramedics' safety in transporting IABP patients.

OCEBM level of evidence is a ranking system designed to evaluate the results of medical trials. It provides an overall evaluation of the strength of individual

studies. The level of evidence utilized in this systematic review is provided in appendix 12.

Another reason is that data were obtained largely from a single source of records (the transferring agency), which can be biased, as only one provider was the source of the collected data. Finally, neither cardiac study followed the transported patients, although paramedics did perform resuscitative procedures and administered high alert medication that might have had a delayed side effect or adverse event. In conclusion, literature on paramedics undertaking critical care interfacility transfer of IABP-dependent patients is limited, and a definite conclusion cannot be drawn from the current literature (see Table 3).

The paramedics' safety in transferring different clinical categories patients was examined by Domeier, Hill and Simpson (1996) and they reported adverse events in 20 patients out of 111 included patients (18%). The frequency of adverse events was comparable to a later work by Singh et al. (2009b). The level of evidence provided was a Level 4 OCEBM. The Domeier, Hill and Simpson (1996) study on paramedics' safety in transferring and managing critically-ill patients in interfacility transfer did not provide a persuasive conclusion due to multiple reasons. First, the study design was limited: Domeier, Hill and Simpson (1996) monitored only three variables of the APACHE scoring system (HR, RR and BP) while other components of APACHE score were kept constant, and the study design raises vital questions regarding adverse events that were not covered by these three variables, such as ECG changes and arrhythmia. Second, the study only monitored patients during transfer; pre-transfer patient status was unknown and post-transfer follow-up was missing.

Finally, the Domeier, Hill and Simpson (1996) study excluded important patients, for example any assisted ventilated patient with Fractional Inspiratory Oxygen (FiO2) >0.50, as well as any patient who received ventilator support

and a vasopressor infusion simultaneously. These excluded patients, in the author's opinion, represent the vast majority of what we define as critically-ill patients requiring interfacility transfer. In conclusion, the Domeier, Hill and Simpson (1996) study could not provide a persuasive conclusion on the safety of interfacility transfer of critically-ill patients by paramedics (see Table 3).

2.5.2 Prevalence of adverse events

Heterogeneity in modes of transport was an obstacle to forming a conclusion on the frequency of adverse events seen by paramedics in interfacility transfer. The literature examined two modes of transportation: air and ground. Allendes and MacDonald (2013) and MacDonald and Farquhar's (2005) cardiac patient studies were excluded from our discussion because of the special case of adverse events to the specific clinical status of their included patients.

The frequency of adverse events seen by paramedics in interfacility transfers ranged from 5.1% (Singh et al., 2009a) to 18% (Domeier, Hill and Simpson, 1996). All published literature was Level 3 OCEBM. A summary of sample size and adverse events reported is provided in Table 2. The research question and the primary outcome of identified studies were similar (in terms of measuring adverse events); the research question of MacDonald, Banks and Morrison (2008) was designed to identify the frequency and all causes of adverse events, while the Singh et al. (2009a) study was trying to identify the association of adverse events with specific patient groups. In conclusion, all included studies explored similar research questions to identify the frequency of adverse events.

Study design of the included publications varies. The method of a retrospective chart review from Singh et al. (2009a) was the common method seen in three out of five included publications. The method of MacDonald, Banks and Morrison (2008) was designed to collect data from a mandatory error-reporting system, and patient care report query system, while Domeier, Hill and Simpson (1996) designed a direct prospective observational study,

where only three parameters (HR, MAP and RR) were monitored during the transfer. The main weakness of all studies included is the lack of longitudinal follow-up of transported patients, even though the research questions were focusing on in-transit adverse events; following up these patients is essential to determine the outcome of such critical events. In addition, paramedics performed resuscitative procedures or administered advanced pharmacological agents that might have had delayed effects, including mortality. Another important weakness of the published literature is the accuracy of reported adverse events. Paramedics are known to under-report medical errors (Hobgood et al., 2004). The source of obtaining data from most published literature was EMS medical reports (run reports), where the paramedic is the only provider documenting data. The risk of bias and under-reporting errors exists in published literature.

Types of adverse events reported in literature vary significantly. There was no standard method to detect types of adverse event. The extensive work of MacDonald, Banks and Morrison (2008) resulted in defining what is an adverse event; moreover, their definition was used in their work and later publications. While defining an adverse event was an important step, detecting an adverse event in MacDonald, Banks and Morrison (2008) work remained subjective to the author's opinion of what is an adverse event due to the lack of an identified list of adverse events. In later work by Singh et al. (2009a) a list of adverse events was developed; however, the adverse event list included only cardiovascular events, respiratory events, major resuscitative intervention or death. Other adverse events, such as neurological events, were missing. In conclusion, there was a lack of a standardised method of detecting adverse events in the literature.

Published literature on the prevalence of adverse events seen in interfacility critical care transfers cannot be generalised (external validity) to other EMS systems for many reasons. First, paramedics conducting interfacility transfer in all published literature have received an extensive advanced training in

interfacility transfers, also they are experienced pre-hospital care providers. Second, the research for published literature was conducted mainly in North American healthcare systems (USA and Canada), which are considered to be well-developed healthcare systems.

As a consequence, prevalence of adverse events reported in the literature might be limited in the context of a well-developed healthcare system. Finally, the method of detecting adverse events in literature lacks standardisation; many publications reported limited adverse events seen in such transfers, while others monitored limited parameters to detect adverse events.

2.5.3 Implication for future research

The studies reviewed did not compare patients' adverse events when transferred by paramedics with adverse events when transferred by other health care professionals involved in interfacility critical care transfer, Belway et al. (2006) revealed that favourable hospital outcomes do not correlate with specialised transporting teams, but this does not mean there is no difference in adverse events. Adverse events are fairly rare and unfavourable in-transit outcomes, such as death and stroke, are rarer still. However, it is important to detect small difference in such outcomes.

Arguably, adverse events could be a surrogate for such outcomes. Literature in its current form cannot provide strong reassurance that there is no difference in either adverse events or outcomes. There is also an interesting question which can be raised in all studies concerning skill substitution, this is the question of the variable levels of training that the paramedics have had. It is the important that all studies should make a detailed note of that when comparing adverse events and outcomes.

2.6 Limitation

The initial screening was done through the student, no blinding was applied to authors' names, institutions or journals. The risk of bias was minimised by applying an independent second assessor and a pre-set protocol, also, two authors were directly involved in reviewing all aspects of this systematic review. This review reported the prevalence of AE in patients transferred by paramedics, no comparative studies to other providers were included which limit the rate of AE to patients transferred by paramedics. Another limitation to this review is the failure to generalise the findings of this review to providers other than paramedics such as doctors or to interfacility transfers in general.

2.7 Conclusion

There is a gap found in the literature on the safety and adverse events in interfacility transfers by paramedics. The frequency of in-transit adverse events is 5.1% to 18%; however, due to the weakness of published literature in lacking longitudinal monitoring of patients and only reporting in-transit events, we believe that further research in this area might provide the basis of paramedic safety in interfacility transfers. Also, collecting data from other sources beside the records of the provider conducting the transfer might offer a better understanding of patient safety in interfacility transfers.

2.8 Funding

The access of electronic databases and the retrieval of selected papers were granted through University of Warwick access. The student is a recipient of a full scholarship at the specified university. The funders had no role in conducting this review.

3 Feasibility study on incidence of adverse events in adult critical patients transferred to a tertiary hospital by paramedics

3.1 Abstract

Objectives: To evaluate access, examine accuracy, completeness of data and to validate the data collection form developed by the student.

Methods: All patient records that were transferred by EMS to KAMC after March 1, 2014 were accessed (interfacility transfers are categorised by a special icon on the system). KAMC is a university tertiary medical facility, located in Riyadh, Kingdom of Saudi Arabia. KAMC has more than 1,500 beds, 21 general ICU beds, eight Trauma ICU beds, nine Surgical ICU beds, four Burn ICU beds, eight Neurological ICU beds and 14 intermediate care unit beds. The ER has a total of 85 adult beds, including 15 critical care ER beds. KAMC is one of the biggest hospitals in the Middle East.

The first 25 interfacility records included. After applying the inclusion criteria and selecting patients, identified patients were tracked using their KAMC medical record number. A data collection form was utilised to record patients' data.

Results: The first 25 interfacility transfers which were completed by March 22, 2014 were selected, after applying inclusion and exclusion criteria, 18 (72%) patients were excluded (non-critical patients), seven (28%) patients were identified as possible critical patients and they were admitted to acute care units (CCU, ICU or direct catheterisation lab admission). From the seven possible critical patients, four were excluded (three neonates and one paediatric). Three patients (12%) met the inclusion criteria as adult critical patients transferred by paramedic, one patient was admitted to the ICU, and two were admitted to the Coronary Care Unit (CCU).

Conclusion: The feasibility study showed that the methodology is feasible at KAMC. The data collection form was sufficient to collect the data needed, but

a clear description of timing and repeated vital signs will be needed to describe the case to be utilised in work stream 3. Access to information was feasible, also the necessary data were available and valid electronically. Paper records were matched with electronic data and no evidence of missing data was observed.

3.2 Introduction

The student travelled to the Saudi facility. EMS database access was granted and ICU administration was contacted to grant access to the patients' records transported by physicians (the control group) required in work stream 2b. ICU approval was granted and access to the physician group patients would be secured upon the collection of the data in work stream 2b. The aim of the feasibility study was to evaluate access, examine accuracy, completeness of data and to validate the data collection form (Appendix 7) developed by the student. Before conducting the feasibility study, the student discussed with supervisors possible alternative methods to conduct the quantitative part of this PhD thesis.

3.3 Methods

The EMS database was accessed on October 13, 2014 to review patient records transferred by paramedics. The EMS database contains the pre-departure medical reports and transfer run reports that are uploaded electronically.

3.3.1 Setting

KAMC was established by a royal decree in 1983, a university tertiary medical facility, located in Riyadh, Kingdom of Saudi Arabia. The medical facility operates under the Ministry of National Guard (MNG), and all Saudi citizens with valid medical referral can be accepted. KAMC has more than 1,500 beds, 21 general ICU beds, eight Trauma ICU beds, nine Surgical ICU beds, four Burn ICU beds, eight Neurological ICU beds and 14 intermediate care unit beds. The ER has a total of 85 adult beds, including 15 critical care ER beds. KAMC is one of the biggest hospitals in the Middle East.

KAMC, as a tertiary academic facility, accepts referred critically-ill patients on a daily basis, and their ground ambulance service is available 24 hours a day to retrieve such patients. Patients are retrieved from different sites; the most

common site is Dirab medical facility, a National Guard healthcare emergency centre, located approximately 50km south-west of KAMC. An off-peak journey can take more than 50 minutes. Another common site is the Saudi Medevac (MedEvac) base, located approximately 28km west of KAMC. In off-peak hours, the journey can be completed in 25 minutes. However, in most cases, due to heavy traffic, such journeys may exceed an hour. Interfacility transfer is usually conducted with lights and sirens (except between 2300–0700). Most interfacility transfers are scheduled in advance through an ambulance service dispatch centre, operated by qualified emergency medical technicians. The paramedic receives a full medical report from the referring hospital via dispatch, then, the required equipment is prepared in advance.

The EMS department at KAMC is a division under emergency medicine. Appendix 2 lists EMS resources at KAMC. Medical oversight and consultation are available 24 hours a day, 365 days a year under an on-duty critical care area ER consultant. Minimum manpower shift requirements include one advance life support unit operated with at least one paramedic in addition to an ambulance driver, two basic life-support units operated with at least one basic emergency medical technician and an ambulance driver. The KAMC EMS department is a diverse department, and heterogeneity in paramedic training exists due to the diversity of EMS personnel. However, minimum skill competency is granted through the Saudi Commission for Health Specialties (SCFHS) paramedic license requirements, appendix 12 lists paramedics competencies.

3.3.2 Patients selection

All patient records that were transferred by EMS after March 1, 2014 were accessed (interfacility transfers are categorised by a special icon on the system). The first 25 interfacility transferred patients were analysed. Patients who met the inclusion criteria specified below were recruited.

The inclusion criteria were:

- Adult patients (14 years or older are classed as adults according to KAMC policies; however, for this study, we define adults as 16 years or older)
- Interfacility transferred to KAMC by paramedics via land ambulance
- Risk Score for Transported Patient (RSTP) > 6

The RSTP is a score system developed to identify patients at higher risk of developing complications during interfacility transfer (Etxebarría et al., 1998; Markakis et al., 2006). Patients with RSTP > 6 were defined as critically-ill patients. The complete RSTP list can be found in Appendix 8.

3.3.3 Data collection

Patients' data were collected anonymously on-site using the paper data collection form (Appendix 7). The data were then transferred to a computer where they were encrypted and saved on an Excel spreadsheet. Data were collected from referring hospital reports, EMS patient-care records and receiving hospital's records. Data extracted included patient demographics: the patient's age, sex, reason for transfer, length of transfer, mode of transfer and patient group (patients were divided into medical, trauma or cardiac based on their clinical diagnosis). The following physiological parameters were collected: pulse, respiratory rate, temperature, blood pressure, oxygen saturation, Glasgow coma scale, lung sounds, skin condition, electrocardiogram results, glucose level, haemoglobin, airway devices, mechanical ventilation, ventilator setting, medication infusion, central intravenous line, chest drainage system, intracranial pressure monitoring, invasive blood pressure monitoring, blood transfusion, cardiac pacing, comorbidity, RSTP, mortality and 30-days survival.

3.3.4 Method of measurements

AE in this study is defined as "unfavourable and potentially harmful occurrence during or after the course of patient care. Adverse events are due to

circumstances that may or may not be preventable" (MacDonald, Banks and Morrison, 2008). This definition was developed in a similar setting and the rationale behind adopting this definition is to assure applicability. The definition of AE in hospital setting might be slightly different than interfacility transfer, as AEs in interfacility transfer can be transit and less harmful such as perturbation in physiology.

A modified list of adverse events was adapted from the Royal College of Anaesthetists list of critical incidents. The Royal College list itself was adopted from Dewhurst et al. (2001). The criteria list was modified to match the Saudi ground interfacility transfer system. Modification of the criteria included changing all air transport terms to meet ground transport processes. As with the definition of AE, applicability is an important factor. The logistics and process of interfacility transfer are different from hospital setting. Adopting a list of events that were utilized in a similar setting will provide a better measurement of AEs.

The in-hospital mortality and 30-days survival were measured by accessing the hospital electronic charts for each patient. When 30-days survival was unknown, the data was considered missing. The modified list of AEs is below:

- Cardiovascular:
    - Cardiac arrest
    - Cardiac arrhythmia
    - Cardiac failure
    - Cardiac ischaemia/infarction
    - Haemorrhage
    - Hypertension (MAP > 120mmHg or systolic > 160)
    - Hypotension (MAP < 60mmHg or systolic < 80)
    - Other – describe
- Respiratory:
    - Airway obstruction
    - Aspiration
    - Bronchospasm/asthma
    - Tracheal tube blocked or kinked

- Extubation (inadvertent)
- Peak airway pressures > 45cmH_2O
- Hypercapnia Paco2 > 7kPa
- Hypoxia Spo2 <90%
- Intubation problem
- Pneumothorax
- Pulmonary oedema
- Respiratory arrest
- Ventilation difficulty/failure
- Other – describe

- Neurological:
  - Convulsion
  - Reduction in Glasgow coma scale by 3 points
  - Other – describe
- Equipment failure:
  - Drug/fluid delivery system problem
  - Equipment disconnection
  - Equipment failure
  - Equipment not available
  - Monitoring problem
  - Supply failure (gas or power)
  - Ventilator problem
  - Other – describe
- Drug Related:
  - Wrong dose/route
  - Wrong drug given
  - Other – describe
- Logistics:
  - Vehicle problem

    Communication/information problem
  - Handover of care problem
  - Patient-handling problem

- Other - describe

AEs were identified by reviewing patient records before, during and post transfer. Any intervention that was not initiated by the referring facility was considered a new intervention. Receiving facility records, including receiving hospital unit records, were screened to identify undocumented events or interventions that were not documented by the transfer team.

3.4 Results

During the period of March 1, 2014 to March 22, 2014, the KAMC EMS department transferred 189 patients (calls included emergency calls and interfacility transfers). The first 25 interfacility transfer records, which were completed by March 22. 2014 were included. After applying inclusion and exclusion criteria, 18 (72%) patients were excluded for being non-critical patients and seven (28%) patients were identified as possible critical patients and they were admitted to acute care units (CCU, ICU or direct catheterisation lab admission). From the seven possible critical patients, four were excluded (three neonates and one paediatric). Three patients (12%) met the inclusion criteria as adult critical patients transferred by paramedic, one patient was admitted to the ICU, and two were admitted to the CCU.

Patients transferred by paramedics had a mean age of 51. The mean length of transfer was 88 minutes. All patients were male and their mean RSTP was 9.6, patient's clinical diagnosis was cardiac (66.6%) and medical (33.3%). Table 4 summarises the feasibility study findings. Table 5 illustrates the availability of data extracted from the hospital' and EMS databases.

Table 4 Summary of the feasibility study

Characteristic (n=3)	Value
Number of critical patients (%)	3 (100%)
Mean age in years ± SD	51 ±19.9
Sex (%)	Male (100%)
Mean length of transfer in minutes ±SD	88 ±39.9
Mode of transfer (%)	Ground (100%)
Mean RSTP ±SD	9.6 ±2.5
Diagnosis (%)	Cardiac (66.6%) Medical (33.3%)
Crew level (%)	Paramedic (100%)
Frequency of adverse event (%)	1 (33.3%)
Type of adverse event (%)	Hypotension (100%)
Intervention documented (%)	Medication administration 2 (40%) Oxygen therapy 1 (20%) IV insertion 1 (20%) Fluid administration 1 (20%)
Mortality at discharge (%)	0 (0%)

Table 5 Summary of the availability of data extricated from the databases

Parameter (n=3)	**Pre-transfer**	**During transfer**	**On arrival**
Advance airway (%)	0 (0%)	0 (0%)	0 (0%)
Respiratory rate (%)	3 (100%)	3 (100%)	3 (100%)
SPO2 (%)	3 (100%)	3 (100%)	3 (100%)
Vent setting (%)	0 (0%)	0 (0%)	0 (0%)
Lung sound (%)	3 (100%)	3 (100%)	3 (100%)
Capnography (%)	0 (0%)	0 (0%)	0 (0%)
Pulse (%)	3 (100%)	3 (100%)	3 (100%)
MAP (%)	3 (100%)	3 (100%)	3 (100%)
Skin condition (%)	3 (100%)	3 (100%)	3 (100%)
Temp (%)	3 (100%)	1 (33.3)	3 (100%)
ECG (%)	3 (100%)	3 (100%)	3 (100%)
Capillary refill (%)	1 (33.3)	3 (100%)	3 (100%)
Invasive BP (%)	0 (0%)	0 (0%)	0 (0%)
Glasgow coma (%)	3 (100%)	3 (100%)	3 (100%)

Pupils (%)	3 (100%)	3 (100%)	3 (100%)
ICP monitoring (%)	0 (0%)	0 (0%)	0 (0%)
Hb (%)	3 (100%)	0 (0%)	3 (100%)
Glucose (%)	2 (66.6%)	1 (33.3%)	3 (100%)
Blood gas (%)	2 (66.6%)	0 (0%)	3 (100%)
Radiological studies (%)	3 (100%)	0 (0%)	3 (100%)
Infusions (%)	2 (66.6%)	2 (66.6%)	3 (100%)
Central IV (%)	0 (0%)	0 (0%)	0 (0%)
Chest tube (%)	0 (0%)	0 (0%)	0 (0%)
Blood transfusion (%)	1 (33.3%)	0 (0%)	0 (0%)
Comorbidity (%)	3 (100%)	3 (100%)	3 (100%)
RSTP (%)	3 (100%)	3 (100%)	3 (100%)
TISS (%)	3 (100%)	3 (100%)	3 (100%)
APACHE II (%)	3 (100%)	3 (100%)	3 (100%)
Mortality (%)	0 (0%)	0 (0%)	(0%)
AE (%)	0 (0%)	0 (0%)	1 (33.3%)
Intervention (%)	2 (66.6%)	1 (33.3%)	3 (100%)

3.5 Discussion

After accessing all databases and tracking-included patients, the student met the second supervisor who reviewed the data; he also accessed the EMS database (on-line) to assure that accuracy of information was provided in this phase.

The hospital database user interface had multiple information which was needed to fulfil research requirements, which include physician and nurse progress notes, lab results, vital signs, discharge notes and mortality at discharge, all this information being available along with dates and times. The data collection form was tested and a summary of data availability is provided in table 4. The data form was not enough to record multiple vital signs and multiple interventions. It was decided that any case with clinical event or

interventions will utilise the space below the table to record time and event to assure enough data are available to narrate the case.

Data missing, as shown in table 5, were either not applicable (ventilator setting, airway, capnography, invasive BP monitoring, central IV and chest tubes) or data were not recorded at one phase of transfer (blood gas, glucose and capillary refill). The cases of non-recorded data were investigated; one glucose and blood gas tests were missing due to the fact that the patient was diagnosed with acute MI and the patient was transferred urgently for emergency Percutaneous Coronary Intervention (PCI). The case of missing capillary refill time was confirmed to be not recorded, even in the referring facility report (the referring facility report was reviewed and the patient record lacks the capillary refill time).

Patient medical record number and date of admission were sufficient to track patients in the hospital's database. After completing data collection and verifying patient identification information (patient name, medical record number and date of admission) data were anonymised and stored in patients database (Excel sheet). The KAMC EMS medical director supervised the process of anonymising data.

One adverse event (33.3%) was observed (hypotension), and it was noticed that the paramedic did not document the hypotension event in his run report. The paramedic documented the last blood pressure measurement as 120/80, just one minute before handing the patient over to nursing staff at the ICU. The ICU nurse reported a blood pressure of 79/40 (with dopamine infusion at 5mcg/kg/min) and the ICU physician ordered a different vasopressor. One of the main challenges in this research is undocumented or unrecognised events, with our methodology of comparing both pre, during and post transfer records it was feasible to detect such events. The explanation of undocumented or unrecognised events needs more investigation, including more cases to

analyse. The expert survey will explore such events, and possible causes might be identified at the end of this research.

The high frequency of adverse events reported in the feasibility study (33.3%) compared to literature (5%-18%) is likely to be due to the small number (three patients) included in feasibility study. Another explanation might be that this reported frequency (33.3%) or one in every three patients, is the real frequency of adverse events in the Saudi EMS system, although a larger number of cases are needed to confirm this finding.

The feasibility study showed that, within 22 days, KAMC EMS transferred 25 interfacility patients, and seven (28%) were critical patients that required intensive care or an urgent transfer. The small number of patients meeting the inclusion criteria (three patients, 12%) in this feasibility study has suggested that an extra year of patient recruitment might be needed to fulfil the required sample size. It was discussed with both hospital and supervisors that we might extend our study period to include interfacility patients transferred to KAMC until Dec 31, 2014.

3.6 Conclusion

The feasibility study showed that the methodology is feasible at KAMC. The data collection form was sufficient to collect the data needed, but a clear description of timing and repeated vital signs will be needed to describe the case in work stream 3. Access to information was feasible; also, the necessary data were available and valid electronically. Paper records were matched with electronic data and no evidence of missing data was noticed. One undocumented event was observed. All included patients were successfully tracked from referring facility to receiving facility discharge. Finally, the feasibility study suggested that the study period might need to be extended to include patients transferred to KAMC until December 31, 2014.

4 Incidence and predictors of adverse events and outcomes for adult critically-ill patients transferred by paramedics to a tertiary care medical facility

4.1 Abstract

Objectives: To determine the incidence of adverse events and patients' outcomes in interfacility critical care transfers by paramedics.

Methods: We conducted a retrospective cohort study of adults undergoing interfacility transfer to a tertiary medical facility by paramedics. We included all patients transferred between June 1, 2011 and December 31, 2014. The primary outcome is in-transit adverse events and the secondary outcome is in-hospital mortality. Multiple logistic regression models were fitted to assess predictor variables associated with adverse events and in-hospital mortality.

Results: The incidence of adverse events was 13.7% (31/227 patients had an in-transit adverse event), the most common adverse events reported were desaturation and hypotension, respectively. A unit increase in Risk Score for Transported Patients (RSTP) significantly increased occurrence of adverse events (adjusted odd ratio [OR] 1.36, 95% CI 1.07-1.72 and adjusted p=0.01). Compared to medical patients, cardiac patients were less likely to develop adverse events (adjusted OR 0.117, 95% CI 0.02-0.52 and adjusted p=<0.01). The in- hospital mortality was 30.4% and 30-days survival was 68.1%. For two patients, whose age differed by one year, the older patient was more likely to die (adjusted OR 1.03, 95% CI 1.01-1.05 and p<0.01) and a unit increase in RSTP significantly increased occurrence of in-hospital mortality (adjusted OR 1.30, 95% CI 1.06-1.60 and p=0.01).

Conclusion: The incidence of adverse events was 13.7%. The most common observed adverse events were desaturation and hypotension. In hospital mortality was 30.4% and 30-days survival was 68.1. %.

4.2 Introduction

The data collection phase was planned to be completed in 90 days. The EMS department secured a desk and personal computer with access to both EMS and hospital databases. The student received one-to-one training on accessing and extracting data from both databases, the medical director was available to answer any questions pertaining to data and medical care given to patients.

4.3 Methods

4.4 Study Design and Setting

A retrospective cohort study of all adult patients transferred by KAMC paramedics was conducted. Ethical approval was obtained from King Abdullah International Medical Research Center (KAIMRC) Institutional Review Board (IRB). KAIMRC is the responsible ethical institution that supervises research activities conducted in KAMC.

Interfacility transfer is usually operated with two paramedics. In the rare cases where two paramedics are not available, a registered nurse from the receiving hospital unit may support the transfer but, as per the hospital's policies and procedures, the paramedic is the designated primary provider of clinical care.

Paramedic protocols utilise a wide range of medications, including advanced life-support medications and Rapid Sequence Intubation (RSI) medications. The following list is the medications available to paramedics:

Activated Charcoal	Dextrose 50%
Adenosine	Diazepam (Valium)
Adrenaline 1:1000 Adrenaline 1:10000	Diltiazem (Cardizem)
Albuterol	Diphenhydramine
Amiodarone	Dopamine
Aspirin	Etomidate

Atropine	Fentanyl
Calcium Chloride	Furosemide (Lasix)
Glucagon	Naloxone (Narcan)
Haloperidol (Haldol)	Nitroglycerin
Ipatropium (Atrovent)	Oxygen
Lidocaine	Sodium Bicarbonate
Magnesium Sulfate	Succinylcholine
Methylprednisolone	Thiamine
Midazolam	Ketamine
Morphine	

The following list is medications NOT approved to be initiated by paramedics, but paramedics are approved to maintain it.

Amrinone	Norepinephrine
Anti-infectives: Anti-biotics/Anti-virals/Anti-fungals/Anthelmintics	Phenytoin
Blood products	Propofol
Dobutamine	Racemic Epinephrine
Heparin	Thrombolytics
Insulin	Vecuronium
Mannitol	Drugs familiar to the paramedic

If a medication is not common or familiar to the paramedic, an on-line medical direction is required.

Interfacility transfer is operated with type-3 ambulance vehicles. Interfacility critical care transfer vehicles are equipped with portable transport ventilator, a defibrillator and monitor, at least two syringe pumps and a refrigerator to maintain opioids and intravenous fluids.

4.4.1 Sample size calculation

Sample size was calculated based on the prevalence of adverse events published in the literature (Chapter 2). Assuming an observed prevalence of 18%, the maximum reported prevalence in the (Domeier, Hill and Simpson, 1996), 227 patients were required to achieve a margin of 5% (corresponding to 95% confidence interval (CI) of 13%-23%).

4.4.2 Patients selection

Four years of data (from June 1, 2011 to December 31, 2014) were screened and details of the first 227 adult critically-ill patients who met the inclusion criteria specified below and who were transported by paramedics were included.

The inclusion criteria were:

- Adult patients (14 years or older are classed as adults according to KAMC policies; however, for this study, we define adults as 16 years or older)
- Interfacility transferred to KAMC by paramedics via land ambulance
- Risk Score for Transported Patient (RSTP) > 6

4.4.3 Data Collection

Patients' data were collected anonymously on-site using the paper data collection form (Appendix 7). The data were then transferred to a computer where they were encrypted and saved on an Excel spreadsheet. Data were collected from referring hospitals' reports, EMS patient-care records and the receiving hospital's records. Data extracted included patient demographics: the patient's age, sex, reason for transfer, length of transfer, mode of transfer and patient group (patients were divided into medical, trauma or cardiac based on their clinical diagnosis).

The following physiological parameters were collected: pulse, respiratory rate, temperature, blood pressure, oxygen saturation, Glasgow coma scale, lung sounds, skin condition, electrocardiogram results, glucose level, haemoglobin, airway devices, mechanical ventilation, ventilator setting, medication infusion, central intravenous line, chest drainage system, intracranial pressure monitoring, invasive blood pressure monitoring, blood transfusion, cardiac pacing, comorbidity, RSTP, mortality and 30-dayssurvival.

The RSTP is a score system developed to identify patients at higher risk of developing complications during interfacility transfer (Etxebarría et al., 1998; Markakis et al., 2006). Patients with RSTP > 6 were defined as critically-ill patients. The complete RSTP list can be found in Appendix 8.

4.4.4 Method of measurements

A modified list of adverse events was adapted from the Royal College of Anaesthetists list of critical incidents. The Royal College list itself was adopted from Dewhurst et al. (2001). The criteria list was modified to match the Saudi ground interfacility transfer system. Modification of the criteria included changing all air transport terms to meet ground transport processes.

The in-hospital mortality and 30-days survival were measured by accessing the hospital electronic charts for each patient. When 30-days survival was unknown, the data were considered missing. The modified list of AEs is as below:

- Cardiovascular:
    - Cardiac arrest
    - Cardiac arrhythmia
    - Cardiac failure
    - Cardiac ischaemia/infarction
    - Haemorrhage
    - Hypertension (MAP > 120mmHg or systolic > 160)
    - Hypotension (MAP < 60mmHg or systolic < 80)

    - Other – describe
- Respiratory:
    - Airway obstruction
    - Aspiration
    - Bronchospasm/asthma
    - Tracheal tube blocked or kinked
    - Extubation (inadvertent)
    - Peak airway pressures > 45cmH_2O
    - Hypercapnia Paco2 > 7kPa
    - Hypoxia Spo2 <90%
    - Intubation problem
    - Pneumothorax
    - Pulmonary oedema
    - Respiratory arrest
    - Ventilation difficulty/failure
    - Other – describe
- Neurological:
    - Convulsion
    - Reduction in Glasgow coma scale by 3 points
    - Other – describe
- Equipment failure:
    - Drug/fluid delivery system problem
    - Equipment disconnection
    - Equipment failure
    - Equipment not available
    - Monitoring problem
    - Supply failure (gas or power)
    - Ventilator problem
    - Other – describe
- Drug Related:
    - Wrong dose/route

- Wrong drug given
- Other – describe

- Logistics:
  - Vehicle problem
    Communication/informationproblem
  - Handover of care problem
  - Patient-handling problem
  - Other - describe

AEs were identified by reviewing patient records before, during and post transfer. Any intervention that was not initiated by the referring facility was considered a new intervention. Receiving facility records, including receiving hospital unit records, were screened to identify undocumented events or interventions that were not documented by the transfer team.

4.4.5 Statistical analysis

All data collected were analysed using IBM SPSS® version 22. Statistics software was provided by Warwick University Information Technology (IT) license. Continuous characteristics of patients, such as age, were summarised using mean and standard deviation. Categorical characteristics, such as gender and diagnosis, were summarised by reporting count and percentages in each category. The rate of adverse events was calculated as percentage of patients with at least one adverse event.

The 95% CI for the rate of adverse events was calculated using normal approximation to the binomial distribution. Odds ratios (ORs) were used to assess whether patient and transfer characteristics predict occurrence of adverse events. Unadjusted and adjusted ORs were obtained by fitting simple and multiple logistic regression models, respectively. ORs were considered statistically different from one (no difference) if $p \leq 0.05$. The same methods were used to analyse in-hospital mortality. The only exception was that

occurrence of an in-transit adverse event was considered a potential predictor for in-hospital mortality.

4.5 Results

4.5.1 Incidence of adverse events

The study identified the first 227 adult critically-ill patients meeting the inclusion criteria and who were transferred by EMS paramedics. The mean age of patients was 53 years, 143 patients were male (63%) and 84 patients were female (37%). The mean length of transfer was 54.5 minutes. The mean RSTP was 9.8 and 55 patients (24.2%) were on mechanical ventilation. The patients' clinical diagnosis was cardiac (49.8%), trauma (25.6%) and medical (24.7%). A summary of patients' characteristics is provided in Table 6.

Table 6 Characteristics of patients transported by paramedics

Characteristic (n=227)	**Value**
Number of critical patients (%)	227 (100%)
Mean age in years ± SD* (Age range)	53 ± 21.07 (17-108)
Sex, number (%)	Male, 143 (63.0%) Female, 84 (37.0%)
Mean length of transfer in minutes ± SD	54.50 ± 26.27
Mode of transfer (%)	Ground (100%)
Mean RSTP** ± SD	9.86 ± 3.02
Diagnosis by category (%)	Cardiac 113 (49.8%) Trauma 58 (25.6%) Medical 56 (24.7%)
Crew level (%)	Paramedic (100%)
Patients on mechanical ventilation (%)	55 (24.2%)
Patients with central intravenous line (%)	24 (10.6%)
Patients with chest tubes (%)	4 (1.8%)
Frequency of in-transit adverse event (%)	31 (13.7%)
Mortality at discharge (%)	69 (30.4%)

** SD= standard deviation.*
***Risk Score for Transported Patient. Range 0-22. Patients >6 are "high risk".*

The rate of in-transit adverse events was 13.7% (31 patients had an in-transit adverse event). The most common adverse event seen in adult critical-care transport in Saudi Arabia was desaturation, and a full list of adverse events is provided in Table 7. Multiple logistic regression analysis revealed that RSTP was significantly higher in patients who developed adverse events (adjusted odd ratio [OR] 1.36, 95% CI 1.07-1.72 and adjusted p=0.01). A full summary of multiple logistic regression is provided in Table 8.

Table 7 List of adverse events seen by paramedics

Type of adverse event (n=31)	Frequency (% of total patients)
Desaturation (SPO2*< 90%)	10 (4.4%)
Hypotension (MAP** < 60mmHg or systolic <80)	7 (3.1%)
Arrhythmia	5 (2.2%)
Agitation***	4 (1.8%)
Arrest	4 (1.8%)
Convulsion	1 (0.4%)

** SPO2= peripheral capillary oxygen saturation.*
*** MAP= mean arterial pressure*
****Patients on mechanical ventilation required a bolus or alternation of sedative and/or paralytic agent*

Table 8 Summary of results assessing which variables are associated with adverse events

Variable	Unadjusted analysis	Adjusted analysis	
	OR (95%CI)	OR (95%CI)	P-value
Age (per year increment)	1.01 (0.99-1.03)	1.00 (0.97-1.02)	0.99
Sex (female)	1.27 (0.58-2.74)	1.14 (0.46-2.81)	0.77
Medical	Reference	Reference	
Trauma	0.82 (0.33-2.02)	0.53 (0.17-1.60)	0.26
Cardiac	0.36 (0.11-1.13)	0.11 (0.02-0.52)	<0.01
RSTP*	1.32 (1.17-1.49)	1.36 (1.07-1.72)	0.01
Length of transfer	1.01 (0.99-1.02)	1.00 (0.98-1.01)	0.80
Mechanical ventilation	0.16 (0.07-0.37)	0.40 (0.08-1.97)	0.27
Central IV**	0.42 (0.15-1.16)	2.54 (0.65-9.86)	0.18

** Risk Score for Transported Patient*
*** IV= intravenous line*

4.5.2 In-hospital mortality and 30-days survival

The in-hospital mortality was 30.4% of patients transferred by paramedic. The 30-days survival was 68.1% (three patients died within 30-days post-discharge). Missing data pertained to one patient (this patient had been discharged to a long-term care facility). Multiple logistic regression analysis showed that patients with in-hospital mortality had a higher age (adjusted OR 1.03, 95% CI 1.01-1.05 and adjusted p=<0.01) and a higher RSTP (adjusted OR 1.30, 95% CI 1.06-1.60 and adjusted p=<0.01). A full summary of the multiple regression analysis is provided in Table 9.

Table 9 Summary of results assessing which variables are associated with in-hospital mortality

Variable	Unadjusted analysis	Adjusted analysis	
	OR (95%CI)	OR (95%CI)	P-value
Age (per year increment)	1.02 (1.01-1.03)	1.03 (1.01-1.05)	<0.01
Sex (female)	1.24 (0.69-2.22)	0.98 (0.46-2.09)	0.97
Medical	Reference	Reference	
Trauma	1.24 (0.62-2.47)	0.86 (0.35-2.13)	0.76
Cardiac	1.01 (0.50-2.01)	0.75 (0.25-2.29)	0.62
RSTP*	1.48 (1.32-1.65)	1.30 (1.06-1.60)	0.01
Length of transfer	1.02 (1.01-1.03)	1.00 (0.98-1.01)	0.83
Mechanical ventilation	0.08 (0.04-0.02)	0.32 (0.08-1.23)	0.10
Central IV**	0.14 (0.06-0.36)	0.78 (0.22-2.75)	0.71
In-transit adverse event	6.47(2.85-14.70)	2.84 (0.97-8.30)	0.06

** Risk Score for Transported Patient*

4.6 Discussion

4.6.1 Alternative methodology

The first step to answer the PhD research questions is detecting the incidence of AEs in the Saudi interfacility critical care transfers by paramedics. There are no published studies found in the literature on the incidence of AEs in Saudi interfacility transfer system. There are many methodologies that could be utilised to determine the incidence of AEs. The common methodologies utilised in AEs detection are incident reporting systems, chart review, patient interviews and observers (Murf et al., 2003; Montesi and Lechi, 2009). Chart review has been considered the "gold-standard" in detecting AEs in healthcare.

A retrospective chart review of all adult patients (during the study period) transferred to KAMC from other hospitals was the selected method. The observational method of this PhD thesis was designed after conducting the systematic review, which showed that a retrospective chart review is feasible in such settings. The observational retrospective chart review method is based on data that were collected for reasons other than research (Hess, 2004); this type of study design has many advantages. One of the advantages is the access to data that require long latency between the occurrence and the outcome. In this thesis, the patients under investigation are critically-ill patients who usually require a lengthy hospital stay, and a retrospective chart review will assure that the desirable sample of patients with complete outcomes are recruited (within the PhD study period). Another advantage is the ability to study rare occurrence. The rate of AE in interfacility transfers by paramedics in general is < 20%, to ensure detecting rare events, retrospective design is an applicable method, and, finally, one of the advantages of a retrospective chart review is generating hypotheses for future studies (Gearing et al., 2006).

Retrospective design has many disadvantages, one being missing data. This research was designed to ensure that missing data are minimised. First, a feasibility study on 25 random patients was conducted to assure completeness of data. Second, multiple data sources were utilised to collect data, which included the pre and post-transfer reports. Another disadvantage of the retrospective chart review is confounding factors. An attempt to identify confounding factors prior to conducting this phase was considered by identifying possible confounding factors, such as patients' demographics and physiological parameters. In addition, a logistic regression model to adjust for these confounding factors was utilised in the analysis; however, there is still a possibility for unmeasured confounding factors that might directly impact the results of this phase.

There are many alternative methods to this study; the two research methods presented below were discussed with supervisors at the beginning of this PhD and the decision to utilise a retrospective chart review was based on the nature of the research question, available PhD time frame and resources.

- Direct patient care observation:

Observing patient care personally or by video is a method utilised in different hospital settings, including intensive care units (Donchin et al., 1995). This method has many advantages, one being is the accuracy in detecting AEs. Another advantage is the ability to detect active adverse events and errors (Thomas and Petersen, 2003). On the other hand, patient care observation has disadvantages, one of the many being confidentiality. The patient and the provider confidentiality are compromised in such design. Providers can be easily identified and the risk of disciplinary actions in case of error exists. Patient confidentiality is also compromised, as the observer can identify selected patients. Another disadvantage is the Hawthorne effect. Providers can alter their behaviour in the observation method (personal or video), which can impact the accuracy of the incidence of AEs.

For this PhD thesis, the applicability of direct patient care observation is challenging. First, the video method of observation is difficult, as the interfacility transfer requires moving patients frequently. Another challenge is observers' training. The observers will require extensive training to ensure reliable results. The final challenge is the cost. The video equipment, observer recruitment, and training will require a large budget.

- Incident reporting system

The second alternative method is the incident reporting system. There are two types of incident reports, obligatory and voluntary. The obligatory reporting is usually reserved to severe events, such as death, while voluntary reporting is more general and it is usually confidential. The possible alternative to this study is voluntary incident reporting.

Voluntary incident reporting has many advantages, one being confidentiality. Most voluntary incident reports are anonymised. Another advantage is the relative acceptability of such design by staff. As most of these systems are anonymous, staff will be less anxious about reporting events. On the other hand, voluntary reporting also has many disadvantages, one being selection bias; providers might not report all AEs seen in their clinical practice. Another disadvantage is the difficulty of utilising such design to examine the root causes of AEs.

For this PhD thesis, incident reporting is not suitable for many reasons. First, the providers are not familiar with such design and implementing incident reporting will require training and time. Second, the sample size required will take time to be recruited, as this method is prospective and years of data will be required to recruit enough patients. Finally, voluntary reporting might be appropriate for error detection and near miss events, but rarely applicable for AEs (Pierson et al., 2007).

In conclusion, while retrospective design has many disadvantages and other alternative methods might be stronger in producing clinical evidence, for this specific project, retrospective design will be the suitable research design that can produce valid results with consideration to available time and resources.

4.6.2 Study discussion

In this retrospective chart review of critically-ill adult patients transferred to a tertiary hospital by paramedics, we found that adverse events occurred in 13.7% of patients. The most common adverse events reported were desaturation, 4.4% (10 patients) and hypotension, 3.1% (seven patients). Four patients (1.8%) had an in-transit cardiac arrest. Adverse events were more common in patients with a higher RSTP and less common in cardiac patients. The adverse event rate is consistent with a similar study done in the United States of America (Domeier, Hill and Simpson, 1996), but higher than the adverse events rate reported in Ontario, Canada (6.5%) (Singh, MacDonald and Ahghari, 2014).

The association of increased risk of developing an adverse event in patients with higher RSTP is consistent with previous studies on RSTP (Etxebarría et al., 1998; Markakis et al., 2006). The small percentage of traumatic patients transferred by paramedics prevents the possibility of drawing a firm conclusion regarding the development of an adverse event in this group of patients. Cardiac patients were the majority of the transported patients in our study and they were less likely to have in-transit adverse events. The low rate of adverse events (6.5%) reported from Canada by Singh, MacDonald and Ahghari (2014) could be attributed to the different population in the Canadian study; also, our study included more adverse events compared to the Singh, MacDonald and Ahghari (2014) study, which only included new in-transit haemodynamic instability, new in-transit respiratory instability, in-transit death or in-transit major resuscitative procedure.

Four of our patients (< 2%) developed in-transit cardiac arrests. The rate of cardiac arrest and death is comparable to rates in other studies (Ligtenberg et al., 2005; Rittenberger et al., 2008; Seymour et al., 2008). These four patients were initially urgently transported to a tertiary care facility because they had a cardiac arrest (in the previous 60 minutes of transfer) and they were revived successfully, but these patients were transferred urgently in critical conditions

(low blood pressure, low heart rate, decreased level of consciousness and respiratory rate). Paramedics transferring critically-ill patients in Saudi Arabia had a noticeably high frequency of switching mechanically-ventilated patients to ventilation by bag valve mask (BVM)when desaturation occurred, which required a further analysis to be taken to investigate these actions. It is hard to conclude that such acts had affected the patients' outcomes. In many cases, paramedics intervened to a patient's clinical status before it reached the threshold at which it could be considered an adverse event. For example, a paramedic in one of the cases switched to BVM when the patient's SPO2 dropped to 93% and rapidly restored the level to 99%. Also, it is important to note that the existence of mechanical ventilation (in our multiple logistic regression) was not associated with increased patient risk of developing an adverse event (p=0.26).

Patients transferred by paramedics had an in-hospital mortality of 30.4% and 30-days survival was 68.1%. The rate of in-hospital mortality is consistent with both local and internationally published data (Arthur et al., 2013; Uusaro et al., 2002; Rishu et al., 2013).

It is planned to conduct an international expert survey to examine consensuses on the safety of paramedics' intervention to adverse events. Adverse events are not always preventable. The question that remains is whether the adverse events in this study were preventable or not. The usual way to determine preventability is by means of chart (case note) review (Brennan et al., 1991; Hayward and Hofer, 2001; Thomas and Petersen, 2003). We planned a study of expert, implicit review of the case notes where each case would be reviewed by four independent reviewers as use of this many reviewers would mitigate the human low reliability of implicit case note review (Lilford et al., 2007)

4.7 Limitation

One important limitation of this study is the retrospective design. The risk of unmeasured confounding variables is possible. Despite our effort in obtaining data from several resources (sending hospital reports, paramedics' patient care reports and receiving hospital records) the risk of undocumented events and the question of accuracy in providers' documentation still exist in our study. Another limitation is the narrow outcomes measured in our study' this study reports only in-transit adverse events and hospital outcomes and other outcomes, such as morbidity and length of stay, were not measured. The hospital-based EMS where the study was conducted is a diverse system with different level of training received, also the population represented were mainly Saudi citizens, which might directly impact the external validity of our study.

4.8 Conclusion

In conclusion, the rate of adverse events in adult critical patients transferred by paramedics to a tertiary care facility in Saudi Arabia is 13.7%. The most common adverse events reported were hypoxia and hypotension. The in-hospital mortality was 30.4% and 30-days survival was 68.1%. A further analysis of interventions and the root causes of adverse events is recommended.

5 In-hospital mortality and 30-days' survival in the paramedic model versus the physician model in interfacility transfers of critically-ill adult patients in Saudi Arabia

5.1 Abstract:

Objectives: To compare patients' outcomes in two different models utilised in interfacility transfer of critically-ill adult in the Kingdom of Saudi Arabia.

Methods: We conducted a retrospective chart review study of adults undergoing interfacility transfer to a tertiary medical facility. We included patients transferred between June 1, 2011 and December 31, 2014. The primary outcome is in hospital mortality and the secondary outcome is 30-days survival.

Results: In our study, 454 patients were included (227 patients in each group). The mean age in the physician group was 56 and 53 for the paramedic group. The clinical diagnosis of patients in the physician group was medical 56.4%, trauma 28.2% and cardiac 15.4%. On the other hand, the clinical diagnosis of the paramedic group was cardiac 48.8%, trauma 25.6 and medical 24.7%. The in-hospital mortality was 31.7% (72 patients) in the physician group and 30.4% (69 patients) in the paramedic group, respectively. A chi-square test of in-hospital mortality was p=0.76. From the 155 patients survived to hospital discharge in the physician group, five died within 30 days compared to 158 survived in the paramedic group and three died within 30 days. A chi- square test of 30-days survival was p= 0.49. There was no missing data affected in-hospital mortality; however, in 30-days survival data there were three missing data (two in the physician group and one in the paramedic group).

Conclusion: In this study, there is no difference found regarding in-hospital mortality or 30-days survival between the paramedic and physician groups, however, the study was underpowered and the risk of type II error is a major

threat to the precision of results. A large multi-centre prospective study is highly recommended.

5.2 Introduction

The data collection started immediately after conducting work stream 2a. The ICU and ER units were contacted. A list of all patients transferred from another medical facility to these two units during the study period was received. The list was on Excel spreadsheet and it contained patients' medical record number, date of admission and the unit outcome.

5.3 Methods

The list was screened to remove patients transferred by paramedics and included in the previous chapter. Then, all remaining patients received a chart review.

5.3.1 Study design and setting

A retrospective chart review study of adult patients transferred to KAMC was conducted. Ethical approval was obtained from KAIMRC IRB. KAIMRC is the responsible ethical institution that supervises research activities conducted in the KAMC.

Patients identified in the previous chapter represent the first group (paramedic group), and the steps to recruit patients in the second group (physician group) were as follows:

- Reviewing medical records lists provided by the hospital receiving units
- Chart review to identify transferring team (there is a special icon on the system that determines the transferring team)
- Applying inclusion criteria
- Determining patient outcomes from the patient's chart

Patients transferred by physicians are usually identified by accessing the type of ambulance transferring the patient to KAMC. On the hospital system, it clearly states that the patient was accompanied by either medical doctor, specialised nurse or other healthcare provider. Most of the doctors

accompanying direct ICU transfers are either intensivists or anaesthetists. On the other hand, most of the doctors accompanying patients transferred to ER are either emergency medicine or family medicine doctors.

5.3.2 Patients selection

Four years of data (from June 1, 2011 to December 31, 2014) were screened and details of the first 227 adult critically-ill patients who met the inclusion criteria specified below were included.

The inclusion criteria were:

- Adult patients (defined as 16 years or older)
- Interfacility transferred to KAMC by physician via land ambulance
- RSTP > 6

5.3.3 Data collection

Patients' data were collected anonymously on-site using the paper data collection form (Appendix 7). The same data collection form utilised in the previous chapter was reused. The data were then transferred to a computer where they were encrypted and saved on an Excel spreadsheet. Data were collected from referring hospitals' reports and receiving hospital's records. Data extracted included patient demographics: the patient's age, sex, reason for transfer, length of transfer, mode of transfer and patient group (patients were divided into medical, trauma or cardiac based on their clinical diagnosis). The RSTP was calculated based on the last medical report (containing latest vital signs) received from the sending facility. Finally, patient outcomes were recorded from the patient's electronic medical chart.

5.3.4 Method of measurements

The primary outcome is in-hospital mortality and the secondary outcome is 30-days survival. If the outcome is missing, patient data were recorded as missing.

5.3.5 Patients follow-up process

The majority of patients transferred to KAMC are eligible patients that are treated under MNG health services. The referred patients from other medical facilities are eligible to benefit from KAMC services for one year after acceptance. The follow-up method to these patients after discharge is to review the patient's outpatient medical record. These patients are usually transferred to KAMC with complicated medical cases and treatment requires lengthy outpatient follow-up. If the patient did not attend the outpatient visit, then a review to the administrative reports is granted to identify death reports, reasons of not attending appointment or reason of terminating the patient eligibility; if no clear reason is identified, then the patient data is considered missing.

5.3.6 Statistical analysis

All data collected were analysed using IBM SPSS® version 22. Statistics software was provided by Warwick University IT license. Continuous characteristics of patients, such as age, were summarised using mean and standard deviation. Categorical characteristics, such as gender and diagnosis, were summarised by reporting count and percentages in each category. The in-hospital mortality and 30-days survival were calculated as percentage of patients with the outcome being measured. The 95% CI for the in-hospital mortality was calculated using normal approximation to the binomial distribution. Odds ratios (ORs) were used to assess whether patient and transfer characteristics predict occurrence of outcomes. Unadjusted and adjusted ORs were obtained by fitting simple and multiple logistic regression models, respectively. ORs were considered statistically different from one (no difference) if $p \leq 0.05$. A chi-square test was utilised to compare the outcomes between the two groups being studied and statistical significance was set at $p \leq 0.05$.

5.4 Results

In this study, 454 patients were included (227 patients in each group). The mean age in the physician group was 56 and 53 for the paramedic group. The clinical diagnosis of patients in the physician group was medical 56.4%, trauma 28.2% and cardiac 15.4%. On the other hand, the clinical diagnosis of the paramedic group was cardiac 48.8%, trauma 25.6 and medical 24.7%. Characteristics of patients included in this study are provided in Table 10. The in-hospital mortality was 31.7% (72 patients) in the physician group and 30.4% (69 patients) in the paramedic group, respectively. A chi-square test of in-hospital mortality was p=0.76. From the 155 patients survived to hospital discharge in the physician group, five died within 30 days compared to 158 survived in the paramedic group and three died within 30 days. A chi- square test of 30-days survival was p= 0.49.

There were no missing data affecting in-hospital mortality; however, in 30-days survival data, there were three missing data (two in the physician group and one in the paramedic group). Multiple logistic regression analysis showed that patients with in-hospital mortality had a higher age (adjusted OR 1.03, 95% CI 1.01-1.04 and adjusted p=<0.01) and a higher RSTP (adjusted OR 1.77, 95% CI 1.56-1.97 and adjusted p=<0.01). A full summary of the logistic regression analysis is provided in Table 11.

Table 10 Characteristics of patients

Characteristic (n=454)	Paramedic group (n=227)	Physician group (n=227)
Number of critical patients (%)	227 (50%)	227 (50%)
Mean age in years ± SD* (Age range)	53 ± 21.07 (17-108)	56 ± 22.39 (16-96)
Sex, number (%)	Male, 143 (63.0%) Female, 84 (37.0%)	Male, 138 (60.8%) Female, 89 (39.2%)
Mode of transfer (%)	Ground (100%)	Ground (100%)
Mean RSTP** ± SD	9.86 ± 3.02	9.24 ± 2.51
Diagnosis by category (%)	Cardiac 113 (49.8%) Trauma 58 (25.6%) Medical 56 (24.7%)	Cardiac 35 (15.4%) Trauma 64 (28.2%) Medical 128 (56.4%)
Crew level (%)	Paramedic (100%)	Physician (100%)

** SD= standard deviation.*
***Risk Score for Transported Patient. Range 0-22. Patients >6 are "high risk".*

Table 11 Summary of results assessing which variables are associated with in-hospital mortality

Variable	Unadjusted analysis	Adjusted analysis	
	OR (95%CI)	OR (95%CI)	P-value
Transfer personnel (paramedic)	0.94 (0.63-1.40)	0.73 (0.41-1.30)	0.29
Age (per year increment)	1.02 (1.01-1.03)	1.03 (1.01-1.04)	<0.01
Sex (female)	1.49 (0.99-2.24)	0.99 (0.58-1.70)	0.98
Medical	Reference	Reference	
Trauma	1.24 (0.79-1.95)	0.91 (0.48-1.71)	0.77
Cardiac	0.44 (0.25-0.79)	0.50 (0.22-1.14)	0.10
RSTP*	1.70 (1.54-1.87)	1.77 (1.59-1.97)	<0.01

**Risk Score for Transported Patient. Range 0-22. Patients >6 are "high risk".*

5.5 Discussion

5.5.1 Study discussion

In this study, there was no difference in patients' outcomes when transported by paramedics vs. physicians. The 30-days survival in both groups was similar; however, it is rare to have a mortality 30-days post-discharge. The multivariate logistic regression adjusted for age, transfer provider, sex, patient's diagnosis group and RSTP showed that only increased age and increased RSTP were associated with in-hospital mortality. There were not enough patients to perform logistic regression on 30-days survival. Missing data were just three patients, in which one was discharged to a long-term rehabilitation facility.

The results of this study suggest that there is no association between the provider who conducts the transfer and patients' outcomes. These findings are similar to previous studies on outcomes in interfacility critical care transfers (Fan et al., 2006).

The rate of in-hospital mortality might be higher than reported in the literature' however, it is comparable to a previous study done by the KAMC ICU team (Rishu et al., 2013). This high rate of in-hospital mortality can be contributed to multiple factors, including the delay in transporting patients due to patients being medically unstable to be transported to another hospital. Another possible factor is patients' age, the mean age of both groups being investigated was above 50 which suggests the existence of comorbidity that might directly impact the patient's outcome. Finally, the small sample size in this study might be a factor in the high rate of in-hospital mortality.

The association of increased risk of in-hospital mortality with increased age is expected. Increased age is usually associated with comorbidity. According to WHO, the prevalence of hypertension in the Saudi population is 24.2% and obesity is more than 33% (WHO, 2015). These factors with age increment are

a cause of complications, including death. The association of increased risk of in-hospital mortality with increased RSTP contributes to the fact that these patients are critical. RSTP is designed to predict patients at higher risk of in-transit adverse event (Etxebarría et al., 1998; Markakis et al., 2006); however, RSTP can be an instrument that indirectly reflects the overall clinical status of a patient, and it is logical to conclude that higher RSTP means higher acuity of patients and higher risk of adverse outcome.

5.5.2 Alternative methodology

The study is aimed to compare in-hospital mortality and 30-days survival between two interfacility transfer models. There are many methodologies that can be utilised to compare hospital outcomes and 30-days survival. The methodologies that can be utilised to measure hospital outcomes are retrospective or prospective observational studies and prospective experimental study, such as randomised clinical trials. The common methodology utilised in clinical literature is the retrospective chart review (Leape et al., 1991).

There are many alternative methods to this study; the two research methods presented below are possible alternatives, the decision to utilise retrospective chart review was based on the nature of the research question, available PhD time frame and resources. The two alternative methods are:

- Prospective randomised clinical trial

Randomised clinical trial can be interpreted as powerful evidence in clinical research. It has many advantages, including decreasing the “chance” effect. Randomised trials are known for their superiority in minimising bias and false results compared to retrospective studies (more specifically in building a causation relationship); however, they have disadvantages, one being the cost; usually, randomised clinical trials are expensive and require manpower. Another disadvantage is time; clinical randomisation trials usually take years to be completed.

For this PhD thesis, the applicability of a randomised clinical trial in such setting is difficult. First, to apply such design, it requires two interfacility critical care transfer teams. The first is run by the paramedics and the second is led by the doctors. Doctors usually do not transfer critically-ill patients at KAMC. To apply this method, we would have to create a special team led by an anaesthetist or an intensivist. KAMC is a tertiary medical facility, the work demand on both the anaesthesia and critical care departments is high and both departments have a shortage in staff; the transfer team would require a doctor dedicated to the ambulance department to respond to interfacility calls, which is challenging.

The second challenge would be the compensation to these doctors if we were to ask them to do an extra shift. Extra shifts for a consultant or a senior registrar are expensive and would require a large budget. Finally, a randomised clinical trial would require a long time to recruit enough patients, considering that these patients would have to be followed through their hospital stay and up to 30-days post-hospital discharge. In ten years, KAMC received only 600 patients from other medical facilities (Rishu et al., 2013). To ensure enough patients would be recruited, it would require at least five years.

- Prospective cohort study

The prospective cohort study is another possible method to this PhD. It has many advantages compared to retrospective design, including minimising confounders; nevertheless, it has disadvantages, including the difficulty in monitoring rare occurrence of events (it usually requires a larger sample size), and the time required to recruit enough subjects.

For this PhD, prospective cohort study is difficult due to the time required for recruiting the sample size needed. As mentioned above, to recruit enough patients would require years. Another limitation is the larger sample that is

required to have enough patients to perform statistical analysis. Because prospective cohort design has a limitation in observing rare event occurrence, it requires a very large sample size to produce significant statistical results.

5.6 Limitation

The retrospective design is an important limitation of this study, despite the effort to adjust for confounding factors through multivariate logistic regression, the risk of unmeasured or unidentified confounders is possible. The small sample size is another limitation; the data presented were the sum of four years of critically-ill adult patients' data. To achieve a high statistical power when applying similar inclusion criteria to this study, a sample size of more than 1,000 patients is necessary; to recruit such large number of patients, a single medical centre study might not be the appropriate design. Another limitation is the narrow outcomes measurement. This study only reports in-hospital mortality and 30-days survival, other indicators, such as hospital/ICU length of stay, might provide a better understanding of the question being investigated. A final limitation is the failure to address comorbidity. The study did not measure comorbidity in both groups, and instate it utilized RSTP as a tool to evaluate the acuity of the transferred patients.

5.7 Conclusion

There is no significant difference regarding in-hospital mortality or 30-days survival between the paramedic and physician groups. A further prospective designed comparison study in this area might provide a better understanding of the association of transferring team and hospital outcomes.

6 A pilot study on experts survey of paramedics' interventions in adult critical patients transferred to a tertiary hospital in Saudi Arabia

6.1 Abstract

Objective: To examine the clarity of medical scenarios and the feasibility of the online survey uploaded on an external web host.

Methods: Seven international paramedics were selected to validate the clarity of 53 medical scenarios. Reviewers were a pre-hospital care provider, three paramedics practising in the UK and four paramedics practising in the US. Online links were sent via email. All reviewers were asked to answer the same questions in the experts' survey with an additional question asking them to rate the clarity of the scenario on a 5-point Likert scale (very clear, clear, slightly ambiguous, ambiguous, incomprehensive). Validators were also provided a comment box with no maximum number of characters at the end of the scenarios to illustrate the clarity of the scenario (if needed).

Results: Thirty-seven scenarios (70%) were validated by reviewers. In one scenario (3%), the reviewer skipped the clarity question, but answered all other questions, three scenarios (8%) were rated very clear, 26 scenarios (68%) were rated clear, eight scenarios (22%) were rated slightly ambiguous and no scenarios were rated ambiguous or incomprehensible. There were no written comments.

Conclusion: The completed scenarios were 37/53 (70%). There were no scenarios rated ambiguous or incomprehensible and eight (22%) scenarios were rated slightly ambiguous.

6.2 Introduction

The objective of the pilot study was to examine the clarity of the medical scenarios developed. Seven international pre-hospital care providers were invited to complete the scenarios in an online-based survey.

6.3 Methods

6.3.1 Reviewers selection

There were 53 different medical scenarios written (appendix 13). Seven pre-hospital care providers from the US and the UK were invited to participate in the pilot study. Participants were proposed by the student and supervisors. An email with information, including the research protocol and participant information leaflet (Appendix 11), was sent to all participants. The reviewers were informed that this review is part of a pilot study. The same research protocol designed to the main study was applied in this phase. When a provider agreed to participate, a second email was sent with online links to different medical scenarios. There was no demographic information collected in this phase.

6.3.2 Scenario writing

From a previous research on the incidence of adverse events in adult critical care interfacility transfer in Saudi Arabia (chapter 4), 227 patient records were reviewed, and 53 synopses where safety events were detected were identified. A clinical scenario was written to summarise the case. In each clinical scenario, all clinical data found in the patient's transfer record (run report) were provided, a synopsis of the sending facility report (diagnosis, medications, radiological results, blood tests, interventions done at the sending facility, and the latest vital signs available in the report), and all clinical data from the receiving hospital unit. An example of the medical scenario is given below, and the 53 cases are provided in appendix 13. Reviewers were informed that the time presented in scenarios started from when the

paramedic arrived to deal with the patient. The patient's status in the scenario was assumed to be unchanged unless otherwise stated.

Case example:

Presentation: A 70-year-old male patient, conscious, alert and oriented with stabbing chest pain was to be transported by a ground ambulance from a local hospital to a tertiary hospital. The distance is 32 miles.

Relevant medical history: The patient has a history of diabetes mellitus hypertension and hyperlipidaemia.

Medications: The patient is on insulin, Lipitor (Atorvastain 20mg) and Capoten (Captopril 50mg).

Allergies: No known allergies.

Observations (sending facility report): Conscious, alert and oriented. Vital signs: HR: 49, Pain score: 3/10, RR: 20, SPO2: 96%, BP: 130/60, Glasgow Coma Scale (GCS):15, 12 lead ECG: sinus bradycardia with no ectopic or heart blocks and no ST abnormalities, Temp: 36.8, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm, Glucose: 7.4 mmol/l and chest X-ray (CXR): no significant findings.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion at 80cc/h, Isosorbide nitrate 5mg Sub Lingual (SL) and Aspirin 300mg orally.

Time	Event
00:00	Arriving to examine a 70-year-old male with chest pain.
00:01	Initial physical examination: conscious alert and oriented male patient with mild chest pain started 45 min. ago. Vital signs: HR: 49, Pain score: 3/10, RR: 20, SPO2: 100% on 6L face mask, BP: 130/60, GCS: 15, 12 lead ECG: sinus bradycardia with no ectopic or heart blocks and no ST abnormalities, Temp: 36.8, Capillary refill: <2, Pupils: PEARL at 3mm,

	Glucose: 7.4 mmol/l and chest X-ray (CXR): no significant findings. Patient is transported to EMS monitor, on nasal cannula 3LPM and loading to ambulance. (Bradycardia)
00:05	Patient on cardiac monitor with no changes in patient status en route to main hospital.
00:23	HR: 38, BP: 110/54, RR: 18 and 0.5mg atropine was given by paramedic. Increasing fluid infusion to 120cc/h. (Bradycardia detected and intervention was performed)
00:24	HR: 52, RR: 24.
00:29	BP:119/67 and fluid infusion decreased to 80cc/h.
00:62	HR: 54, RR: 18 BP: 113/60.
00:67	Arriving at main hospital.
00:67	Receiving facility data: Conscious alert and oriented male patient with right AC IV access, fluid infusion of normal saline at 80cc/h. HR:57 with no ectopic or heart blocks and no other abnormalities. Pupils: PEARL, RR: 22, SPO2:100% on nasal cannula 3LPM, Pain score: 4/10, Glucose: 6.2 mmol/l, Temp: 36.5. Patient has received 0.5mg atropine 30 minutes ago. Patient to be transported to resuscitation area.

A list of paramedic competencies framework was available to reviewers and is provided appendix 2.

List of medications approved by the system medical director to be used by paramedics in interfacility transfers:

Activated Charcoal	Dextrose 50%	Glucagon	Naloxone (Narcan)
Adenosine	Diazepam (Valium)	Haloperidol (Haldol)	Nitroglycerin
Adrenaline 1:1000 Adrenaline 1:10000	Diltiazem (Cardizem)	Ipatropium (Atrovent)	Oxygen
Albuterol	Diphenhydramine	Lidocaine	Sodium Bicarbonate
Amiodarone	Dopamine	Magnesium Sulfate	Succinylcholine
Aspirin	Etomidate	Methylprednisolone	Thiamine
Atropine	Fentanyl	Midazolam	Ketamine
Calcium Chloride	Furosemide (Lasix)	Morphine	

The following list is medications NOT approved to be initiated by paramedics, but paramedics are approved to maintain it.

Amrinone	Norepinephrine
Anti-infectives: Anti-biotics/Anti-virals/Anti-fungals/Anthelmintics	Phenytoin
Blood products	Propofol
Dobutamine	Racemic Epinephrine
Heparin	Thrombolytics
Insulin	Vecuronium
Mannitol	Drugs familiar to the paramedic

If a drug is not common or familiar to the paramedic, an on-line medical direction is required.

6.3.3 Questionnaire process

Reviewers were instructed to complete the questionnaire and to rate statements and answer questions (when applicable) using the 6-point Likert scale:

1) Very likely (90%–100%)
2) Likely (70%–89%)
3) More likely than not (50%–69%)
4) Less likely than not (30%–49%)
5) Unlikely (10%–29%)
6) Very unlikely (0%–09%)

Also, reviewers were provided with a space to write their opinion on any statement if they needed to illustrate.

The statements were presented to every scenario using the same order, as follows:

1) Using the Likert scale provided, what are the probabilities that this incident could have been prevented? If the answer on the Likert scale is > 50%, how could this event have been prevented?

2) Using the Likert scale provided, what are the probabilities that an error (by the paramedic) occurred in this specific scenario? If the answer on the Likert scale is > 50%, what was the error?
3) Using the Common Terminology Criteria for Adverse Event (CTCAE) can you rate this specific incident?
4) Using the Likert scale provided, was the paramedic intervention appropriate? If the answer on the Likert scale is > 50%, the survey will end at this point. If the answer is < 50% the survey will continue to Question 5.
5) In your opinion, what would be the optimal management plan for this specific event given the same circumstances? Is the optimal management plan within the paramedic competencies?
6) Can you rate the scenario in terms of its clarity (language)?

For the final question, a 5-point Likert scale with the following order was applied:

- Very clear
- Clear
- Slightly ambiguous
- Ambiguous
- Incomprehensible

6.3.4 Analysis plan

There was an agreement between student and supervisors that any scenario rated “ambiguous” or “incomprehensible” would be rewritten and revalidated. Scenarios rated “very clear” and “clear” would qualify to be included in the experts survey. Scenarios rated “slightly ambiguous” would be discussed with the second supervisor, who is an ER consultant, to review the clinical data, language, and to assure that all clinical information needed for a clinical decision is available and clear.

6.4 Results

Fifty-three scenarios were sent to seven validators. The completed scenarios were 37 (70%). A summary of the pilot study is provided in Table 12.

Table 12 Summary of the survey pilot study

Characteristics	Value
Number of validators	7
Number of scenarios	53
Number of completed scenarios	37 (70%)
Number of scenarios rated “Very clear”	3 (8%)
Number of scenarios rated “Clear”	26 (68%)
Number of scenarios rated “Slightly ambiguous”	8 (22%)
Number of scenarios rated “Ambiguous”	0
Number of scenarios rated “Incomprehensible”	0
Number of scenarios the clarity question was skipped	1 (2%)

6.5 Discussion

The pilot study showed that there were three scenarios rated very clear, 26 rated clear, eight were rated slightly ambiguous and no scenarios were rated ambiguous or incomprehensible. There was one scenario in which the validator skipped the clarity question, a second request was sent to the validator to complete the skipped clarity question.

The eight scenarios rated slightly ambiguous were collected in Microsoft Word file and discussed with the second supervisor. From the eight scenarios, six were patients transferred with endotracheal tube (ETT) and on mechanical ventilation. There was too much clinical information provided in these scenarios. Each patient on ETT and receiving mechanical ventilation was

presented with ETT size and length (pre, during and after the transfer). At the end of transfer, a second method (usually chest X-ray) was presented to confirm tube position.

The ventilator settings (Fio2, PEEP and respiratory rate) were also offered in all transfer stages (pre, during and after transfer). Sedation/paralysis agents and/or vasopressor/inotropes agents and doses (if applicable) were also provided in all transfer stages. This information, in addition to the patient's past medical history, medications, observations, adverse incidents and interventions, were all present in all cases. After reviewing the cases, the possibility that these cases were rated slightly ambiguous might be contributed to the complexity of the medical case rather than the language or the presentation of the case. We concluded that no further changes to the written cases were necessary.

The pilot results suggested that reviewers can skip part of the survey and move forward without answering the question. This weakness will be resolved in the experts' survey to assure complete data collection. The possible solution will be to require an answer to every question presented in the survey, by assuring that survey will not move forward before an answer is collected. This option will be applied with consideration to the logic of the survey.

There were 16 scenarios that validators did not answer in this pilot study. These results suggested that there is a possibility of incomplete surveys in the main study, and solutions should be provided to handle these. A possible solution is to follow up the experts during data collection, and to send a reminder email to participants to assure survey completeness. However, there will be a risk that surveys will continue to be incomplete despite this effort. After a discussion with supervisors and a statistician, the incomplete surveys with completed scenarios will be included in the analysis, and incomplete scenarios will be disregarded. Completed scenarios are defined as scenarios

with all five questions pertaining to the scenario having been answered (each survey has at least 12 scenarios).

The logic and questions presentation appear feasible since validators completed the majority of the scenarios provided to them. There were no written feedback comments on the logic and chronological order of the survey, which supports the fact that the survey logic and questions presentation were likely sufficient.

6.6 Conclusion

The pilot study showed that the majority of questions were clear; slightly ambiguous questions were likely rated ‘unclear’ due to the complexity of the medical case rather than the language or the presentation of the case. The pilot study suggested requiring an answer to questions before moving forward in the survey, and incomplete surveys with completed scenarios will be included in the analysis phase.

7 Experts survey on adverse events preventability, paramedics' errors and proportion of care in which the paramedics' interventions were appropriate in adult critical patients transferred to a tertiary hospital in Saudi Arabia

7.1 Abstract

Objective: To determine the proportion of care in which the paramedics' interventions were appropriate or inappropriate. The study was an audit of the quality of paramedics' care in interfacility critical care transfers.

Methods: Sixteen international experts (eight paramedics and eight doctors) were invited to participate in an expert survey to analyse patients' safety events during interfacility critical care transfers. The study asked experts to answer four questions which branched to further questions depending on reviewer responses, the questions are:

1) What are the probabilities that this event could have been prevented?
2) What are the probabilities that an error during care (by the paramedic) occurred in this specific scenario?
3) Can you rate the event using the Common Terminology Criteria for Adverse Event (CTCAE) rating system?
4) Were the paramedic interventions appropriate?

Results: There were nine local experts (practising in Saudi Arabia), while seven were international (two practising in the UK, four in the US and one in Canada). The safety events rated as preventable were 9/53 (17%), non-preventable were 33/53 (62%) and disagreement was observed in 11/53 (21%) of cases. The paramedics' care rated by experts as appropriate were 46/53 (86.8%), inappropriate 9/53 (17%) and disagreement was observed in 3/53 (5.7%). The paramedics' errors in care judged by experts was observed in 3/53 cases (6%), no error 42/53 (79%) and disagreement was observed in 8/53 (15%).

Conclusion: The paramedics' interventions in interfacility adult critically-ill patients were rated appropriate by the majority of the case reviewers in 86.8% of cases; the difficulty on achieving inter-rater agreement in implicit case review was observed in this study.

7.2 Introduction

Paramedics are the primary pre-hospital (out of hospital) emergency providers in many countries. Recently, an expanded scope of practice has allowed them to be directly involved in interfacility critical care transfers. Patients encountered in interfacility transfers represent a special challenge to paramedics. These patients are usually managed in stable environments (ICU, CCU and ER) under the supervision of interdisciplinary teams (such as Surgery, ICU and Neurology…etc.) with backup in case of deterioration. However, paramedics often lack these options when a critically-ill patient has to be transferred to another facility. Limited resources in the back of an ambulance substantially limit the care options compared to the hospital environment. Patient safety in interfacility transfers is crucial to improve patient outcome. The ability of paramedics to transfer these patients needs to be investigated and assessed to assure that patient safety is maximised.

Patient safety in interfacility transfers is a research priority highlighted by numerous international organisations (Jensen et al., 2013; Droogh et al., 2015). A study analysing incidents in interfacility transfers reported alarming results with 91% of adverse events described as preventable (Flabouris, Runciman and Levings, 2006). Interfacility transfers by paramedics in Saudi Arabia have never been investigated. This research was designed to investigate the ability of paramedics to transfer critically-ill patients in Saudi Arabia. A retrospective cohort study to examine the incidence and types of AEs seen by paramedics in interfacility transfer of critically-ill patients in Saudi Arabia was conducted. The results of our study showed that 31 out of 227

(13.7%) patients transferred by paramedics had at least one in-transit adverse event (see AE definition, Table 12). A further 22 patients (9.6%) had a deterioration in their physiological parameters that did not reach the threshold to be considered an adverse event. All these adverse events and perturbation of physiology (total n=53) were abstracted and translated into medical scenarios. Then, an expert questionnaire was developed to examine opinions on paramedics' interventions in interfacility adult critical care transfers. The idea was to determine the proportion of care in which the paramedics' responses were appropriate or inappropriate. The study was an audit to the quality of paramedics' care in interfacility critical care transfers.

7.3 Methods

Sixteen international experts (eight paramedics and eight doctors) were invited to participate in a semi-structured survey to analyse patients' safety events during interfacility critical care transfers, and to determine whether these events could have been prevented, and, if so, by what means. Experts were also questioned to analyse whether there were any errors by paramedics that were unrelated to the event but nevertheless had happened during patient care. Table 13 shows the definitions of terms utilised in the survey. Ethical approval was granted through the Biomedical and Scientific Research Ethics Sub-Committee at Warwick University.

Table 13 Definitions of terms in experts survey

Term	Definition

Adverse event	"An adverse event is an unfavourable and potentially harmful occurrence during or after the course of patient care. Adverse events are due to circumstances that may or may not be preventable. A significant adverse event is an occurrence that results in serious, undesirable, or unexpected patient outcome that has the potential to negatively impact the patient's health and quality of life. Examples include death, loss of function, or change in patient condition due to equipment malfunction or administration of an inappropriate drug or drug dose. Administration of any inappropriate drug or drug dose is considered a significant adverse event." (MacDonald et al., 2008)
Medical error	"A medical error occurs when a health-care provider chooses an inappropriate method of care or improperly executes an appropriate method of care. Medical errors are often described as human errors in healthcare". (Zhang, Patel and Johnson, 2008)
Common Terminology Criteria for Adverse Event (CTCAE)	The CTCAE is a widely accepted adverse event severity score system utilised in oncological clinical trials developed by the United States National Cancer Institute (NCI) (NCI, 2010). The system is based on five grades to evaluate the severity of each adverse event. For this specific research, only the general guideline will be utilised. A modified version of the five grades system will be utilised in this research, the modification of the scale excluded non-transport related terms.
Appropriate paramedic intervention	"The condition where the expected health benefit (i.e. increased life expectancy, relief of pain, reduction in anxiety, improved functional capacity) exceeds the expected negative consequences (i.e. mortality, morbidity, anxiety of anticipating the procedure, pain produced by the procedure, misleading or false diagnosis, time lost from work) by a sufficiently wide margin that the procedure was worth performing". (Khan, et al. 1998)

7.3.1 Criteria for Selection of Experts

- Paramedics:
    - Are currently licensed to practise in their country

    - Have at least five years of experience in interfacility transfers
- ICU and Anaesthesia consultants:
    - Are currently licensed to practise in their country
    - Have at least five years of experience in interfacility transfers
    - Hold a position of a consultant (a senior doctor with a completed specialty programme)
- Emergency medicine consultants:
    - Are currently licensed to practise in their country
    - Have at least five years of experience in pre-hospital care
    - Hold a position of a consultant

7.3.2 Case presentation

A clinical scenario was written to summarise the case. In each clinical scenario, all clinical data found in the patient's transfer record (run report) were provided, a synopsis of the sending facility report (diagnosis, medications, radiological results, blood tests, interventions done at the sending facility, and the latest vital signs available in the report), and all clinical data from the receiving hospital unit. An example of the medical scenario is given in appendix 13. Reviewers were informed that the time presented in scenarios started from when the paramedic arrived to deal with the patient. The patient's status in the scenario was assumed to be unchanged unless otherwise stated. A list of paramedic competencies framework was available to experts and is provided in appendix 2.

List of medications approved by the system medical director to be used by paramedics in interfacility transfers:

Activated Charcoal	Dextrose 50%	Glucagon	Naloxone (Narcan)
Adenosine	Diazepam (Valium)	Haloperidol (Haldol)	Nitroglycerin
Adrenaline 1:1000 Adrenaline 1:10000	Diltiazem (Cardizem)	Ipatropium (Atrovent)	Oxygen
Albuterol	Diphenhydramine	Lidocaine	Sodium Bicarbonate
Amiodarone	Dopamine	Magnesium Sulfate	Succinylcholine
Aspirin	Etomidate	Methylprednisolone	Thiamine
Atropine	Fentanyl	Midazolam	Ketamine
Calcium Chloride	Furosemide (Lasix)	Morphine	

The following list is medications NOT approved to be used by paramedics, but paramedics are approved to maintain it.

Amrinone	Norepinephrine
Anti-infectives: Anti-biotics/Anti-virals/Anti-fungals/Anthelmintics	Phenytoin
Blood products	Propofol
Dobutamine	Racemic Epinephrine
Heparin	Thrombolytics
Insulin	Vecuronium
Mannitol	Drugs familiar to the paramedic

If a drug is not common or familiar to the paramedic, an on-line medical direction is required.

7.3.3 Scenarios validation

A pilot study to analyse the clarity and language of medical scenarios was conducted prior to this survey. In the pilot study, 53 scenarios were sent to seven reviewers, and a question to the survey to rate the clarity of each scenario on a 5-point Likert scale (very clear, clear, slightly ambiguous, ambiguous, incomprehensive) was added. The pilot results showed that eight

scenarios were rated “slightly ambiguous” and no scenarios were rated ambiguous or incomprehensive. The eight scenarios were reviewed by the research team.

7.3.4 Expert questionnaire

Experts participating had the option of filling in a paper questionnaire or an online questionnaire. All experts opted for an online survey, which was conducted using an external web host (SurveyMonkey®).

7.3.5 Questionnaire process

Experts were instructed to complete the questionnaire, to rate statements and answer questions (when applicable) using a 6-point Likert scale:

1) Very likely (90%–100%)
2) Likely (70%–89%)
3) More likely than not (50%–69%)
4) Less likely than not (30%–49%)
5) Unlikely (10%–29%)
6) Very unlikely (0%–9%)

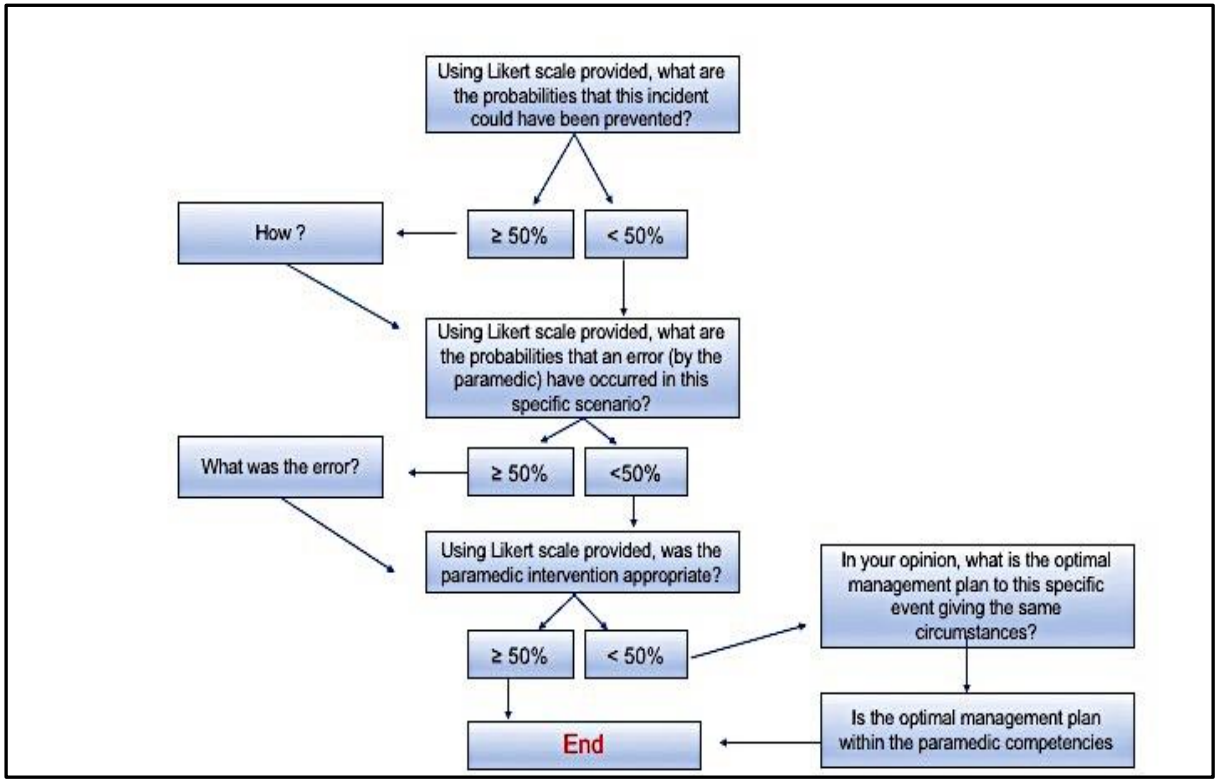
Experts were asked to answer four questions, which branched to further questions depending on reviewer responses. Figure 3 illustrates the logic utilised in the survey, and below are the four questions:

- What are the probabilities that this event could have been prevented? If (≥ 50%), how?

- What are the probabilities that an error (by the paramedic) occurred in this specific scenario? If (≥ 50%), what was the error?
- Can you rate the event using the CTCAE rating system?

- Were the paramedic interventions appropriate? If (<50%), what is the appropriate care for this patient? Is the appropriate care within the paramedics' competencies as presented in this research?

Figure 3 Survey logic and questions branching for each safety event

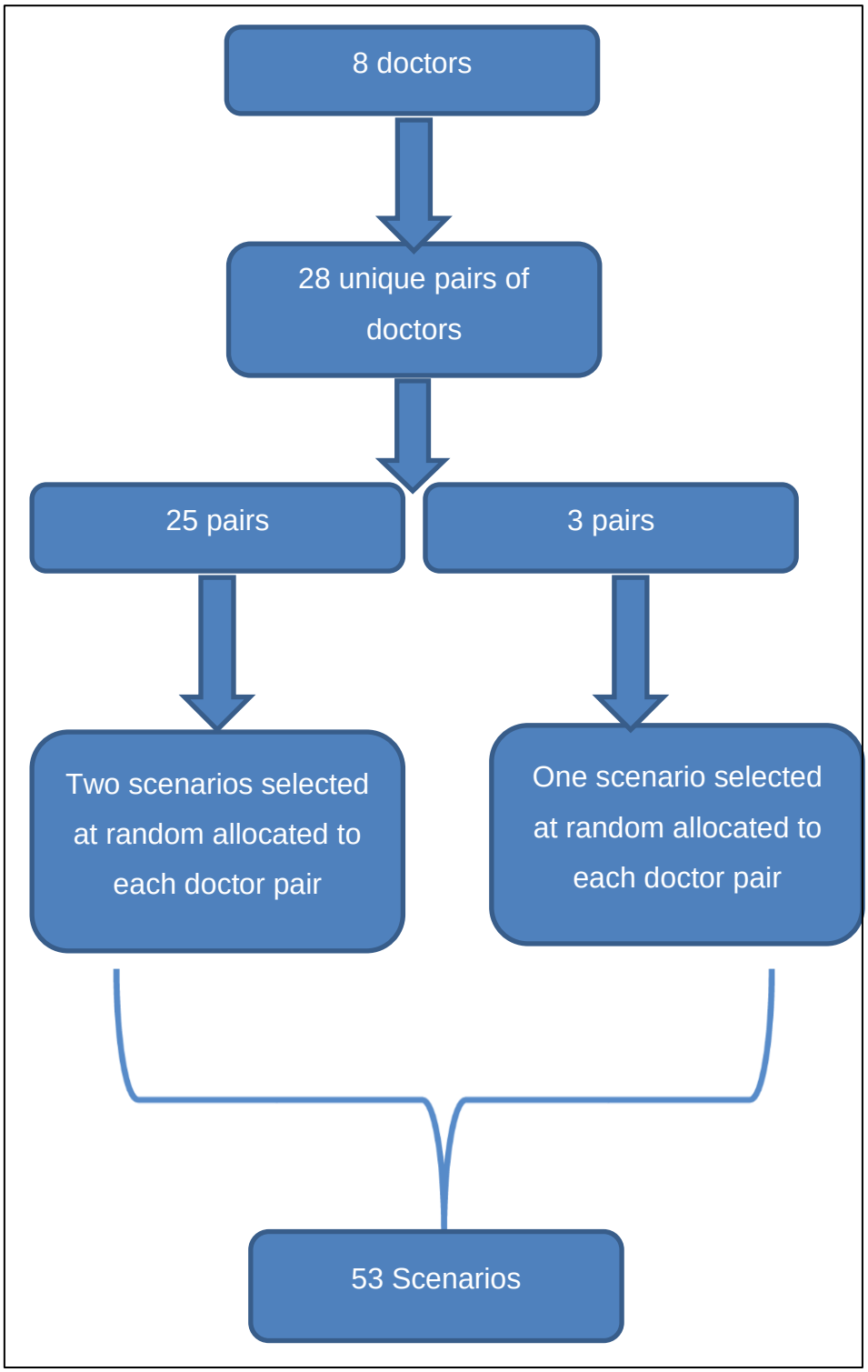


7.3.6 Randomisation of scenarios

It was expected that each scenario would be completed in 10 minutes. Because of the length of scenarios and the limitation of experts' availability, it was not possible for each scenario to be reviewed by all sixteen experts. The study was initially designed so that each scenario would be reviewed by two doctors and two paramedics.

From the eight participating doctors, 28 unique pairs of doctors were generated. Once a scenario had been allocated, it could not be drawn again by the same pair. Each of the first 25 pairs was randomly allocated two scenarios to review (out of a total of 53). The remaining three pairs of doctors were randomly allocated just one scenario of the 53 scenarios to review. Similar allocation was done for the paramedics. Random allocation continued until each scenario had been allocated to four experts. Illustration of the randomisation technique is provided in Figure 4.

Figure 4 Scenarios randomization technique



7.3.7 Statistical analysis

Responses on each 6-point Likert scale presented above were dichotomous into positive (if the probability was 50% or more) or negative (if the probability was less than 50%) for the statistical analysis. The results reported in favour of an outcome (whether an event was preventable, whether an error occurred during paramedic care and whether appropriate action was taken) when there was full agreement (2/2, 3/3 or 4/4) or when a majority of experts reviewing the case agreed (2/3 or 3/4). For each outcome, a random effects (RE) logistic regression model was fitted to estimate the probability of the outcome and the associated 95% confidence interval (CI).

The models were adjusted for an expert reviewing multiple cases and for a case being reviewed multiple times by including two random effects for expert and case. The models were not adjusted for any other variable and, so, the intercept estimates from the models were used to compute probabilities of outcomes. Inter-rater reliability was assessed using the Intra-class Correlation Coefficient (ICC) for outcomes from the same case. The ICCs were calculated using the latent formulation. The formula for ICC using this formulation is

$$\frac{RE \text{ estimate for case}}{RE \text{ estimate for case} + RE \text{ estimate for expert} + \pi/3}$$

For the qualitative analysis, the responses to the open-ended questions were collected, and themes and sub-themes were developed based on the care suggested by experts.

7.4 Results

The study sample consisted of 16 experts (eight paramedics and eight doctors). There were nine local experts (practising in Saudi Arabia), while seven were international (two practising in the UK, four in the US and one in Canada). One expert withdrew from the study and three experts returned

incomplete surveys. Scenarios evaluated by the experts in the incomplete surveys were included. There were 12 out of 16 surveys returned complete (all scenarios completed). The experts' characteristics are shown in Table 14. Each scenario was reviewed by at least two experts. The mean number of experts per scenario was three (scenarios reviewed by two experts= 13 scenarios, three experts =30 and four experts= 10 scenarios), a detailed description of experts' responses is shown in Appendix 9. The total number of experts' responses was 156. Experts rated each event's severity with CTCAE, and the mean CTCAE was 3.

Table 14 Experts characteristics

Characteristics	n (15)	Percentage
Profession		
Doctor	7	47%
Paramedic	8	53%
Country		
Saudi Arabia	9	60%
United States	4	27%
Canada	1	7%
United Kingdom	1	5%
Age		
30-44	11	73%
45-49	3	20%
>49	1	7%
Specialty		
Intensive Care	3	20%
Emergency Medicine/ Emergency Medical Services	4	27%
Critical care paramedic	8	53%
Interfacility transfers per month		
>10	12	80%
5-9	1	7%
1-5	2	13%
Experts per scenario		
2	13	24%
3	30	57%
4	10	19%

Event Preventability:

The events rated as preventable were 9/53 (17%), non-preventable were 33/53 (62%) and disagreement was observed in 11/53 (21%) of cases. Using the random effects logistic regression, the adjusted probability of any event to be preventable was 27.4% (95% CI 18.0%-39.9%). A complete analysis of experts' responses on event preventability is provided in Table 15.

Intervention appropriateness:

The paramedics' care rated by experts as appropriate were 46/53 (86.8%), inappropriate 9/53 (17%) and disagreement was observed in 3/53 (5.7%). Using the random effects logistic regression, the probability of an intervention to be appropriate was 84.9% (95% CI 73.9%-91.8%). Table 15 shows experts' responses on intervention appropriateness.

Errors in paramedics' care:

The paramedics' errors in care as judged by experts was observed in 3/53 cases (6%), no error 42/53 (79%) and disagreement was observed in 8/53 (15%) (see Table 15). Using the random effects logistic regression, the probability of an error during paramedics' care was 16.6% (95% CI 8.7%-29.4%).

Agreement:

The percentage of agreement on event preventability was 67.1% (95 CI 51.5%-80.0%), ICC= 0.02. The percentage of agreement on intervention appropriateness was 83.4% (95 CI 67.3%-92.1%), ICC= 0.10, and the percentage of agreement on paramedics' errors was 86.7% (95 CI 49.0%-98.0%), ICC= 0.08.

Content analysis:

There were 156 responses to 53 scenarios. Multiple themes and sub-themes were developed; an event could have been prevented by one of the following: pre-transfer stabilisation, terminating transfer due to the patient's unstable condition and better management during transfer. Errors by the paramedics during transfer were failure to address a problem during physical examination, inappropriate ventilator setting during transfer, inadequate sedation, medication/procedure error, and late intervention. A complete analysis of responses is provided in Table 16.

Table 15 Summary of experts' responses

Variable (n=53)	n (%) of cases
Preventable	
Complete agreement event was preventable (2/2,3/3 or 4/4)	1 (2%)
Majority of experts agree it was preventable (2/3, 3/4)	8 (15%)
Complete agreement event was NOT preventable (2/2,3/3 or 4/4)	24 (45%)
Majority of experts agree it was NOT preventable (2/3, 3/4)	9 (17%)
Complete disagreement (2/2,3/3 or 4/4)	11 (21%)
Appropriateness	
Complete agreement intervention was appropriate (2/2,3/3 or 4/4)	31 (58%)
Majority of experts agree it was appropriate (2/3, 3/4)	15 (28%)
Complete agreement intervention was NOT appropriate (2/2,3/3 or 4/4)	1 (2%)
Majority of experts agree it was NOT appropriate (2/3, 3/4)	2 (4%)
Complete disagreement (2/2,3/3 or 4/4)	4 (8%)
Error	
Complete agreement error occurred during care (2/2,3/3 or 4/4)	1 (2%)
Majority of experts agree error occurred during care (2/3, 3/4)	2 (4%)
Complete agreement error did NOT occur during care (2/2,3/3 or 4/4)	29 (55%)
Majority of experts agree error did NOT occur during care (2/3, 3/4)	13 (24%)
Complete disagreement (2/2,3/3 or 4/4)	8 (15%)

Table 16 Content analysis of experts responses

Variable (n=156)	n (%)
Preventable (n=44)	
By pre-transfer stabilisation	29 (65.9%)
Patient unstable for transfer	6 (13.6%)
Management during transfer	9 (20.5%)
Error (n=30)	
Failure to address a problem	10 (33.3%)
Inappropriate ventilator settings	4 (13.3%)
Inadequate sedation	3 (10%)
Medication/procedure error	7 (23.3%)
Late intervention	6 (20%)
Intervention appropriateness (n=156)	
Appropriate	129 (82.7%)
Inappropriate	27 (17.3%)
Is appropriate intervention within paramedics competencies (n=27)?	
Yes	26 (96.3%)
No	1 (3.7%)

7.5 Discussion

7.5.1 Alternative methodology

Incidence of AEs as an indicator of patients' safety is insufficient to evaluate patients' safety. To determine patients' safety, root cause analysis of AEs is one of the most powerful tools in health care systems (Longo et al., 2005; Chen, Chen and Su, 2010).

This study is developed to explore the root causes of AEs and to measure the proportion of appropriate paramedics' interventions. This study was designed using implicit case note review. Implicit case note review has many advantages, such as it can measure the quality of care, does not require prior assumptions of individual cases and is quick (Hutchinson et al., 2010). On the other hand, implicit chart review also has many disadvantages. One of the disadvantages of such design is the human low reliability (Hayward and Hofer, 2001; Lilford et al., 2007). Another disadvantage is the subjectivity of results, as experts are measuring the care based on their own experience and knowledge (Preston and Colman, 2000).

An alternative method to implicit chart review is explicit chart review. Explicit chart review has many advantages, one being the objectivity of the method in analysing AEs and errors, as these elements are predetermined. Another advantage is that explicit study can minimise inter-observer variance. On the other hand, explicit study also has disadvantages, one such being the limited scope of measurement as this method is limited to a predetermined list.

In this study, I decided to use the implicit chart review design. The rationale behind my selection is that implicit review study will produce qualitative data that will help in analysing paramedics' safety. In addition, implicit review will suggest areas of weaknesses in interfacility transfers by paramedics which can improve the existing model.

7.5.2 Study discussion

The study utilised semi-structured survey. The structured questions were asked on a 6-point Likert scale. The rationale of using a 6-point Likert scale was to ensure that experts will choose either a positive or negative side. The survey was designed initially to evaluate the safety of paramedics' interventions and to analyse the causes of events in such transfers; as such, 'neutral' position will not be effective in such cases. In terms of the reliability and validity of a 6-point scale versus other Likert scale points, evidence suggests that there is no difference (Preston and Colman, 2000; Krosnick and Presser, 2010). To verify that experts understood the options on the Likert scale and to avoid misinterpreting the scale wording, a continuous scale (percentage) was also provided. Both Likert scale and continuous scale have almost equal results when compared to each other (Manaseki-Holland et al., 2016).

The results showed that the probability of any event to be preventable was 27.4%, the probability that error occurred during paramedics' care was 16.9%, and the probability of appropriate medical intervention by paramedics in interfacility transfer was 84.9%,

Preventable events, including death, and errors are essential indicators to patient safety and this study suggested that 9/53 (17%) of events were preventable according to the majority of experts reviewing the case. Furthermore, errors during paramedics care were observed in 3/53 cases (6%). The full disagreement between experts in evaluating preventability and errors was high, 11/53 (21%) of cases and 8/53 (15%) of cases, respectively. The high number of cases that had full disagreement might be contributed to the complexity of the medical cases. These patients were critically-ill patients and the mean age was 53, which suggest a comorbidity that might further complicate the cases. Another possible explanation to the disagreement is the

difficulty to achieve agreement in implicit chart review studies (Hayward, McMahon Jr. and Bernard, 1993; Hayward and Hofer, 2001)

Comparing rates of errors and preventable events with other studies might be challenging (Garrouste-Orgeas, 2012), especially when there is a significant heterogeneity in the settings, personnel and resources. The rate of preventability (17%) is comparable to studies done in ICU (Forster et al. 2008; Vlayen, 2017), and significantly lower than a previous study on interfacility transfer (Flabouris, Runciman and Levings, 2006). Paramedics' errors during care as judged by majority of expert was observed in 3/53 (6%) of the cases, the rate of error is lower than studies reported in ICU (Giraud et al., 1993; Bracco, Favre and Bissonnette, 2001; Garrouste-Orgeas, 2010). However, the study sample size is quite small (53 cases), which can directly impact the low rate of errors. Another explanation to the low rate of errors is the retrospective design of data. The possibility of undocumented errors exists.

This is the first study to my knowledge that has calculated the appropriateness of paramedics' interventions in interfacility transfer. An appropriate intervention judged by the majority of experts reviewing the case was observed in 46/53 cases (86.8%), inappropriate intervention was observed in 3/53 (5.7%) and there were 4/53 (7.5%) cases that had absolute disagreement between experts. Experts in one of the three cases where the majority of experts judged an inappropriate intervention, suggested appropriate (optimal care) that was not within paramedics' competencies (the suggested optimal care was to transfuse blood products). It is noticeable that most of the paramedics' interventions were judged appropriate by the majority of the case reviewers; there were no similar studies to compare.

Experts' qualitative responses were collected and multiple themes and sub-themes were developed. Experts suggested that events could have been prevented by one of the following: (1) pre-transfer stabilisation, which further

sub-categorises to correcting pre-transfer hypotension, appropriate ventilator setting, providing adequate sedation and a better physical examination prior to transfer; (2) patient was unstable to be transferred, which further sub-categorises to one of the following: patient was dead or patient's vital signs (blood pressure and oxygen saturation) were critically low and transfer should have been cancelled; (3) management during transfer, which sub-categorises to one of the following: inappropriate sedative agent or low dose sedation, late intervention (late fluid or drug administration), failure to initiate Non-Invasive Positive Pressure ventilation (NIPPV) or failure in Rapid Sequence Intubating (RSI) the patient. The paramedics' education areas identified in this survey that need to be emphasised in interfacility critical care transfers were physical examination, a more aggressive approach in administering sedative and vasopressor agents, comprehensive education on utilising sophisticated transport ventilators and training in NIPPV and RSI.

The study reported percentages of agreement with 95% CI. It was initially planned to have four independent reviewers per case, as use of this many reviewers would mitigate the human low reliability of implicit case note review (Lilford et al., 2007; Forster et al., 2008). The study had withdrawn and incomplete surveys, cases were reviewed by an average of three independent reviewers. The duplication of experts reviewing some, but not all cases, was an obstacle to calculate inter-rater agreement and in order to solve such problem a random effect logistic regression model accounting for cases and experts was developed. Percentage of agreement among experts on event preventability was 67.1%, paramedics intervention appropriateness was 83.4% and error during paramedics' care 86.7%. Many authors have warned that percentage might not be appropriate to estimate inter-rater reliability (Hallgren, 2012), so ICC to measure inter-rater agreement was calculated. The study was initially conducted to evaluate the appropriateness of paramedics' interventions in interfacility critical care transfers and the ICC on appropriateness of paramedics' interventions was 0.10.

Although ICC of 0.10 suggested a poor agreement between experts, it was expected to have a difficulty in achieving agreement in such design. In fact, the research question of evaluating a specific care provided to patients has shown to have a low rate of agreement (Vlayen, 2017). A secondary sub-analysis to explore the ICC showed that agreement between doctors when reviewing a case was high, ICC=0.42, while paramedics had a significant disagreement between each other, ICC= <0.00. With attention to the small sample size, the sub-analysis difference between doctors and paramedics can be contributed to the difference in training between these healthcare providers and a future exploratory research in this area is recommended.

7.6 Conclusion

In conclusion, the paramedics interventions in interfacility adult critically-ill patients were rated appropriate by the majority of the case reviewers in 86.8% of cases, the probability of an intervention to be appropriate was 84.9%, the rate of error in care was lower than reported literature and the rate of preventable events was similar to hospital setting. The difficulty on achieving inter-rater agreement in implicit case review was observed in this study.

8 Discussion and summary of the research

8.1 Overview of the PhD results

The aim of this dissertation was to investigate safety issues regarding paramedics' involvement in adult interfacility critical care transfers. The objectives included undertaking a systematic literature review on the safety and AE in adult critical interfacility transfers by paramedics, a retrospective chart review exploring the incidence of AE in the Saudi paramedic model under investigation, a retrospective chart review to analyse the characteristics of AE including identifying any predictors of AE in interfacility transfers, a comparison of in-hospital mortality and 30-days survival between the paramedic model and the physician model of transferring critically-ill patients to the same setting, and a semi-structured experts survey to examine consensus on all causes of AE and paramedics' interventions safety in interfacility transfers.

The literature review demonstrated that the frequency of AEs in the paramedic model in interfacility critical care transfers ranges between 5.1% to 18%. The results suggest that the paramedic model in adult interfacility critical care transfers in Saudi Arabia has a similar incidence of AE compared to reported literature. The incidence of adverse events in the Saudi interfacility critical care transfer system was 13.7%.

In terms of patient outcomes, this thesis compared in-hospital mortality and 30-days survival between the paramedic model and the physician model, which is considered the "standard model" in multiple interfacility transfer systems. The in-hospital mortality was 31.7% (72 patients) in the physician group and 30.4% (69 patients) in the paramedic group, respectively. A chi-square test of in-hospital mortality was p=0.76. A chi- square test of 30-days survival was p= 0.49. There were no missing data that affected in-hospital mortality; however, in data relating to 30-days survival, there were three

missing pieces of data (two in the physician group and one in the paramedic group.

Most of the safety events in the paramedic model were not preventable (62%) and most paramedics' interventions were appropriate (87%). The probability of any event to be preventable was 27% and the probability that paramedics' intervention is appropriate was 85%.

8.1.1 Definitions

There were many definitions needed in this thesis. The main two definitions essential to this thesis were AEs and critically-ill patients. The first step was to conduct a literature review to find definitions. There were many concerns found in the literature.

- **Adverse events:**

The definition of AE is crucial in analysing published results. No international consensus on the definition of AE was found. Some definitions are based on patient harm alone, whereas others include diminishment in physiology, which does not always lead to patient harm. Many definitions are based on a hospital settings environment, but the logistics challenges and the process of hospital is totally different to the challenges found in the transfer settings. MacDonald, Banks and Morrison, (2008) defined AE in an air medical transport system. Their definition was utilised later in their ground interfacility transfer work. The definition included events that can occur after the transfer process. This inclusion of after the transfer events is a vital component to any future attempt to define AE, because paramedics perform procedures and administer medications that might have a delayed effect on patients. Another limitation found in the literatures was the lack of a standardised method of detecting AE. Much of the published literature relies on reviewers who are either the programme medical director or personnel working within the transferring agency. Others have utilised a predetermined list of AEs, such as the work done by Dewhurst et al. (2001) who relied on the Royal College of

Anaesthetists list of critical incidents. The list covers both physiological and logistical events that may occur during the transfer, and has clear definitions of the clinical events, such as hypoxia and hypotension.

Literature shows that there are two methods of detecting AEs. Explicit by a predetermined list of AEs and implicit using reviewers. The selected method of detecting AEs has a major impact on the frequency of reported AEs. For example, the explicit method using a predetermined list of events may increase the number of events reported and it can minimise the inter-observer variance and under-reporting in interfacility critical care transfer research, but it has a disadvantage of the limited types of events included in the predetermined list. On the other hand, the implicit method can be more producible in terms of AEs types, but it has a disadvantage of the low human reliability in such method.

In this PhD thesis, I decided to use the explicit predetermined list of AEs, adopted from the Royal College of Anaesthetists list of critical incidents and utilised previously by Dewhurst et al. (2001) with a modification to the list terms to suit the Saudi ground interfacility transfer system.

- **Critically-ill patient:**

The second definition was the critically-ill patient, and an essential part of conducting a successful research project was defining who is a critically-ill patient? Critically-ill patient is a complex term that requires a clear definition to classify these vulnerable patients. The acuity of the patient's symptoms will not be sufficient to define him/her as a critically-ill patient. The systematic literature review was a good resource to define the critically-ill patients. From the literature, one study had either a medical supervisor or the programme medical director reviewing the transfer request prior to the transfer, to determine which are critically-ill patients. Such an approach is difficult and impractical in most clinical settings, because it would require a medical doctor to be present 24 hours a day, 365 days a year, which would be both expensive and time-consuming. Others suggested critically-ill patients to be those who

are intubated and require mechanical ventilation, and there are no doubts that such patients are critically-ill patients. However, there are other patients who do not require mechanical ventilation, but, even so, are still critically-ill. Such cases would include patients with myocardial Infarction (MI) as well as status asthmatics patients, who might require an urgent advanced airway management or a lifesaving intervention at any time.

Etxebarría et al. (1998) developed a risk score system called Risk Score for Transported Patients (RSTP) that, according to them, was “widely utilized in Spain”, and was revalidated by Markakis et al. (2006) in a Greek interfacility transfer system with acceptable discrimination power and adequate goodness of fit. The risk score was initially developed to categorise patients that need a medical doctor escort. Patients scoring more than six out of 22 are defined as “high risk” patients and require a doctor escort. The score system analyses the patient’s clinical condition, including the latest vital signs, the necessity of special transfer equipment and the level of the patient’s monitoring required during the transfer.

In this PhD thesis, I decided to utilise the RSTP as a triage tool to identify critically-ill patients.

The main difficulty of utilising definitions found in the literature was the question of applicability of such definitions to the local interfacility transfer system. To overcome such difficulty, this PhD thesis tried to utilise definitions that were developed in similar settings, or at least have been utilised in more than one interfacility transfer system.

In conclusion, there is no international consensus on the definition of AE or critically-ill patients; the two methods of detecting AEs found were explicit by a predetermined list and implicit by utilising reviewers.

8.1.2 Factors associated with increased risk of in-transit adverse events and in-hospital mortality

This PhD thesis examined whether there are any factors associated with increased risk of developing in-transit AE in interfacility critical care transfers. The study utilised a multiple logistic regression model to examine the association of multiple factors with AE. The factors examined were: age, sex, patient category (medical, trauma or cardiac), RSTP, length of transfer, the presence of central IV, and the presence of mechanical ventilation. The results of the logistic regression model with R^2=0.28 showed that only increased RSTP score was associated with an increased risk of developing AE during transfer. A unit increase in RSTP was associated with an increased chance of in-transit AE (adjusted OR 1.36, 95% CI 1.07-1.72 and adjusted p=0.01).

The second analysis was factors associated with increased risk of in-hospital mortality. The multiple logistic regression utilised in predicting in-hospital mortality examined the following predictors: age, sex, patient category (medical, trauma or cardiac), RSTP, length of transfer, the presence of mechanical ventilation, and the occurrence of in–transit AE. The results of the model with R^2= 0.42 showed that RSTP and increased age were associated with increased chance of in-hospital mortality. The increased risk per year of age was 1.03 (adjusted) (95% CI 1.01-1.05 and p<0.01). It can be expected that increased age will increase the risk of in-hospital mortality because of increasing comorbidity and the decline in human biology with ageing. RSTP also significantly increased the occurrence of in-hospital mortality; a unit increase in RSTP was associated with increased risk of in-hospital mortality (adjusted OR 1.30, 95% CI 1.06-1.60 and p=0.01).

One of the most important findings of this research was the applicability and effectiveness of utilising RSTP as a triage tool in interfacility transfers. The increment in RSTP was associated with an increased occurrence of in-transit AE and in-hospital mortality; however, the applicability of utilising RSTP as a mortality prediction tool is difficult, because only patients with RSTP > 6 were included, while less acute patients (RSTP < 6) were not included as a control

in this research. The cut-off point of RSTP with more than 6 as a predictor of increased risk of AE was established from previous studies on RSTP (Etxebarría et al., 1998; Markakis et al., 2006); nevertheless, it was designed to predict AE and it cannot be generalised to in-hospital mortality. The RSTP is an important triage tool that can be implemented in interfacility critical care transfers. It can assist in determining the risk of in-transit AE and assist with resources allocation.

In conclusion, the increased risk of in-hospital mortality and the occurrence of in-transit AE with increased RSTP is interpreted as a strength of RSTP as a triage tool to the patient's acuity status in interfacility transfers. There is a suggestion on the future possibility of RSTP as a promising tool in predicting in-hospital mortality, but it needs further research.

8.1.3 Incidence of AEs in Saudi interfacility critical care transfers by paramedics

The rate of in-transit AEs in the Saudi interfacility critical care transfers was 13.7% (31 patients had an in-transit adverse event). The most common AEs were desaturation, 4.4% (10 patients) and hypotension, 3.1% (seven patients). Four patients (1.8%) had an in-transit cardiac arrest. The AEs rate is consistent with a similar study done in the United States of America (Domeier, Hill and Simpson, 1996), but higher than the AEs rate reported in Ontario, Canada (6.5%) (Singh, MacDonald and Ahghari, 2014). The small percentage of traumatic patients transferred by paramedics prevents the possibility of drawing a firm conclusion regarding the development of an AE in this group of patients. Cardiac patients were the majority of the transported patients in this study and they were less likely to have in-transit AE. The low rate of AEs (6.5%) reported from Canada by Singh, MacDonald and Ahghari, (2014) could be attributed to the different population in the Canadian study. Also, my study included more AEs compared to the predetermined list of AEs from the study above which only included new in-transit haemodynamic

instability, new in-transit respiratory instability, in-transit death or in-transit major resuscitative procedure.

This thesis added to the literature on the Saudi interfacility incidence of AEs. It showed that desaturation events are the most common AEs in the Saudi interfacility critical care transfers. There was no association of increased risk of AE with the presence of mechanical ventilation. However, a further analysis on the ability of paramedics to manage patients on mechanical ventilation is recommended. The second common AEs was hypotension. Haemodynamic instability is well documented as a common AE seen in interfacility critical care transfers (Chapter 2). Certainly, the Saudi interfacility critical care transfer by paramedics shares similar characteristics of AEs compared to published literature.

The precision of the incidence of AEs in this study is threatened by the limitation of the retrospective design of the study. The risk of unmeasured confounding variables is possible. Despite the effort in obtaining data from several sources (sending hospital reports, paramedics' patient care reports and receiving hospital records) the risk of undocumented events and the question of accuracy in providers' documentation still exist in this study.

Acceptable rate of AE is a complicated term. Comparing AE across studies is difficult due to the difference in both definitions and method of detecting AE (Garrouste-Orgeas, 2012). For example, a hypotension is defined in one study as a systolic blood pressure of < 90 mmHg while another study defines hypotension as a systolic blood pressure of < 80 mmHg. This difference in definitions creates a variance in the frequency of AE reported. Another important factor is the difference in patients' population and comorbidity. An alternative approach to determine the acceptable rate of AE is whether these AE could have been prevented? As stated above many factors directly impact the rate of AE and to determine "acceptable" rate of AE, it is crucial to distinguish these factors. In conclusion, literature has shown that the maximum reported rate of AE is 18% and rates above 18% might be alarming.

The important questions that need to be addressed in future studies of AEs are whether these AEs were preventable? Were providers capable of managing AEs appropriately?

8.1.4 Patient outcomes in interfacility critical care transfers

There is no evidence that a specialised transfer team can improve patient outcomes in adult interfacility critical care transfers. Belway et al. (2006) revealed that favourable hospital outcomes do not correlate with specialised transporting teams. This study examined patient outcomes requiring interfacility transfers to a higher medical centre. There were two different groups of patients, patients transferred by paramedics (paramedic group) and patients transferred by a medical doctor who usually was an intensivist or an anaesthetist (physician group). In this study, 454 patients were included (227 patients in each group). The in-hospital mortality was 31.7% (72 patients) in the physician group and 30.4% (69 patients) in the paramedic group, respectively. A chi-square test of in-hospital mortality was p=0.76. From the 155 patients survived to hospital discharge in the physician group, five died within 30 days compared to 158 who survived in the paramedic group and three died within 30 days. A chi- square test of 30-days survival was p= 0.49. There were no missing data which affected in-hospital mortality; however, in 30-days survival data, there were three missing pieces of data (two in the physician group and one in the paramedic group). Multiple logistic regression analysis showed that patients with in-hospital mortality had a higher age (adjusted OR 1.03, 95% CI 1.01-1.04 and adjusted p=<0.01) and a higher RSTP (adjusted OR 1.77, 95% CI 1.56-1.97 and adjusted p=<0.01). In addition, the logistic regression showed that transfer provider (doctors vs. paramedics) was not associated with increased in-hospital mortality (adjusted OR 0.73, 95% CI 0.41-1.30 and adjusted p=0.29).

From this study's results, there was no statistical difference between the paramedic and physician groups in terms of in-hospital mortality, p=0.76. The small number of patients who died within 30 days of hospital discharge (eight

patients) could not be considered suitable for logistic regression since the results will be imprecise.

The paramedic model might be comparable to the physician model in regard to patient outcomes. However, there are many limitations to this study. First, the characteristics of patients transferred by physicians vs. those transferred by paramedics in terms of age and sex were similar, but there was a heterogeneity in the patients' diagnoses (trauma, cardiac or medical). An explanation of the heterogeneity in patients' conditions between these two models could be contributed to the fact that paramedics are the primary pre-hospital care providers in Saudi Arabia and they are more likely to transfer critically-ill patients from the local ER compared to doctors. The majority of the cardiac patients transferred by the paramedics were adult patients with acute onset of chest pain or ST-Elevation Myocardial Infarction (STEMI), while physicians transferred more medical patients, and their cardiac patients were those with chronic cardiac complaints, such as cardiac valvular disease or cardiomyopathy. Second, the retrospective design of the study imposes a risk of confounders in terms of comorbidity and the degree of acuity in patients' conditions. The suggestion of conducting a prospective study could overcome this limitation and I do recommend it. Another limitation is the risk of selection bias. The study did not match patients' characteristics or perform randomisation, which suggests that this result might be biased. Finally, the study was underpowered and the risk of type II error is a major threat to the precision of results. The sample size required to obtain a significant power in such studies is enormous and a single medical centre design might be inappropriate. To produce a statistically significant study, I suggest a multicentre large prospective cohort study.

8.1.5 AEs preventability, paramedics' errors and proportion of care in which the paramedics' interventions were appropriate in interfacility critical care transfers

One of the main contributions of this PhD thesis is the in-depth analysis of AEs in interfacility critical care transfers by paramedics. To the best of my knowledge, and from the literature review (Chapter 2), this PhD study is the first in-depth analysis of paramedics' AEs in interfacility transfers.

Many of the literature have examined hospital deaths preventability and errors in healthcare (Leape et al., 1991; Giraud et al., 1993; Kohn, Corrigan and Donaldson, 2000; Braco et al., 2001; Forster et al., 2008; Manaseki-Holland et al., 2016). One study reported the incidence of AE preventability in interfacility transfers using incident reporting system (Flabouris, Runciman and Levings, 2006). Flabouris, Runciman and Levings (2006) examined different team composition (doctor/paramedic, doctor/nurse and nurse), and found that 91% of incidents reported in interfacility transfer were documented as preventable.

This PhD study examined preventability of AEs, errors in care and interventions appropriateness by paramedics in interfacility transfers.

Most of the safety events in the paramedic model were not preventable (62%) and most paramedics' interventions were appropriate (86%). The probability of any event to be preventable was 27% and the probability that paramedics' intervention was appropriate was 85%. Estimating the probability of event preventability and appropriateness of interventions is an important step for any future studies that will compare different models in interfacility transfers. There were no other studies found in the literature that estimated the event preventability, and the thesis results provided a valid measurement point to any future attempt of model comparison in interfacility critical care transfers.

- **Preventability:**

The results showed that 17% of events could have been prevented. A detailed qualitative analysis of the data showed that events could have been prevented by one of the following:

1. Pre-transfer stabilisation
2. Deciding that the patient was too unstable to be transferred
3. Better management during transfer

Pre-transfer stabilisation:

Pre-transfer stabilisation is a complicated process that relies on the sending facility more than the transferring team. The process contains multiple factors that directly impact the ability to stabilise patients. Some factors are controllable, such as the skill of the team and the availability of equipment, while others, such as the pathology and the degree of damage, might not be so easily controlled. Pre-transfer stabilisation, according to experts, is needed to stabilise oxygenation/ventilation, correct hypotension, or administer high dosages of paralytic/sedative agents to prevent agitation during transfer. The oxygenation and blood pressure are the most important vital signs that must be stabilised prior to transfer, and, in most cases, there was an intervention done by the paramedics to correct these abnormalities. However, experts argue that these interventions were either too late or needed to be more aggressive. The sending facilities, in most cases, were small rural (peripheral) ER facilities without ICU capability, without a blood bank (they are not allowed to infuse blood products since they are small), and no access to specialist services (doctors were ER specialists or General Practitioners/ Family Medicine), which limited the sending facility's ability to stabilise patients prior to transfer, hence, the urgent need to transfer patients to a more appropriate medical facility.

The inability of paramedics to intervene early or aggressively, even though they have the appropriate equipment/medications, can be corrected by enhancing paramedics' continuing education. Experts argued that paramedics could have administered or altered the dose of paralytics/sedatives to prevent in-transit agitation. The paramedics, in all cases, continued the

sedative/paralytic infusions that were initiated by the sending facility, and, in my opinion, this practice is effective and sufficient, since these patients were critically-ill patients, and any alternation in dosage or changing in agents being administered might have had a negative impact on the patient's condition. On the other hand, the sedatives/paralytics infusions (initiated by the sending facility) were sufficient to sedate the patients at the sending facility and at the beginning of the journey; moreover, paramedics were ready and intervened effectively and safely when an alternation to dosage or the agent being administered was needed to control the patient's agitation.

Patient was too unstable to be transferred:

Most patients (all but one) judged by experts as too unstable to be transferred were adult patients post-cardiac arrest (within 30 minutes) in the local ER with a return of spontaneous circulation and transferred to a facility offering a higher level of care due to lack of ICU services. It was expected to find these patients in critical unstable conditions in terms of vital signs. The risk benefit analysis and international guidelines in these patients are in favour of transferring them urgently to a higher level of care. The question remaining is, could this patient have stayed longer in the sending facility to be stabilised before transfer? To answer this question, it is important to analyse the available resources in the sending facilities. These are small ERs with limited human resources availability and, even if there are enough ER staff, there are no specialist services available in these ERs. In addition, these ERs were designed to handle minor injuries and primary care (it can be best described as doctors' offices, walk in centres or GP surgeries) with limited ancillary services (such as fixed X-ray machine and having limited blood laboratory services).

Patients who are post-cardiac arrest require a specialised range of tertiary services that are not available in such facilities. These facts suggested that there were more benefits to be had by transferring patients post-cardiac arrest, as opposed to waiting for the sending facility to stabilise them, while, in addition, maintaining care at the sending facility with the same or even more advanced level was continued.

The remaining one patient who was not in cardiac arrest and was unstable to be transferred was a brain-dead patient, confirmed as such by the sending facility. It is not clear if this patient was transferred for organ donation, but I assume this was the case because KAMC, as a tertiary medical facility, has an organ transplant programme.

Better management during the transfer:
Experts argue that better management during transfer might have prevented some of the events seen in interfacility transfers. There were nine responses in this category, and six pertained to inappropriate ventilator settings and three pertained to an inappropriate sedative agent. Four responses of inappropriate ventilator settings were because paramedics increased Fio2 to 100% at the beginning of transfer. The other two responses were because paramedics switched to BVM when the patient desaturated. In general, these two practices are common in pre-hospital care. Paramedics are trained to give oxygen as soon as possible and the more oxygen the better, for example paramedics are trained to give MI patients oxygen via nasal cannula even if they do not need it (oxygen saturation >94%) and this was the standard practice until studies confirmed that it might be harmful to patients (Stub et al., 2015). The second point in analysing inappropriate ventilator settings is that of switching mechanically-ventilated patients to BVM. Paramedics utilise BVM frequently in pre-hospital care, in fact, in this specific system, paramedics do not routinely carry transport ventilators unless there are interfacility transfers, and the familiarity and comfortability of paramedics with BVM might be the reason of switching desaturating patients to BVM.

In conclusion, evidence-based medicine and standard clinical practice changes constantly, and continuing professional development and training is a vital point in assuring patient safety is maximised in interfacility critical care transfers by paramedics.

- **Errors during paramedics' care:**

The experts' response showed that paramedics' error during care was 6%. The probability of an error occurring during paramedics' care was 16%. After analysing the qualitative data from the experts' responses, paramedics' errors during care were due to one of the following:

1. Failure to address a problem
2. Inappropriate ventilator settings
3. Inadequate sedation
4. Medication/procedure error
5. Late intervention

Failure to address a problem:

There were 10 responses under "failure to address a problem", of which eight were related to patients who were too unstable to be transferred (post-cardiac arrest or brain-dead). I disagree with the idea that paramedics, in these cases, failed to address the problem, because they were able to manage the patients during transfer, which suggests that they were anticipating the difficulties raised during transfer. As mentioned above, the risk benefit analysis was in favour of transferring these patients, and the paramedics understood this risk and were able to manage such patients, despite their unstable status during transfer. The other two responses in failure to address a problem were related to the decision of infusing blood products prior to transfer. The two responses pertained to one case.

In this specific case, the patient was post-cardiac arrest with query of an upper GI bleed, and the sending facility did not have suitable blood products available; therefore, again, the risk benefit analysis was in favour of transferring this patient. Paramedics were able to utilise their available resources in an effort to stabilise this specific patient (they infused almost 3l of crystalloid fluid). The question of making blood products available in interfacility critical care transfers is beyond the scope of this thesis, and it can be included in future research; however, the data suggested that, in four years, only one case "might" had benefited from blood products if they had been

available. Saudi Arabia's climate will be a major obstacle in implementing an interfacility blood product programme.

The paramedics' physical examination skills in interfacility critical care transfers might be under question; however, most interfacility critical care transfer systems that utilise paramedics require at least five years of pre-hospital experience. Also, in recent years, many critical care paramedic courses have been developed, and the benefit of utilising critical-care paramedics versus other interfacility critical care transfer providers might be investigated in future research.

Inappropriate ventilator settings:

There were four responses in this category. The error in this category was the increment of Fio2 at the beginning of transfer to 100%.

Inadequate sedation:

There were three responses in this category. All responses were related to patients on Dexmedetomidine infusion. Experts suggested that Dexmedetomidine might be appropriate for ICU sedation, but not during interfacility transfer. Paramedics continued the infusion of Dexmedetomidine and intervened appropriately if patients needed more sedation by administering a bolus of Midazolam. This practice of maintaining the sending facility's sedative option might be the most appropriate action, due to the risk of the patient's deterioration with the introduction of a new sedative. Sedatives are known for their side effects, and most sedative agents will cause hypotension, and, in these specific patients (critically-ill patients), the adequate MAP is usually achieved with the assistance of vasopressors and/or inotropes, and a sudden alteration to the sedatives, including introducing a new sedative agent, might be disastrous in such patients.

Medication/procedure error:

There were seven responses to three patients in this category. The first case was an obese patient who developed a desaturation during transfer, and the error was the failure of paramedics in switching the ventilator correctly. The

expert suggested “performing breath hold, clamp tube, switch ventilators and perform manoeuvres to re-recruit lost alveoli, also could have considered patient positioning if high peak pressures due to obesity.” It is not clear if paramedics follow this practice, and the limitation of a retrospective chart review design prevented the ability to observe such practices. It is important to note that this case was reviewed by three experts and only one suggested there was an error in paramedic care.

The second case was a patient in heart failure with pulmonary edema and hypoxia. The paramedic administered furosemide and morphine. All experts marked the administration of morphine as an error. Evidence-based medicine is changing constantly, since, at one time, administering furosemide, nitroglycerin and morphine was the standard treatment for pulmonary edema. The change of recommendations in managing such patients did not apply in practice until recently. It could be that paramedics managed this patient at the beginning of the study period (2011), when such practice could have been considered appropriate and standard. Experts also suggested initiating Non-Invasive Positive Pressure Ventilation (NIPPV) or Rapid Sequence Intubation (RSI) in such patients. During the study period, paramedics did not have NIPPV available. The suggestion of RSI might be the appropriate method that paramedics could have used in treating such patients. One important finding in this research is the importance of training paramedics in RSI, for, if paramedics are to be utilised in such transfers, they must have adequate training in advanced airway management.

The last case affected by paramedics’ error was a patient with known bradycardia, which paramedics tried to correct during transfer. They tried to administer Atropine (two doses of 0.5mg). The patient was transferred from the local ER, and the paramedics did not have access to the patient’s medical records at the receiving facility, which would have told them that the patient was known to have a bradycardia. This case suggests that, in interfacility critical care transfers, communication, including a full access to the patient’s

medical record, is vital and crucial to ensure that patient safety is maximised in such transfers.

Late intervention:

There were six responses to two cases in this category. The two cases were bradycardia and atrial fibrillation. In the bradycardia case, experts argued that the paramedics should have initiated transcutaneous cardiac pacing earlier; the initiation of electrical therapy before using chemical agents is a subject of discussion. The paramedics tried chemical therapy and reserved electrical therapy as a “last resort”. This conservative approach is a matter of personal preference and subjective to the agency guidelines and medical protocols. Both the American Heart Association (AHA) and the European Resuscitation Council (ERC) guidelines regarding symptomatic bradycardia suggest that use of a chemical agent should be considered before attempting transcutaneous cardiac pacing (CPR Guidelines, 2017; ECC Guidelines, 2017)

The second late intervention observed was the suggestion of synchronised cardioversion to a patient with atrial fibrillation. According to the patient’s records, the patient developed a fast rate of atrial fibrillation one minute before arriving to the ER door (after entering the hospital premises); paramedics documented that a synchronised cardioversion was not provided because preparation of electrical therapy (applying pads and administering sedative) would result in a delay of delivering the patient to definitive care. In this situation, it is difficult to judge the paramedics responsible for delaying cardioversion. The preparation to deliver a synchronised cardioversion will take at least a few minutes (preparing the sedative, administering the sedative, waiting for adequate sedation, applying pads, assuring synchronisation and, finally, delivering the electrical therapy). On the other hand, even though atrial fibrillation is a serious arrhythmia, usually it is not a lethal rhythm that requires an emergency electrical therapy or emergency drug administration unless rapid ventricular response is present.

8.2 Paramedic model in interfacility critical care transfers

This section discusses the argument of utilising paramedics in interfacility critical care transfers. The paramedic model in interfacility critical care transfers exists in multiple countries. It is not the standard care or the standard model in interfacility transfers; however, it can be interpreted as an extension to the pre-hospital care system. The most common practice in interfacility transfers around the globe is to utilise a medical doctor (usually an anaesthetist or intensivist) and a specialised nurse. The feasibility of utilising paramedics in interfacility critical care transfers releases capacity in over-stretched healthcare systems.

It is one of many examples of skill substitution in healthcare (Dubois and Singh, 2009). The main motivation of utilising paramedics in interfacility critical care transfers is to provide high quality medical care in the absence of a specialised medical doctor. This opportunity might be most useful in rural areas or low income countries. The question is whether paramedics can act as a substitute for the skills of specialised medical doctors and nurses. The majority of published literature on skill mix and skill substitution examines the doctor/nurse mix and substitution and, in most cases, the results have shown the feasibility of skill substitution, but no evidence of effect on cost containment (Antunes and Moreira, 2013).

The results presented in this thesis showed that utilising paramedics in interfacility critical care transfers is feasible and safe. In terms of mortality outcomes, the paramedic model is similar to the physician model. Generally, my findings regarding mortality are imprecise, but the null conclusion is supported by the in-depth review of case notes. The PhD thesis showed evidence to conduct a large clinical study. The cost-effectiveness issue can be investigated in future research, but there is a great opportunity in view of the fact that this model substitutes the medical doctor with a lower-cost paramedic; therefore, it is expected that the paramedic model might be at a lower cost compared to current models in interfacility transfers.

This study did not examine cost-effectiveness of utilising the paramedic model in interfacility transfer; other drivers of utilising the model might be an appropriate motivation to implement it. The WHO suggested multiple drivers to skill mix/substitution, including skill shortage, cost control, quality improvement and change in regulatory/legislative environment. The skill shortage is a global problem, and also applies to high income countries. In modern healthcare systems, care regionalisation and specialist care services have increased the demand of interfacility transfers. It is expected that the number of interfacility transfers will continue to grow. A study conducted in the USA showed that hospitals with higher patient volumes have lower mortality rates of critically-ill patients compared to hospitals with lower volumes. In addition, the study suggested that more than 4,000 lives could potentially be saved if these patients were transferred to higher-volumes hospitals (Khan et al., 2008). These facts, along with the building of evidence on the clinical benefits of a regionalised healthcare systems, will increase the demand on skilled manpower (doctors and nurses) which will exacerbate the healthcare providers' shortage.

The paramedic model in interfacility critical care transfers will be of a great assistance to address the shortage in skilled workforce. The paramedic model will preserve highly specialised medical doctors (anaesthetists and intensivists) to function in their designated units, which will have a major impact on improving patient care. In addition, the model will promote the transfer of more patients between healthcare facilities, more specifically, areas of short medical coverage, such as rural areas, will have a great opportunity of benefiting from such a flexible model by decreasing the transfers process time and effectively utilising their pre-hospital care systems. This flexibility will ensure that increased demand on interfacility critical care transfers is supplied by an appropriate transfer model.

8.3 Implementation of the paramedics' model in interfacility critical care transfers

The motivation of implementing the paramedic model in interfacility critical care transfers will depend on the local healthcare system needs. Theoretically, in most cases, it will be the question of providing tertiary healthcare services in the designated area versus implementing a transfer system that is safe, flexible and accessible. The cost-effectiveness of a transfer system model in such a case is obvious; however, the implementation method and implementation cost will be challenging. There are two basic methods suggested for implementing the paramedic model in interfacility critical care transfers: the hospital-based retrieval system and the pre-hospital care system.

The first method is the hospital-based retrieval services. This method is based on the hospital recruitment of paramedics to function in their ambulance services. This method might be applicable to large hospitals, such as the hospital presented in this research, or rural hospitals and communities. In this specific design, the ambulance services are functioning as an EMS system attached to the hospital, and this model is well known as a hospital-based EMS. There are many advantages to this model. First, paramedics are available and based within the hospital to urgently transfer or retrieve patients to receive a higher level of care. This availability has a major impact on reducing transfer time and increasing patient satisfaction. Additionally, the hospitals directly manage this service, which offers a more flexible approach on implementing internal policies and ensuring that interfacility transfer providers are meeting the hospital requirements in relation to training and quality of medical care provided during transfer. Secondly, paramedics can respond to pre-hospital community calls.

The paramedics in this design are functioning as a pre-hospital care provider and a retrieval provider. This dual role provides a relief for the hospital staff and ensures that community emergency services are covered. Finally, the attachment of paramedics to the hospital will provide a possible solution to the

hospital staff shortage. Paramedics can fill the gap caused by staff shortages when they are not engaged in their EMS duties. Even though the clinical role of paramedics in hospital settings needs a research examination, there is a great opportunity that paramedics can fulfil the shortage in ER, intensive care facilities and primary care (Ball, 2005). The hospital-based system might be most suitable for communities that receive public funding.

The hospital-based EMS system has many disadvantages, one being the cost of implementing ambulance services. Assets in ambulance services will require a large budget to cover their cost. The ambulance vehicles and logistics are usually expensive (usually hundreds of thousands in pounds sterling). Another disadvantage of the model is the financial profitability. In most cases, ambulance services are unprofitable, and most hospital-based EMS payments do not cover their operational costs.

The privatisation of ambulance services is almost unremarkable (Sutton and Eichner, 2008). In most international ambulance services, the system is supported by public funds. There are small private EMS services (most common in the United States of America), but usually they are restricted to non-emergency transfers.

The second possible method of implementing the paramedic model in interfacility transfer is the pre-hospital care system. This method is to combine interfacility transfers to the existing pre-hospital care system. The most common system is the system utilised in Ontario, Canada (Robinson et al., 2009) This method is based on providing the emergency calls with regular paramedics and responding to interfacility transfers with more specialised paramedic teams. There are many different levels of paramedic training (discussed in the next section) and choosing the suitable level of training in interfacility transfers is crucial. There are many advantages to this model, one being the large geographical coverage of the community, as retrieval teams are linked to the pre-hospital care system.

The linkage of pre-hospital care to interfacility transfers will allow easier access and less processing time. Another advantage is the centralisation of dispatch services. Dispatch services can perform a major role in coordinating interfacility transfers. Pre-hospital care dispatchers are usually trained personnel who can provide coordination to minimise logistics difficulties, and this can be most beneficial in limiting EMS waiting time at medical facilities, and can ensure that patients are accepted and admitted to the designated unit quicker. A final advantage is the containment of interfacility cost. Pre-hospital care services are equipped with logistics required in interfacility transfers (ambulances, dispatch centre, buildings and paramedic) which can limit the cost of interfacility transfers.

There are, however, many disadvantages to the combination of interfacility transfers to the pre-hospital care system. One such is the difficulty of controlling the care provided in the pre-hospital care systems. The hospitals do not have the power to impose their internal policies on pre-hospital care. The coordination on medical care will require more effort to achieve target objectives. For example, some hospitals desire that patients with STEMI for PCI are to be transferred on heparin infusion, and have received appropriate antiplatelet agents (Aspirin and Clopidogrel), and such practices and medications are not routinely provided in pre-hospital care. To combine the two systems, many logistics (medications provided in interfacility transfer, storage of the medication and supplies) should be discussed in detail before deciding to implement the model.

8.4 Paramedics' minimum training requirements in interfacility critical care transfers

The paramedics' competencies required in pre-hospital care varies across the globe. The medico-legal authority of paramedics is an important predictor of the competencies and practices in pre-hospital care. EMS systems with a clear medico-legal authority of paramedics, such as are used in the UK, Australia and New Zealand, have a clear description of the competencies required to

be a paramedic. However, the extension of the paramedics' role, including the expansion of their scope of practice, must be clearly defined. On the other hand, systems where paramedics work under a medical doctor's license are usually subjective to the system needs, for example, a paramedic working under a doctor's license in one system might not be authorised to perform RSI; however, in a different system, the medical director has authorised paramedics to perform RSI under his/her medical license.

The paramedics working under a doctor's license might have a more flexible approach, as they can be trained to fulfil their system requirements. In general, this international variation of competencies in paramedics' practice has created a difficulty in structuring a unified model to the paramedic training needed in interfacility critical care transfers. There is no international consensus or governmental guidelines of a "critical care paramedic". In the interests of this discussion, the paramedics' competencies presented in this research will be utilized as a standard model.

To practise as a paramedic in Saudi Arabia, the applicant must register with the Saudi Commission for Health Specialties (SCFHS). SCFHS requires paramedics to have undertaken a course recognised by the commission. The paramedic licensed by the commission must hold at least a diploma in pre-hospital care or a similar degree. The course will usually provide the paramedic with a basic science education. Also, additional courses offer the paramedics with basic training in clinical science. Appendix 10 shows courses offered to paramedics.

In addition to the courses, skill teaching (usually in clinical labs) offers paramedics the opportunity to gain the clinical skills required in pre-hospital care. The following competencies are usually covered in the basic training provided to paramedics:

- **Airway and breathing:**
    - Oral and nasal airway
    - Bag Valve Mask (BVM)

- Suctioning
- Sellick's Manoeuvre
- Head-tilt chin lift/ Jaw thrust/ Modified chin lift Obstruction–manual
- Oxygen therapy: Nasal cannula/Non-rebreather/face mask/ Partial rebreathers/ Venturi mask
- Humidifiers
- Manually Triggered Ventilator (MTV)/ Automatic Transport Ventilator (ATV) /Oesophageal-Tracheal Multi-Lumen Airways/ Bi-level Positive Airway Pressure (BiPAP)/ Continuous Positive Airway Pressure (CPAP)
- Needle chest decompression
- Chest tube monitoring
- Percutaneous cricothyrotomy
- Surgical cricothyrotomy
- End Tidal CO2 (ETCO2)/Capnography
- Nasogastric tube (NG)/ Orogastric tube (OG) tube insertion and maintaining
- Nasal and oral Endotracheal intubation
- Airway obstruction removal by direct laryngoscopy
- Rapid Sequence Intubation (RSI)

- **Monitoring:**
  - Manual Blood Pressure (BP)
  - Invasive Blood Pressure reading (IBP)
  - Pulse oximetry manual and auto BP
  - Blood glucose monitor
  - Electrocardiogram (ECG) interpretation including interpreting 12 Lead ECG
  - Venous blood sampling
  - Tracheostomy care
  - Urinary Catheterisation
- **Medication administration:**
  - Buccal
  - Oral

- Aerosolised
- Subcutaneous
- Intramuscular
- Nebulised
- Sublingual
- Intranasal
- Endotracheal
- Intravenous (IV) (push and infusion)- including utilising IV pumps
- NG
- Rectal
- Intraosseous
- Topical

- **Trauma:**
  - Manual cervical stabilisation
  - Manual extremity stabilisation
  - Eye irrigation
  - Haemorrhage control
  - Emergency moves for endangered patients
  - Spinal immobilisation
  - Seated spinal immobilisation
  - Long board
  - Extremity splinting - Traction splinting
  - Mechanical patient restraint
  - Tourniquet
  - Cervical collar
  - Rapid extrication
  - Pelvic binder
- **Cardiac**:
  - Cardiopulmonary resuscitation (CPR)
  - Automated external defibrillator **(**AED)
  - Mechanical CPR
  - Cardioversion
  - Carotid massage

    - Manual defibrillation
    - Transcutaneous pacing
    - Maintain a transvenous pacing
- **Obstetrics and Gynaecology (Obs/Gyn):**
    - Assisted normal delivery
    - Assisted complicated delivery

The trainee paramedics are also required to perform a field internship that usually takes between six months to one year before they qualify as paramedics. From the above list, paramedics' competencies are designed to fulfil patient needs in the pre-hospital care setting.

Patients in interfacility critical care transfers represent a different population that requires different skills and training. For example, RSI is one of the core required skills in interfacility transfers. Even though RSI is usually a part of the paramedic education, not all paramedics practising in pre-hospital care are allowed by their protocols and guidelines to use RSI, also it is rare that paramedics in internship will be allowed to perform RSI on patients.

It is recommended to have at least two to five years experience in pre-hospital care. To utilise paramedics in interfacility critical care transfers, decision makers and programme directors must ensure that the skills and training needed in such transfers are achieved. Many international agencies and organisations have proposed special programmes to advance paramedics to perform critical care medicine or to advance emergency practice. These courses range from two weeks to two years and offer different academic degrees (for example courses can be taken as short courses, as a postgraduate certificate or a master's degree). In conclusion, the pre-hospital paramedics without advanced training will not be suitably qualified to fulfil critical care interfacility transfers.

The list below recommends competencies (in addition to the competencies presented in appendix 2) that should be met before utilising paramedics in

interfacility transfers. This list was designed after analysing the research findings and reviewing the guidelines of multiple organisations.

- **Flight environment (if the organisation utilises air mode):**
    - Flight physiology with air medical consideration
        - Gas laws
        - Ventilation and oxygenation
        - Changes in physiology with altitude
        - Medication consideration
        - Medico-legal consideration
    - Flight safety
        - Stress and fatigue
        - Decision-making
        - Drug and substances misuse
- **Airway and breathing:**
    - Intensive training in RSI with both simulation and cadavers. Maintaining a minimum annual number of performing RSI. If not enough cases are performed annually, the utilisation of in-hospital training (ER and anaesthesia) might be required
    - Operating sophisticated transport ventilators, including the initiation of NIPPV and Arterial Blood Gas (ABG) sampling and analysis
    - Advance training in respiratory conditions, including pathophysiology of Acute Respiratory Distress Syndrome (ARDS) and lung protective ventilation
    - Alveolar recruitment manoeuvres
    - Training in thoracostomy and maintaining chest tubes
- **Monitoring**
    - Blood lab data analysis, including ABG
    - Radiographic interpretation (basic radiology and Point of Care Ultrasound (POCUS)
    - Intracranial pressure (ICP) monitoring

    - Central vascular access and monitoring including Pulmonary Artery Catheterisation (PAC) monitoring
- **Cardiac**
    - Pericardiocentesis
    - Advance training in cardiology, including heart failure and Ventricular Assistant devices (VAD)
    - 15 lead ECG interpretation
    - Advance training on maintaining pacemaker/ Implantable Cardioverter Defibrillator (ICD)
    - Initiating thrombolytic therapy
    - Maintenance and troubleshooting of the intra-aortic balloon pump (IABP)
- **Medication administration**

In addition to the regular medication list available to paramedics, the following list of medications is common in interfacility transfers and paramedics should be familiar with them.

- Antibiotics
- Antiemetics
- Antihypertensive
- Antiplatelet/anti-coagulants including heparin
- Antivenom
- Barbiturates
- Beta-blockers
- Blood products
- Depolarising neuromuscular blocker
- Fibrinolytics/Thrombolytics
- Flumazenil
- Furosemide
- Insulin
- Ketamine
- Mannitol

- Milrinone
- Non-depolarising neuromuscular blocker
- Norepinephrine (noradrenaline)
- Nitroglycerin infusion
- Phenylephrine
- Phenytoin
- Potassium chloride
- Propofol
- Theophylline
- Tocolytics
- Total parenteral nutrition

Most of these medications are not regularly used in the pre-hospital care practice and require the provider to be knowledgeable and skilful in initiating and maintaining these agents. Medical directors and systems decision-makers must ensure that paramedics are familiar with their medications and have received the adequate training required in interfacility critical care transfers.

8.5 Considerations in interfacility critical care transfers by paramedics

There are many considerations to be considered in interfacility critical care transfers by paramedics. First, the competencies provided above are general. The utilisation of paramedics in interfacility critical care transfers requires that the roles of paramedics are clearly defined. The roles of paramedics will vary across systems depending on the system needs. For example, from the literature review (Chapter 2), paramedics were working with different healthcare providers in different interfacility transfers team composition. The literature could not define the roles of paramedics during interfacility transfers, especially when there are other healthcare providers (doctors, respiratory therapists (RT) and nurses) available during the transfer. The definition of paramedics' roles in interfacility transfer, especially with the existence of other healthcare providers, is crucial to ensure that patient safety is maximised. The

definition of procedures, and medications allowed to be initiated by paramedics, must be clearly defined.

Some procedures and medications that may need to be commenced during transfer will lie outside the range of competencies for paramedics. For example, resuscitative thoracotomy is a procedure that is reserved to be done by a surgeon or an emergency physician, and the paramedics will not be able to perform such procedure. However, the applicability of performing such procedures on a moving ambulance during interfacility transfers is a subject of debate. In some cases, where invasive lifesaving procedures are required, alternative and temporary less invasive procedures might be within the paramedics' competencies, for example, patients with tension pneumothorax that need a thoracostomy tube can be temporarily managed by needle thoracostomy.

Secondly, the scope of practice is an important item in the progression of paramedicine as a profession. The ability of paramedics to be autonomous in their practice is dependent on their scope of practice. A few countries, such as the UK and Australia, have already established their scope of practice, which gives paramedics the ability to be autonomous in their practice in pre-hospital care. However, interfacility critical care transfers require a different level of practice that mandates an expanded scope of practice. In recent years, a term known as "critical care paramedic" has developed as an expanding scope of practice to the pre-hospital care paramedics.

This expanding of paramedics' scope of practice must be recognised by local authorities to assure that paramedics are practising under the protection of their local authorities, especially when the critical care paramedics utilise advanced pharmacological agents and perform invasive medical procedures that might have side effects and adverse events that might lead to legal consequences. The paramedics' scope of practice will be the reference in medico-legal cases.

Finally, there will always be a limitation to the paramedics' utilisation in interfacility critical care transfers, as with any other healthcare providers conducting interfacility critical care transfers, and these limitations are not necessarily due to the lack of knowledge or skills, they are due to the complexity of the patient's status and/or the transfer process. For example, in recent years, more patients are transferred on extracorporeal membrane oxygenation (ECMO), also known as extracorporeal life support (ECLS) which requires a whole team, that includes a perfusionist, an intensivist or anaesthetist and/or an ICU nurse to transfer the patient. In situations when such a team is required, the paramedics will not be able to transfer these patients, and decision-makers must ensure that a plan is implemented to ensure that appropriate health care providers are available to fulfil the patient's needs during such transfers.

In conclusion, paramedics are healthcare professionals specialised in pre-hospital care, with appropriate training and skills, the paramedics can safely transfer critical interfacility adult patients. A further cost analysis research to the paramedic model in interfacility critical care transfers is recommended to establish the cost-effectiveness of the model.

8.6 Originality and contribution to knowledge

There has been little in-depth analysis of AEs conducted in interfacility critical care transfers. The originality of this PhD thesis is in exploring AEs in interfacility critical care transfers by paramedics, by providing an in-depth analysis of AEs in interfacility critical care transfers. The PhD thesis reported the incidence of AEs in the Saudi interfacility critical care transfers, which has not been reported previously. With consideration to the underpowered study in this PhD and the imprecision of the results, this PhD thesis reported a mortality comparison of two available models in interfacility critical care transfers. This was followed by in-depth analysis study where I looked at each individual case to allow a detailed assessment of the quality of care, and to identify any particularly risky medical scenarios. All the results of this thesis

contextual by the systematic review which preceded the primary imprecise study.

The methodology of this PhD thesis has not been previously used. I adopted mixed methods research design to examine paramedics' safety in interfacility critical care transfers.

8.7 Recommendation for future research

The PhD thesis has identified a few gaps in our knowledge around interfacility transfers and a further body of research is recommended to fill these gaps. I have argued elsewhere in the thesis that a large experimental study comparing paramedics with doctors does not offer good value of money for two reasons. First, the sample size of such study to exclude clinically related difference in patients' outcomes will be enormous. Second, the results will be highly dependent on the selection and training of the paramedics involved in the study. Bearing this in mind, I would like to recommend the following research:

- A detailed cost analysis of the paramedic model in interfacility critical care transfers, that can establish the cost-effectiveness of the model proposed
- A comparison of various measures for the selection, training and assessment of paramedics
- A large scale multi-centre study of adverse events following interfacility transfers
- Further to the failure of paramedics and doctors in the expert survey to achieve agreement, I think a future study of the perception will be needed
- The preparation and timing of interfacility transfers are crucial, and I recommend a further study to carefully look at these two factors
- Interfacility transfer is highly stressful as clinicians have to work under difficult conditions and communicate in noisy situations with increased invariance noise. I recommend a further research on the minimization of distractions and cognitive demand, following the success that has been

seen in aviation with cockpit conditions, that leave a room for improvement in interfacility critical care transfers

References

Allendes, F. and MacDonald, R.D. (2013) Safe transport of intra-aortic balloon pump-dependent patients by skilled air and land critical care Crews. *Air Medical Journal*, 32(5) 251-252.

Andrew, E., de Wit, A., Meadley, B., Cox, S., Bernard, S. & Smith, K. (2015) Characteristics of Patients Transported By A Paramedic-Staffed Helicopter Emergency Medical Service In Victoria, Australia. *Prehospital Emergency Care*, 19(3): 416-424.

Antunes, V. & Moreira, J.P. (2013) Skill mix in healthcare: An international update for the management debate. *International Journal of Healthcare Management,* 6(1):112-17. http://dx.doi.org/10.1179/2047970012Z.00000000028,

Arthur, K.R., Kelz, R.R., Mills, A.M., Reinke, C.E., Robertson, M.P., Sims, C.A., Pascual, J.L., Reilly, P M. & Holena, D.N. (2013) Interhospital transfer: an independent risk factor for mortality in the surgical intensive care unit. *The American Surgeon*, 79: 909-913.

Asaithambi, G., Chaudhry, S.A., Hassan, A.E., Rodriguez, G.J., Suri, M.F.K. & Qureshi, A.I. (2013) Adherence to guidelines by emergency medical services during transport of stroke patients receiving intravenous thrombolytic infusion. *Journal of Stroke and Cerebrovascular Diseases*, 22(7): e42-e45.

Australian & New Zealand College of Paramedicine. (2016) *Protection of Paramedic Title* [online]. Available from: https://www.anzcp.org.au/news/protection-of-paramedic-title-nsw/ [Accessed 8 November 2016].

Ball, L. (2005) Setting the scene for the paramedic in primary care: a review of the literature. *Emergency Medicine Journal*, 22(12): 896-900.

Bellingan, G., Olivier, T., Batson, S. & Webb, A. (2000) Comparison of a specialist retrieval team with current United Kingdom practice for the transport of critically ill patients. *Intensive Care Medicine*, 26(6): 740-744.

Barry, P.W. & Ralston, C. (1994) Adverse Events Occurring During Interhospital Transfer of the Critically Ill. *Archives of Disease in Childhood*, 71(1): 8-11.

Belway, D., Henderson, W., Keenan, S.P., Levy, A.R. & Dodek, P.M. (2006) Do specialist transport personnel improve hospital outcome in critically ill patients transferred to higher centers? A systematic review. *Journal of Critical Care*, 21(1): 8-17; discussion 17-18.

Bigham, B.L., Buick, J.E., Brooks, S.C., Morrison, M., Shojania, K.G. & Morrison, L.J. (2012) Patient safety in emergency medical services: a systematic review of the literature. *Prehospital Emergency Care,* 16(1): 20-35.

Billeter, A.T., Miller, F.B., Harbrecht, B.G., Bowen, W., Stephens, M. J., Postel, G.C., Smith, J.W., Penta, M., Coleman, R., Franklin, G.A., Trunkey, D.D. & Polk Jr, H.C. (2014) Interhospital transfer of blunt multiply injured patients to a level 1 trauma center does not adversely affect outcome. *American Journal of Surgery*, 207(4): 459-466.

Blakeman, T.C. & Branson, R.D. (2013) Inter- and intra-hospital transport of the critically ill. *Respiratory Care*, 58(6): 1008-1023.

Brennan, T.A., Leape, L.L., Laird, N.M., Hebert, L., Localio, A.R., Lawthers, A.G., Newhouse, J.P., Weiler, P.C. & Hiatt H.H. (1991)_Incidence of adverse events and negligence in hospitalized patients. Results of the Harvard Medical Practice Study I. *New England Journal of Medicine*, 324(6): 370-376.

Bracco, D., Favre, J.B., Bissonnette, B., Wasserfallen, J.B., Revelly, J.P., Ravussin, P. & Chioléro, R. (2001) Human errors in a multidisciplinary intensive care unit: a 1-year prospective study. *Intensive Care Medicine*, 27(1):137-145.

Britto, J., Nadel, S., Habibi, P. & Levin, M. (1994) Adverse events occurring during interhospital transfer of the critically ill [3]. *Archives of Disease in Childhood*, 71 (6): 559.

Brown, J.B., Stassen, N.A., Bankey, P.E., Sangosanya, A.T., Cheng, J.D. & Gestring, M.L. (2011) Helicopters improve survival in seriously injured patients requiring interfacility transfer for definitive care. *Journal of Trauma*, 70(2): 310-314.

Buchan, J. & Dal Poz, M.R. (2002) Skill mix in the health care workforce: reviewing the evidence. *Bull World Health Organ*, 80: 575-580.

Burney, R.E., Passini, L., Hubert, D. & Maio, R. (1992) Comparison of aeromedical crew performance by patient severity and outcome. *Annals of Emergency Medicine*, 21(4): 375-378.

Burns, B.J., Habig, K., Reid, C., Kernick, P., Wilkinson, C., Tall, G., Coombes, S. & Manning, R. (2011) Logistics and safety of extracorporeal membrane oxygenation in medical retrieval. *Prehospital Emergency Care*, 15(2): 246-253.

Burns, B., Reid, C. & Habig, K. (2013) Review of aeromedical intra-aortic balloon pump retrieval in New South Wales. *European Journal of Emergency Medicine*, 20(1): 23-26.

Byrne, R.W., Bagan, B.T., Slavin, K.V., Curry, D., Koski, T.R. & Origitano, T.C. (2008) Neurosurgical emergency transfers to academic centers in Cook County: A prospective multicenter study. *Neurosurgery*, 62(3): 709-715.

Caldow, S.J., Parke, T.R.J., Graham, C.A. & Munro, P.T. (2005) Aeromedical retrieval to a university hospital emergency department in Scotland. *Emergency Medicine Journal*, 22(1): 53-55.

Catalano, A.R., Winn, H.R., Gordon, E. & Frontera, J.A. (2012) Impact of Interhospital Transfer on Complications and Outcome After Intracranial Hemorrhage. *Neurocritical Care*, 17(3): 324-333.

Celia, M., Paluck, J.N. & Smith, R.L. (1995) Critical care transport: an evolving role in EMS*. Journal of Emergency Medical Services*, 20 (8): 90-94.

Chen, K.-H., Chen, L.-R. & Su, S. (2010) Applying root cause analysis to improve patient safety: decreasing falls in postpartum women. *Quality and Safety in Health Care*, 19(2):138-43.

Chen, M.J., Shu, C.H., Kao, H.A., Hung, H.Y., Chang, J.H., Jim, W.T., Huang, F.Y., Tsou, K.I., Chen, S.J., Lin, H.C., Huang, C.C. & Huang, C.B. (2006) The effect of planned maternal transport on postnatal outcomes in very low birth weight infants. *Clinical Neonatology*, 13(1): 6-11.

Clement, K.C., Fiser, R.T., Fiser, W.P., Chipman, C.W., Taylor, B.J., Heulitt, M.J., Moss, M., Fasules, J.W., Faulkner, S.C., Imamura, M., Fontenot, E.E. & Jaquiss, R.D.B. (2010) Single-institution experience with interhospital extracorporeal membrane oxygenation transport: A descriptive study. *Pediatric Critical Care Medicine*, 11(4): 509-513.

Cliff, D. & Loh, N.H.W. (2012) Emergency transfer of patients into a neurosurgical intensive care unit. *Anaesthesia*, 67: 40.

CPR Guidelines. (2017) *ERC Guidelines 2015 have arrived*. [online] Available from: https://cprguidelines.eu/ (Accessed 13 April 2017)

Deasy, C. & Sullivan, I. (2007) Transfer of patients - From the spoke to the hub. *Irish Medical Journal*, 100(7): 538-539.

Dewhurst, A.T., Farrar, D., Walker, C., Mason, P., Beven, P. & Goldstone, J.C. (2001) Medical repatriation via fixed-wing air ambulance: a review of patient characteristics and adverse events. *Anaesthesia*, 56(9): 882-887.

Dick, W.F. (2003) Anglo-American vs. Franco-German emergency medical services system. *Prehospital Disaster Medicine*, 18, 29-35; discussion 35-37.

Domeier, R.M., Hill, J.D. & Simpson, R.D. (1996) The development and evaluation of a paramedic-staffed mobile intensive care unit for interfacility patient transport. *Prehospital and Disaster Medicine*, 11(1): 37-43.

Donchin, Y., Gopher, D., Olin, M., Badihi, Y., Biesky, M., Sprung, C. L., Pizov, R. & Cotev, S. (1995) A look into the nature and causes of human errors in the intensive care unit. *Critical Care Medicine*, 23(2): 294-300.

Donnelly, J.A., Smith, E.A. & Runcie, C.J. (1995) Transfer of the critically ill obstetric patient: Experience of a specialist team and guidelines for the non-specialist. *International Journal of Obstetric Anesthesia*, 4(3): 145-149.

Dorlac, G.R., Fang, R., Pruitt, V.M., Marco, P.A., Stewart, H.M., Barnes, S.L. & Dorlac, W.C. (2009) Air transport of patients with severe lung injury: development and utilization of the Acute Lung Rescue Team. *Journal of Trauma*, 66(4 suppl): S164-171.

Droogh, J.M., Smit, M., Hut, J., de Vos, R., Ligtenberg, J.J. & Zijlstra, J. G. (2012) Inter-hospital transport of critically ill patients; expect surprises. *Critical Care*, 16(1): R26.

Droogh, J.M., Smit, M., Absalom, A.R., Ligtenberg, J.J. & Zijlstra, J.G. (2015) Transferring the Critically-ill Patient: Are We There Yet? *Critical Care* 19, (1). http://dx.doi.org/10.1186/s13054-015-0749-4.

Dubois, C.A. & Singh, D. (2009) From staff-mix to skill-mix and beyond: towards a systemic approach to health workforce management. *Human Resources for Health*, 7: 87.

Duke, G.J. & Green, J.V. (2001) Outcome of critically ill patients undergoing interhospital transfer. *Medical Journal of Australia*, 174(3): 122-125.

Durairaj, L., Will, J.G., Torner, J.C. & Doebbeling, B.N. (2003) Prognostic factors for mortality following interhospital transfers to the medical intensive care unit of a tertiary referral center. *Critical Care Medicine*, 31(7): 1981-1986.

Eckstein, M., Schlesinger, S. & Sanko, S. (2015) Interfacility Transports Utilizing The 9-1-1 Emergency Medical Services System. *Prehospital Emergency Care*, 19(4): 490-495.

ECC Guidelines. (2017) *2010-Integrated_Updated-Circulation-ACLS-Bradycardia-Algorithm.png* (1600Ã—1733). [online] Available from: https://eccguidelines.heart.org/wp-content/uploads/ 2015/10/2010-Integrated_Updated-Circulation-ACLS-Bradycardia-Algorithm.png (Accessed 13 April 2017)

Elliott, J.P., Foley, M.R., Young, L., Balazs, K.T. & Meiner, L. (1996) Air transport of obstetric critical care patients to tertiary centers. *Journal of Reproductive Medicine*, 41(3): 171-174.

Etxebarría, M.J., Serrano, S., Ruiz Ribó, D., Cía, M.T., Olaz, F. & López, J. (1998) Prospective application of risk scores in the interhospital transport of patients. *European Journal of Emergency Medicine*. 5(1):13-17.

Fan, E., MacDonald, R.D., Adhikari, N.K.J., Scales, D.C., Wax, R.S., Stewart, T.E. & Ferguson, N.D. (2006) Outcomes of interfacility critical care adult patient transport: A systematic review. *Critical Care*, 10 (1)

Fisher, J.D., Freeman, K., Clarke, A., Spurgeon, P., Smyth, M., Perkins, G.D., Sujan, M.A. & Cooke, M.W. (2015) Health Services and Delivery Research, Southampton (UK), NIHR Journals Library.

Flabouris, A. (1999) Patient referral and transportation to a regional tertiary ICU: Patient demographics, severity of illness and outcome comparison with non-transported patients. *Anaesthesia and Intensive Care*, 27(4): 385-390.

Flabouris, A. (2003) A description of events associated with scene response by helicopter based medical retrieval teams. *Injury*, 34(11): 847-852.

Flabouris, A., Runciman, W.B. & Levings, B. (2006) Incidents during out-of-hospital patient transportation. *Anaesthesia & Intensive Care*, 34(2): 228-236.

Flabouris, A., Hart, G.K. & George, C. (2008a) Observational study of patients admitted to intensive care units in Australia and New Zealand after interhospital transfer. *Critical Care and Resuscitation : Journal of the Australasian Academy of Critical Care Medicine*, 10(2): 90-96.

Flabouris, A., Hart, G.K. & George, C. (2008b) Outcomes of patients admitted to tertiary intensive care units after interhospital transfer: comparison with patients admitted from emergency departments. *Critical Care and Resuscitation : Journal of the Australasian Academy of Critical Care Medicine*, 10(2): 97-105.

Flabouris, A., Hart, G.K. & Nicholls, A. (2012) Patients admitted to Australian intensive care units: impact of remoteness and distance travelled on patient outcome. *Critical Care and Resuscitation : Journal of the Australasian Academy of Critical Care Medicine*, 14(4): 256-267.

Forster, A.J., Kyeremanteng, K., Hooper, J., Shojania, K.G. & van Walraven, C. (2008) The impact of adverse events in the intensive care unit on hospital mortality and length of stay. *BMC Health Services Research*, 8: 259.

Frakes, M.A. (2002) Flight team management of in-place endotracheal tubes. *Air Medical Journal*, 21(6): 29-31.

Franco, Y.E., Lorenzo, R.A.D. & Salyer, S.W. (2012) Emergent interfacility evacuation of critical care patients in combat. *Air Medical Journal*, 31(4): 185-188.

Fried, M.J., Bruce, J., Colquhoun, R. & Smith, G. (2010) Inter-hospital transfers of acutely ill adults in Scotland. *Anaesthesia,* 65(2): 136-144.

Garrouste-Orgeas, M., Philippart, F., Bruel, C., Max, A., Lau, N. & Misset, B. (2010) Overview of medical errors and adverse events. *Annals of Intensive Care*, 2:2.

Garrouste-Orgeas, M., Timsit, J.F., Vesin, A., Schwebel, C., Arnodo, P., Lefrant, J.Y., Souweine, B., Tabah, A., Charpentier, J., Gontier, O., Fieux, F., Mourvillier, B., Troché, G., Reignier, J., Dumay, M.F., Azoulay, E., Reignier, B., Carlet, J. & Soufir, L. (2010) Selected medical errors in the intensive care unit: results of the IATROREF study: parts I and II. *American Journal of Respiratory and Critical Care Medicine,* 181(2):134-142.

Gearing, R.E., Mian, I.A., Barber, J. & Ickpwicz, A. (2006) A Methodology for Conducting Retrospective Chart Review Research in Child and Adolescent

Psychiatry. *Journal of the Canadian Academy of Child and Adolescent Psychiatry*, 15(3): 126–134.

Gearing, R. E., Mian, I. A., Barber, J. & Ickowicz, A. (2006) A Methodology for Conducting Retrospective Chart Review Research in Child and Adolescent Psychiatry. In: eds. *J Can Acad Child Adolesc Psychiatry*. 126-134.

General Authority for Statistics. (2016) *Population Statistics*. [online] Available from: https://www.stats.gov.sa/en/411 (Accessed 01 February 2017)

Gerhardt, R.T., Koller, A.R., Rasmussen, T.E., Wright, B., Lacson, E., Love, P., Salter, S., Stewart, R., Eastridge, B., Epley, E. & Blackbourne, L. (2013) Analysis of remote trauma transfers in South Central Texas with comparison with current US combat operations: Results of the RemTORN-I study. *Journal of Trauma and Acute Care Surgery*, 75 (2 suppl. 2): S164-S168.

Gilligan, J.E., Griggs, W.M., Jelly, M.T., Morris, D.G., Haslam, R.R., Matthews, N.T., Everest, E.R., Bryce, R.L., Marshall, P.B. & Peisach, R.A. (1999) Mobile intensive care services in rural South Australia. *Medical Journal of Australia,* 171(11-12): 617-620.

Giovanetti, E.A., Silva, C.S., Barbas, C.S.V., Taniguchi, C., Matos, G.F.J., Timinetsky, K. & Caserta, R.A. (2011) Inter and intra-hospital transport of patients with respiratory failure: The albert einstein hospital multidisciplinary team experience. *American Journal of Respiratory and Critical Care Medicine*, 183(1 MeetingAbstracts)

Giraud, T., Dhainaut, J.F., Vaxelaire, J.F., Joseph, T., Journois, D., Bleichner, G., Sollet, J.P., Chevret ,S. & Monsallier, J.F. (1993) Iatrogenic complications in adult intensive care units: a prospective two-center study. *Critical Care Medicine*, 21(1):40-51.

Goldman, A.P., Tasker, R.C., Cook, P. & Macrae, D. J. (1995) Transfer of critically ill patients with inhaled nitric oxide. *Archives of Disease in Childhood*, 73(5): 480.

Gray, A., Gill, S., Airey, M. & Williams, R. (2003) Descriptive epidemiology of adult critical care transfers from the emergency department. *Emergency Medicine Journal*, 20(3): 242-246.

Gray, A., Bush, S. & Whiteley, S. (2004) Secondary transport of the critically-ill and injured adult. Emergency *Medicine Journal,* 21: 281-285.

Hallgren, K.A. (2012) Computing Inter-Rater Reliability for Observational Data: An Overview and Tutorial. *Tutorials in Quantitative Methods in Psychology*, 8 (1): 23-34.

Harris, E.M. (1996) Interventions during transport. *Pediatric Emergency Care*, 12(5): 390.

Hartke, A., Mumma, B.E., Rittenberger, J.C., Callaway, C.W. & Guyette, F.X. (2010) Incidence of re-arrest and critical events during prolonged transport of post-cardiac arrest patients. *Resuscitation*, 81(8): 938-942.

Hatlestad, D. & Van Horn, J. (2003) EMS transport of the intra-aortic balloon pump patient: assessment and support throughout transport of the IABP patient with proper oxygenation, ventilation and cardiac pharmacology is critical to a safe and successful outcome. *Emergency Medical Services*, 32(6): 79.

Hayward, R.A., McMahon, L.F., Jr. & Bernard, A.M. (1993) Evaluating the care of general medicine inpatients: how good is implicit review? *Annals of Internal Medicine*, 118(7): 550-556.

Hayward, R.A. & Hofer, T.P. (2001) Estimating hospital deaths due to medical errors: preventability is in the eye of the reviewer. *JAMA,*286 (4):415-420.

Health and Care Professions Council. (n.d.) *Protected titles* [online]. Available from http://www.hcpc-uk.co.uk/aboutregistration/ protectedtitles/ [Accessed 8 November 2016]

Health Careers. (2015) *Paramedic*. [online] Available from: https://www.healthcareers.nhs.uk/explore-roles/allied-health-professionals/paramedic [Accessed 25 Mar 2016].

Hess, D.R. (2004) Retrospective studies and chart reviews. *Respiratory Care*, 49:1171-4.

Hobgood, C., Xie, J.P., Weiner, B. & Hooker, J. (2004) Error identification, disclosure, and reporting: Practice patterns of three emergency medicine provider types. *Academic Emergency Medicine*, 11(2): 196-199.

Hui, Y.Y., Lo, W.Y.L., Lee, L.L.Y., Chan, J.T.S., Tang, S.Y.H. & Kalinowski, E. (2012) Measuring performance of night-time interfacility transport service. *European Journal of Emergency Medicine*, 19(4): 264-266.

Hutchinson, A., Coster, J.E., Cooper, K.L., McIntosh, A., Walters, S. J., Bath, P.A., Pearson, M., Young, T.A., Rantell, K., Campbell, M.J. & Ratcliffe, J. (2010) Comparison of case note review methods for evaluating quality and safety in health care. *Health Technology Assessment*, 14 (10): iii-iv, ix-x, 1-144.

Jaynes, C.L., Blevins, G. & Werman, H.A. (2002) Evaluating interfacility ground and air transport of the critical cardiac patient. *Air Medical Journal*, 21(2): 37-41.

Jensen, J.L., Bigham, B.L., Blanchard, I.E., Dainty, K.N., Socha, D., Carter, A., Brown, L.H., Travers, A H., Craig, A.M., Brown, R. & Morrison, L.J. (2013) The Canadian National EMS Research Agenda: a mixed methods consensus study. *CJEM*, 15(2): 73-82.

Kahn, K.L., Kosecoff, J., Chassin, M.R., Flynn, M.F., Fink, A., Pattaphongse, N., Solomon, D. H. & Brook, R. H. (1988) Measuring the clinical appropriateness of the use of a procedure. Can we do it? *Medical Care*, 26(4): 415-422.

Kahn, J.M., Linde-Zwirble, W.T., Wunsch, H., Barnato, A.E., Iwashyna, T.J., Roberts, M.S., Lave, J.R. & Angus, D.C. (2008) Potential value of regionalized intensive care for mechanically ventilated medical patients. *American Journal of Respiratory and Critical Care Medicine*, 177(3): 285-291.

Klein, M.B., Nathens, A.B., Emerson, D., Heimbach, D.M. & Gibran, N.S. (2007) An analysis of the long-distance transport of burn patients to a regional burn center. *Journal of Burn Care & Research*, 28(1): 49-55.

Kohn, L.T., Corrigan, J.M. & Donaldson, M. (eds) (2000) *To Err is Human: Building a Safer Health System*. Washington (DC): National Academies Press (US).

Kreeftenberg Jr, H.G., Ligtenberg, J.J.M., Arnold, L.G., Van Der Werf, T.S., Tulleken, J.E. & Zijlstra, J.G. (2000) Condition on arrival of transferred critically ill patients. *Netherlands Journal of Medicine*, 57(5): 180-184.

Krosnick, J.A. & Presser, S. (2010) Question and Questionnaire Design. In: Marsden, P.V. & Wright, J.D. eds. *Handbook of Survey Research*. 2nd edn. Emerald:263-313.

Kupas, D.F. & Wang, H.E. (2014) Critical care paramedics -a missing component for safe interfacility transport in the United States. *Annals of Emergency Medicine*, 64 (1): 17-18.

Lairet, J., King, J., Vojta, L. & Beninati, W. (2013) Short-Term Outcomes of US Airforce Critical Care Air Transport Team (CCATT) Patients Evacuated From A Combat Setting . *Prehospital Emergency Care*, 17(4): 486-490.

Lamb, D. (2010) Measuring Critical Care Air Support Teams' performance during extended periods of duty. *AACN Advanced Critical Care*, 21(3): 298-306.

Lambert, S.M. & Willett, K. (1993) Transfer of multiply-injured patients for neurosurgical opinion: A study of the adequacy of assessment and resuscitation. *Injury*, 24 (5): 333-336.

Leape, L.L., Brennan, T.A., Laird, N., Lawthers, A.G., Localio, A.R., Barnes, B.A., Hebert, L., Newhouse, J.P., Weiler, P.C. & Hiatt, H. (1991) The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. *New England Journal of Medicine,* 324: 377-384.

Lees, M. & Elcock, M. (2008) Safety of interhospital transport of cardiac patients and the need for medical escorts. *EMA - Emergency Medicine Australasia*, 20(1): 23-31.

Lehmann, R., Oh, J., Killius, S., Cornell, M., Furay, E. & Martin, M. (2009) Interhospital patient transport by rotary wing aircraft in a combat environment: risks, adverse events, and process improvement. *Journal of Trauma*, 66(4 suppl): S31-36.

Ligtenberg, J.J., Arnold, L.G., Stienstra, Y., van der Werf, T.S., Meertens, J. H., Tulleken, J. E. & Zijlstra, J. G. (2005) Quality of interhospital transport of critically ill patients: a prospective audit. *Critical Care*, 9(4): R446-451.

Lilford, R., Edwards, A., Girling, A., Hofer, T., Di Tanna, G.L., Petty, J. & Nicholl, J. (2007) Inter-rater reliability of case-note audit: a systematic review. *Journal of Health Services Research & Policy*, 12(3):173-180.

Linden, V., Palmer, K., Reinhard, J., Westman, R., Ehren, H., Granholm, T. & Frenckner, B. (2001) Inter-hospital transportation of patients with severe acute respiratory failure on extracorporeal membrane oxygenation - national and international experience. *Intensive Care Medicine*, 27(10): 1643-1648.

Longo, D.R., Hewett, J.E., Ge, B. & Schubert, S. (2005) The Long Road to Patient Safety: A Status Report on Patient Safety Systems. *JAMA*, 294 (22): 2858-2865.

Lovelace, M.R., Catenacci, M., Brown, T. & Stephens, S. (2008) The quality of inter-hospital critical care transport of mechanically ventilated patients by a mobile ICU team: A prospective cohort study. *Air Medical Journal*, 27(4): 180-180.

MacDonald, R.D. & Farquhar, S. (2005) Case conferences. Transfer of intra-aortic balloon pump-dependent patients by paramedics. *Prehospital Emergency Care*, 9(4): 449-453.

MacDonald, R.D., Banks, B.A. & Morrison, M. (2008) Epidemiology of Adverse Events in Air Medical Transport. *Academic Emergency Medicine*, 15(10): 923-931.

Maloney Jr, G.E. & Pakiela, J.A. (2008) Characteristics of patients transported by an aeromedical service for acute toxicologic emergencies: A 5-year experience. *Air Medical Journal*, 27(1): 48-50.

Manaseki-Holland, S., Lilford, R.J., Bishop, J.R.B., Girling, A.J., Chen, Y.-F., Chilton, P.J., Hofer, T.P. (2016) Reviewing deaths in British and US hospitals:

a study of two scales for assessing preventability. *BMJ Quality and Safety,* http://dx.doi.org/10.1136/bmjqs-2015-004849

Markakis, C., Dalezios, M., Chatzicostas, C., Chalkiadaki, A., Politi, K. & Agouridakis, P.J. (2006) Evaluation of a risk score for interhospital transport of critically-ill patients. *Emergency Medicine Journal*, 23(4):313-317.

Ministry of Health. (2017) *Kingdom of Saudi Arabia - Statistical Book for the Year 1436* [online]. Available from: http://www.moh.gov.sa/en/ [Accessed 01 February 2017].

Moher, D., Liberati, A., Tetzlaff, J. & Altman, D.G. (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Journal of Clinical Epidemiology*, 62(10): 1006-1012.

Montesi, G. & Lechi, A. (2009) Prevention of medication errors: detection and audit. *British Journal of Clinical Pharmacology*.67(6): 651-655

Muchembled, A., Coyle, C., Snelgrove, H., McAnulty, G., Teig, M., Ogilvie, E. & Toner, A. (2012) Are we stuck in professional silos? A needs analysis for interhospital patient transfer training. *Intensive Care Medicine*, 38 S171-S172.

Murff, H.J., Patel V.L., Hripcsak G. and Bates D.W. (2003) Detecting adverse events for patient safety research: a review of current methodologies. *Journal of Biomedical Informatics,* 36(1-2):131-143.

National Cancer Institute. (2010) *Common Terminology Criteria for Adverse Events (CTCAE) v4.0.* U.S National Institute of Health, Bethesda, [online] Available from: http://evs.nci.nih.gov/ftp1/CTCAE/ About.html [Accessed 16 January 2016).

NHTSA. (1998) National Highway Traffic Safety Administration: EMS Agenda for the Future: implementation guide--moving closer to the vision. *Annals of Emergency Medicine*, 32 (4): 511-512.

National Highway Traffic Safety Administration (NHTSA). (2006) *Guide For Interfacility Patient Transfer.* [online] Available from: http://www.nhtsa.gov/people/injury/ems /Interfacility/images/ Interfacility.pdf [Accessed 25 March 2016].

NHTSA. (2007) *National EMS Scope of Practice Model* [online]. Available from: https://www.ems.gov/education/EMSScope.pdf [Accessed 8November 2016]

Norton, R., Wortman, E., Eastes, L., Daya, M., Hedges, J. & Hoyt, J. (1996) Appropriate helicopter transport of urban trauma patients. *Journal of Trauma-Injury Infection & Critical Care*, 41(5): 886-891.

Nyquist, P. (2012) Where should critically Ill neurologic brain hemorrhage patients go and can transfer harm them? *Neurocritical Care*, 17(3): 309-311.

Oberg, K.C., Kociszewski, C., Dubovsky, J., LaPlante, G. & Lago, B. (1998) Cardiac patient air medical transport in the northeast region of the United States. *Prehospital Emergency Care*, 2(4): 297-303.

OCEBM Levels of Evidence Working Group. (n.d.) *The Oxford Levels of Evidence 2*. [online] Available from: http://www.cebm.net/index.aspx?o=5653 (Accessed 11 October, 2017).

Pierson, S., Hansen, R., Greene, S., Williams, C., Akers, R., Jonsson, M. & Carey, T. (2007) Preventing medication errors in long-term care: results and evaluation of a large scale web-based error reporting system. *Quality and Safety in Health Care*, 16(4): 297-302.

Pozner, C.N., Zane, R., Nelson, S.J. & Levine, M. (2004) International EMS systems: The United States: past, present, and future. *Resuscitation*, 60: 239-244.

Preston, C.C. & Colman, A.M. (2000) Optimal number of response categories in rating scales: reliability, validity, discriminating power, and respondent preferences. Acta Psychologica, 104(1): 1-15.

Ranasingh, I., Barz, F., Briege, D. & Gallaghe, M. (2012) Mortality outcomes following inter-hospital transfer (IHT) for acute myocardial infarction (AMI). *Circulation*, 126 (21).

Raynovich, W., Hums, J., Stuhlmiller, D.F., Bramble, J.D., Kasha, T. & Galt, K. (2013) Critical care transportation by paramedics: a cross-sectional survey. *Air Medical Journal*, 32(5): 280-288.

Reiss, N., El-Banayosy, A., Posival, H., Knobl, H., Minami, K. & Korfer, R. (1996) Transport of hemodynamically unstable patients by a mobile mechanical circulatory support team. *Artificial Organs*, 20(8): 959-963.

Rishu, A.H., Aldawood, A.S., Haddad, S.H., Tamim, H M., Al-Dorzi, H.M., Al-Jabbary, A., Al-Shimemeri, A., Sohail, M.R. & Arabi, Y.M. (2013) Demographics and outcomes of critically-ill patients transferred from other hospitals to a tertiary care academic referral center in Saudi Arabia. *Annals of Intensive Care*, 3(1): 1-8.

Rittenberger, J.C., Hostler, D.P., Tobin, T., Gaines, J. & Callaway, C.W. (2008) Predictors of ROSC in witnessed aeromedical cardiac arrests. *Resuscitation*,76(1):43-46.

Robinson, V., Goel, V., MacDonald, R.D. & Manuel, D. (2009) Interfacility patient transfers in Ontario: do you know what your local ambulance is being used for? *Healthcare Policy*, 4: 53-66.

Runcie, C.J., Reeve, W., Reidy, J. & Dougall, J.R. (1990) A comparison of measurements of blood pressure, heart-rate and oxygenation during inter-hospital transport of the critically ill. *Intensive Care Medicine*, 16(5): 317-322.

Santry, H.P., Janjua, S., Chang, Y., Petrovick, L. & Velmahos, G.C. (2011) Interhospital transfers of acute care surgery patients: should care for nontraumatic surgical emergencies be regionalized? *World Journal of Surgery*, 35(12): 2660-2667.

Sebail, Z.A., Milaat, W.A. & Al-Zulaibani, A.A. (2001) Health Care Services in Saudi Arabia: Past, Present and Future. *Journal of Family & Community Medicine,* 8: 19-23.

Seymour, C.W., Kahn, J.M., Schwab, C.W. & Fuchs, B.D. (2008) Adverse events during rotary-wing transport of mechanically ventilated patients: A retrospective cohort study. *Critical Car*e, 12(3).

Shelton, S.L., Swor, R.A., Domeier, R.M. & Lucas, R. (2000) Medical direction of interfacility transports: National Association of EMS Physicians Standards and Clinical Practice Committee. *Prehospital Emergency Care*, 4(4): 361-364.

Sinclair, T.D. & Werman, H.A. (2009) Transfer of patients dependent on an intra-aortic balloon pump using critical care services. *Air Medical Journal*, 28(1): 40-46.

Singh, J.M. & MacDonald, R.D. (2009) Pro/con debate: Do the benefits of regionalized critical care delivery outweigh the risks of interfacility patient transport? *Critical Care*, 13(4).

Singh, J.M., Ferguson, N.D., MacDonald, R.D., Stewart, T.E. & Schull, M.J. (2009) Ventilation practices and critical events during transport of ventilated

patients outside of hospital: a retrospective cohort study. *Prehospital Emergency Care*, 13(3): 316-323.

Singh, J.M., MacDonald, R.D., Bronskill, S.E. & Schull, M.J. (2009) Incidence and predictors of critical events during urgent air-medical transport. *CMAJ: Canadian Medical Association Journal*, 181(9): 579-584.

Singh, J.M., MacDonald, R.D. & Ahghari, M. (2014) Critical events during land-based interfacility transport. *Annals of Emergency Medicine*, 64(1): 9-15.e12.

Stephens, C., Beehan, S. & Hillman, K. (1995) Preparation of the critically ill for transfer in metropolitan Sydney. *Australian Critical Care:Official Journal of the Confederation of Australian Critical Care Nurses*, 8(4): 14-18.

Stone, C.K., Hunt, R.C., Sousa, J.A., Whitley, T.W. & Thomas, S.H. (1994) Interhospital transfer of cardiac patients: does air transport make a difference? *Air Medical Journal*, 13(5): 159-162.

Strauch, U., Bergmans, D., Winkens, B. & Roekaerts, P. (2015) Short-term outcomes and mortality after interhospital intensive care transportation: an observational prospective cohort study of 368 consecutive transports with a mobile intensive care unit. *BMJ Open*, 5(4): 7.

Stub, D., Smith, K., Bernard, S., Nehme, Z., Stephenson, M., Bray, J. E., Cameron, P., Barger, B., Ellims, A. H., Taylor, A.J., Meredith, I. T. & Kaye, D.M. (2015) Air Versus Oxygen in ST-Segment Elevation Myocardial Infarction.*Circulation,* 131(24):2143-2150.

Sutton, J.P. & Eichner, J. (2008) *Experiences of Critical Access Hospitals in the Provision of Emergency Medical Services (Policy Brief) - Rural Health Research Gateway*. [online] Available from: https://www.ruralhealthresearch.org/publications/655 (Accessed 13 April 2017)

Thomas, S., Judge, T., Lowell, M.J., MacDonald, R.D., Madden, J., Pickett, K., Werman, H.A., Shear, M.L., Patel, P., Starr, G., Chesney, M., Domeier, R., Frantz, P., Funk, D. & Greenberg, R.D. (2010) Airway management success and hypoxemia rates in air and ground critical care transport: a prospective multicenter study. *Prehospital Emergency Care*, 14(3): 283-291.

Thomas, E.J. & Petersen, L.A. (2003) Measuring Errors and Adverse Events in Health Care. *Journal of General Intern Medicine*, 18(1): 61-67.

Uusaro, A., Parviainen, I., Takala, J. & Ruokonen, E. (2002) Safe long-distance interhospital ground transfer of critically-ill patients with acute severe unstable respiratory and circulatory failure. *Intensive Care Medicine*, 28(8): 1122-1125.

Von Elm, E., Altman, D.G., Egger, M., Pocock, S.J., Gøtzsche, P.C. & Vandenbroucke, J.P. (2007) The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Annals of Internal Medicine*, 147(8): 573-577.

Vlayen, A., Verelst, S., Bekkering, G.E., Schrooten, W., Hellings, J. & Claes, N. (2017). Incidence and preventability of adverse events requiring intensive care admission: a systematic review. *Journal of Evaluation in Clinical Practice*, 18(2):485-497.

Walcott, B.P., Coumans, J.V., Mian, M.K., Nahed, B.V. & Kahle, K.T. (2011) Interfacility helicopter ambulance transport of neurosurgical patients: Observations, utilization, and outcomes from a quaternary level care hospital. *PLoS ONE*, 6(10).

Wiegersma, J.S., Droogh, J.M., Zijlstra, J.G., Fokkema, J. & Ligtenberg, J.J.M. (2011) Quality of interhospital transport of the critically ill: Impact of a Mobile Intensive Care Unit with a specialized retrieval team. *Critical Care*, 15(1).

Wolf, G.K., Frakes, M.A., Gallagher, M., Allan, C.K. & Wedel, S.K. (2010) Management of suspected myocarditis during critical-care transport. *Pediatric Emergency Care*, 26(7): 512-517.

World Health Organisation. (n.d.) *Patient Safety* [online]. Available from: http://www.euro.who.int/en/health-topics/Health-systems/patient-safety [Accessed 13 November 2016].

World Health Organisation. (2014) *Noncommunicable diseases country profiles 2014*.

Youngquist, S.T., McIntosh, S.E., Swanson, E.R. & Barton, E.D. (2010) Air ambulance transport times and advanced cardiac life support interventions during the interfacility transfer of patients with acute ST-segment elevation myocardial infarction. *Prehospital Emergency Care*, 14(3): 292-299.

Zalstein, S., Danne, P., Taylor, D., Cameron, P., McLellan, S., Fitzgerald, M., Kossmann, T., Patrick, I., Walker, T., Crameri, J., Bailey, M. & Magilton, G. (2010) The Victorian Major Trauma Transfer Study. *Injury*, 41(1): 102-109.

Zhang, J., Patel, V.L. & Johnson, T.R. (2008). Medical error: Is the solution medical or cognitive? *Journal of the American Medical Informatics Association*, 6(1): 75–77.

Appendices

Appendix 1 Ethical approval:

THE UNIVERSITY OF WARWICK

14th August 2014

PRIVATE
Abdullah Alabdali
Department of Health Sciences
Warwick Medical School,
Coventry
CV4 7AL

Dear Abdullah

Our Ref: REGO-2014-1023

Re **Quality in Inter-facility Critical Care Transfer in Saudi Arabia: adverse events and interventions in adult critical patients transferred by paramedic.**

Thank you for submitting the above-named project to the University of Warwick Biomedical and Scientific Research Ethics Committee for research ethical review.

I am pleased to advise that research ethical approval is granted.

May I take this opportunity to wish you success with the study, and to remind you that any substantial amendments require approval from the Committee before they can be implemented. Please keep a copy of the original signed version of this letter with your study documentation.

Yours sincerely

Secretary
pp Dr David Davies
Chair
Biomedical and Scientific
Research Ethics Sub-Committee

Biomedical and Scientific Research Ethics Sub-Committee
A010 Medical School Building
Warwick Medical School,
Coventry, CV4 7AL.
Tel: 02476-151875
Email: BSREC@Warwick.ac.uk

Appendix 2 EMS resources at KAMC and paramedics competencies:

EMS resources:

Total employees	82
Medical Director	1
Operational manager	1
Quality officer	1
Educational officer	2
Office secretary	1
Emergency Medical Technician Basic (EMT-B)	45
Paramedic	16
Administrative staff including logistics	11
Ambulance driver	4
Vehicles (including logistic vehicles)	22

Paramedics competencies:

- **Airway and breathing:**
    - Oral and nasal airway
    - Bag Valve Mask (BVM)
    - Suctioning
    - Sellick's Manoeuvre
    - Head-tilt chin lift/ Jaw thrust/ Modified chin lift Obstruction–manual
    - Oxygen therapy: Nasal cannula/Non-rebreather/face mask/ Partial rebreathers/ Venturi mask
    - Humidifiers
    - Manually Triggered Ventilator (MTV)/ Automatic Transport Ventilator (ATV) /Oesophageal-Tracheal Multi-Lumen Airways/ Bi-level Positive Airway Pressure (BiPAP)/ Continuous Positive Airway Pressure (CPAP)
    - Needle chest decompression
    - Chest tube monitoring
    - Percutaneous cricothyrotomy
    - Surgical cricothyrotomy
    - End Tidal CO2 (ETCO2)/Capnography
    - Nasogastric tube (NG)/ Orogastric tube (OG) tube insertion and maintaining
    - Nasal and oral Endotracheal intubation
    - Airway obstruction removal by direct laryngoscopy
    - Rapid Sequence Intubation (RSI)

- **Monitoring:**
    - Manual Blood Pressure (BP)
    - Invasive Blood Pressure reading (IBP)
    - Pulse oximetry ,manual and auto BP
    - Blood glucose monitor
    - Electrocardiogram (ECG) interpretation including interpreting 12 Lead ECG

- Blood chemistry analysis
- Central line monitoring and maintaining
- Venous blood sampling
- Chest tube monitoring and suctioning
- Ostomy drainage system care
- Tracheostomy care
- Urinary Catheterisation

- **Medication administration:**
  - Buccal
  - Oral
  - Aerosolised
  - Subcutaneous
  - Intramuscular
  - Nebulised
  - Sublingual
  - Intranasal
  - Endotracheal
  - Intravenous (IV) (push and infusion) - including utilising IV pumps
  - NG
  - Rectal
  - Intraosseous
  - Topical
  - Accessing implanted central IV port

- **Trauma:**
  - Manual cervical stabilisation
  - Manual extremity stabilisation
  - Eye irrigation
  - Haemorrhage control
  - Emergency moves for endangered patients
  - Spinal immobilization

- Seated spinal immobilisation
- Long board
- Extremity splinting - Traction splinting
- Mechanical patient restraint
- Tourniquet
- Cervical collar
- Rapid extrication
- Pelvic binder

- **Cardiac**:
  - Cardiopulmonary resuscitation (CPR)
  - Automated external defibrillator **(**AED)
  - Mechanical CPR
  - Cardioversion
  - Carotid massage
  - Manual defibrillation
  - Transcutaneous pacing
  - Maintain a transvenous pacing

- **Obstetrics and Gynaecology (Obs/Gyn):**
  - Assisted normal delivery
  - Assisted complicated delivery

Appendix 3 WEB OF SCIENCE search strategy:

Number	Search
1	**TOPIC:** ("allied health" or paramedic* or "emergency medical service*" or "emergency medical technician*" or ambulance or "air ambulance" or "pre-hospital care" or "prehospital care" or hems or "helicopter emergency medical service*" or aeromedical) *AND*
2	**TOPIC:** ("intensive care unit*" or "intensive care" or "critical care") *AND*
3	**TOPIC:** ("inter-facility" or interfacility or inter-hospital or interhospital or "transportation of patient*" or "patient trans*" or "hospital trans*") **Timespan:** 1990-2016. Search language=Auto

Appendix 4 EMBASE search strategy(Embase classic+Embase 1947 to 2016 week 6):

Number	Search	Result
1	exp emergency health service/ or exp paramedical personnel/ or paramedic.mp. or exp ambulance/ or exp rescue personnel/	487671
2	Emergency medical service*.mp.	9065
3	emergency medical technician*.mp.	1106
4	ambulance*.mp. or exp ambulance transportation/	15119
5	air ambulance.mp. or exp air medical transport/	2134
6	pre-hospital care.mp.	617
7	prehospital care.mp. or emergency care/	29062
8	exp helicopter/ or helicopter emergency medical service*.mp. or exp patient transport/	23016
9	aeromedical.mp.	1327
10	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9	529702
11	inter-facility trans*.mp. or exp patient transport/	21379
12	interfacility trans*.mp.	276
13	(inter-hospital trans* or interhospital trans*).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]	1146
14	transportation of patient*.mp.	338
15	11 or 12 or 13 or 14	22069
16	intensive care.mp. or exp intensive care/	622552
17	critical care.mp.	36283
18	intensive care unit.mp. or exp intensive care unit/	142023
19	16 or 17 or 18	629571
20	10 and 15 and 19	5986
21	limit 20 to (human and yr="1990 -Current")	5147

Appendix 5 CINAHL search strategy:

Number	Search	Result
1	(MM "Emergency Medical Technicians") OR (MM "Allied Health Professions+") OR (MM "Allied Health Personnel+") OR (MM "Emergency Medical Services+") OR (MM "Prehospital Care")	151666
2	(MM "Ambulances") OR "ambulance*"	4471
3	"air ambulance"	324
4	"helicopter emergency medical service*"	333
5	(MM "Aeromedical Transport") OR "aeromedical"	2596
6	S1 OR S2 OR S3 OR S4 OR S5	152991
7	(MM "Intensive Care Units+") OR (MM "Critical Care+") OR "intensive care"	46934
8	critical care	33143
9	S7 OR S8	64289
10	inter-facility or interfacility or inter-hospital or interhospital	632
11	(MM "Transportation of Patients+") OR "transportation of patient*"	6455
12	"patient transfer*"	395
13	S10 OR S11 OR S12	7176
14	S6 AND S9 AND S13	784
15	S6 AND S9 AND S13 **Limiters** - Published Date: 19900101-20161231	754

Appendix 6 Systematic review data extraction form:

Study ID#	
Title	
Authors	
Publication date	
Outcome measure	
Number of patients	
Patients age	
Country	
Study Methodology	
Mode of transport	
Clinical category	
Team configuration	
Comparison group	
Adverse event percentage	
Types of adverse events	
Intervention	

Appendix 7 Data collection form:

Data collection form				
Age				
Sex				
Reason of transfer				
Length of transfer				
Mode of transfer				
Patient group				
	Variable	**Pre-departure**	**During transfer**	**On arrival**
Airway	**Type of device**			
Breathing	**RR**			
	SO2			
	Vent setting			
	Lung sound			
	Capnography			
Breathing Circulation	**Pulse**			
	BP (MAP)			
	Skin condition			
	Temp			
	ECG			
	Capillary refill			
	Invasive BP			
Disability	**Glasgow coma**			
	Pupils			
	ICP monitoring			
Blood test	**Hb**			
	Glucose			
	Blood gas			
Radilogical studies	**Type of study**			
Critical care parameter	**Infusions**			
	Central IV			
	chest tube			
	Blood transfusion			
	Comorbidity			
Scores	**RSTP**			
	TISS			
	APACHE II			
Outcomes	**Mortality**			
	AE			
	Intervention			

Appendix 8 Risk score for transport patient:

Risk score for transport patients*	
1. Hemodynamics	
Stable	**0**
Moderately stable (requires volume <15 ml/min in adults)	**1**
Unstable (requires volume >15 ml/min or inotropics or blood)	**2**
2. Arrhythmias (existing or probable)	
No	**0**
Yes, not serious (and AMI after 48 hours)	**1**
Serious (and AMI in the first 48 hours)	**2**
3. ECG monitoring	
No	**0**
Yes (desirable)	**1**
Yes (essential)	**2**
4. Intravenous line	
No	**0**
Yes	**1**
Pulmonary artery catheter	**2**
5. Provisional pacemaker	
No	**0**
Yes (not invasive). AMI in the first 48 hours	**1**
Yes (endocavity)	**2**
6. Respiration	
Respiratory rate between 10 and 14 breaths/min in adults	**0**
Respiratory rate between 15–35 breaths/min in adults	**1**
Apnoea <10 or >36 or irregular breathing	**2**
7. Airway	
No	**0**
Yes (Guedel tube)	**1**
Yes (intubation or tracheostomy)	**2**
8. Respiratory support	
No	**0**
Yes (oxygen therapy)	**1**
Yes (mechanical ventilation)	**2**
9. Assessment	
GCS = 15	**0**
GCS 8–14	**1**
GCS < 8 and/or neurological disorder	**2**
10. Prematurity	
Newborn .2000 g	**0**
Newborn between 1200 and 2000 g	**1**
Newborn ,1200 g	**2**

11. Technopharmacological support (see medication group table)	
None	**0**
Group I	**1**
Group II	**2**

Medication group table:

Group I	**Inotropics** **Vasodilators** **Antiarrhythmics** **Bicarbonate** **Analgesics** **Antiepileptics** **Steroids** **Manitol 20%** **Trombolytics** **Naloxone** **Thoracic tube** **Suction**
Group II	**Inotropics + vasodilators** **MAST.** **Infant incubator** **General anaesthetics** **Uterine relaxants**

Appendix 9 Detailed description of experts' responses:

Case ID	No. of reviewers	No. rated event preventable	No rated event not preventable	No. rated error	No. rated no error	No. rated intervention appropriate	No rated intervention not appropriate
1	3	1	2	1	2	2	1
2	4	1	3	1	3	4	0
3	3	2	1	0	3	2	1
4	3	2	1	0	3	3	0
5	4	2	2	2	2	3	1
6	4	2	2	1	3	3	1
7	3	3	0	3	0	0	3
8	3	1	2	1	2	3	0
9	4	2	2	2	2	3	1
10	3	2	1	1	2	1	2
11	3	2	1	1	2	1	2
12	2	0	2	1	1	1	1
13	3	0	3	0	3	3	0
14	4	2	2	2	2	3	1
15	3	1	2	0	3	3	0
16	3	2	1	2	1	2	1
17	3	2	1	0	3	2	1
18	3	1	2	1	2	3	0
19	3	1	2	0	3	3	0
20	3	0	3	0	3	3	0
21	2	1	1	1	1	2	0
22	3	0	3	1	2	2	1
23	2	0	2	0	2	2	0
24	4	1	3	1	3	4	0
25	4	2	2	0	4	3	1
26	4	0	4	1	3	4	0
27	2	0	2	0	2	2	0

28	3	0	3	0	3	3	0
29	3	1	2	2	1	2	1
30	2	0	2	0	2	2	0
31	3	0	3	0	3	3	0
32	3	0	3	0	3	3	0
33	3	0	3	0	3	3	0
34	2	1	1	1	1	1	1
35	4	0	4	0	4	1	3
36	2	0	2	0	2	1	1
37	3	0	3	1	2	2	1
38	3	2	1	1	2	3	0
39	2	0	2	0	2	2	0
40	4	2	2	1	3	4	0
41	2	1	1	0	2	2	0
42	2	0	2	0	2	2	0
43	3	2	1	0	3	3	0
44	3	0	3	0	3	3	0
45	2	0	2	0	2	2	0
46	3	1	2	0	3	3	0
47	3	0	3	0	3	3	0
48	3	0	3	0	3	3	0
49	2	1	1	1	1	1	1
50	3	0	3	0	3	2	1
51	2	1	1	1	1	2	0
52	3	0	3	0	3	2	1
53	3	0	3	0	3	3	0

Appendix 10 Basic courses in paramedics' education:

Basic science	• Chemistry • Physics • Mathematics • Anatomy • Physiology • Psychology • Sociology
Clinical science	• Medical terminology • Patients assessment • Clinical psychology • Pathology • Pharmacology • Medication administration

Appendix 11 Expert survey participant information leaflet:

Study Title:	**Inter-facility Critical Care Transfer in Saudi Arabia: measuring adverse events, mortality comparison and consensus on interventions in adult critical patients transferred by paramedics.**
Investigator(s):	Abdullah Alabdali, Dr. Chetan Trivedy and Prof. Richard Lilford

Introduction

You are invited to take part in a study. Before you decide, you need to understand why the study is being done and what it would involve for you. Please take the time to read the following information carefully. Talk to others about the study if you wish.

(Part 1 tells you the purpose of the study and what will happen to you if you take part. Part 2 gives you more detailed information about the conduct of the study)

Please ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

PART 1

What is the study about?

The study is to investigate the safety of paramedics interventions to adverse events in adult interfacility critical care transfers. It will also examine the root causes of adverse events.

Do I have to take part?

It is entirely up to you to decide. We will describe the study and go through this information sheet, which we will give you to keep. If you choose to participate, we will ask you to sign a consent form to confirm that you have agreed to take part. You will be free to withdraw at any time, without giving a reason and this will not affect you or your circumstances in any way.

What will happen to me if I take part?

This study is to examine your opinion (as an expert) to adverse events seen by paramedics.

What are the possible disadvantages, side effects, risks, and/or discomforts of taking part in this study?

No identified disadvantages, side effects, risks and or discomforts.

What are the possible benefits of taking part in this study?

Your opinion will help the researchers in determining the safety of utilising paramedics in transferring interfacility adult critically ill patients.

Expenses and payments

The researchers will acknowledge all experts in any publications.

What will happen when the study ends?

The data will be encrypted and saved on excel sheet. All names and identification information will be anonymised.

Will my taking part be kept confidential?

Yes. We will follow strict ethical and legal practice and all information about you will be handled in confidence. Further details are included in Part 2.

What if there is a problem?

Any complaint about the way you have been dealt with during the study or any possible harm that you might suffer will be addressed. Detailed information is given in Part 2.

This concludes Part 1.

If the information in Part 1 has interested you and you are considering participation, please read the additional information in Part 2 before making any decision.

PART 2

Who is organising and funding the study?

The study is part of Mr. Abdullah Alabdali PhD project. Mr. Alabdali is a recipient of a full scholarship by his government. He is a PhD student at Warwick Medical School.

What will happen if I don't want to carry on being part of the study?

Participation in this study is entirely voluntary. Refusal to participate will not affect you in any way. If you decide to take part in the study, you will need to sign a consent form, which states that you have given your consent to participate.

If you agree to participate, you may nevertheless withdraw from the study at any time without affecting you in any way.

You have the right to withdraw from the study completely and decline any further contact by study staff after you withdraw.

What if there is a problem?

This study is covered by the University of Warwick's insurance and indemnity cover. If you have an issue, please contact the Chief Investigator of the study: Abdullah Alabdali, Tel:00447506646836, email: a.alabdali@warwick.ac.uk

Who should I contact if I wish to make a complaint?

Any complaint about the way you have been dealt with during the study or any possible harm you might have suffered will be addressed. Please address your complaint to the person below, who is a senior University of Warwick official entirely independent of this study:

Director of Delivery Assurance
Registrar's Office
University House
University of Warwick
Coventry
CV4 8UW
Complaints@Warwick.ac.uk
024 7657 4774

Will my taking part be kept confidential?

All experts names and identification data will be anonymised before entering the data into

the excel sheet. The researchers will only acknowledge experts names in future publications.

What will happen to the results of the study?

The results of this study will be vital to develop the Saudi interfacility transfer system. Results might be published in scientific journals.

Who has reviewed the study?

This study has been reviewed and given favourable opinion by the University of Warwick's Biomedical and Scientific Research Ethics Committee (BSREC): **REGO-2014-1023 AM01 received on 16th of May, 2016**

What if I want more information about the study?

If you have any questions about any aspect of the study, or your participation in it, not answered by this participant information leaflet, please contact:

Abdullah Alabdali, Tel:00447506646836, email: a.alabdali@warwick.ac.uk
Prof. Richard Lilford, Tel: 004424 7652 3523, email: R.J.Lilford@warwick.ac.uk

Thank you for taking the time to read this participant information leaflet.

Appendix 12 Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence:

Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence

Question	Step 1 (Level 1*)	Step 2 (Level 2*)	Step 3 (Level 3*)	Step 4 (Level 4*)	Step 5 (Level 5)
How common is the problem?	Local and current random sample surveys (or censuses)	Systematic review of surveys that allow matching to local circumstances**	Local non-random sample**	Case-series**	n/a
Is this diagnostic or monitoring test accurate? (Diagnosis)	Systematic review of cross sectional studies with consistently applied reference standard and blinding	Individual cross sectional studies with consistently applied reference standard and blinding	Non-consecutive studies, or studies without consistently applied reference standards**	Case-control studies, or "poor or non-independent reference standard**	Mechanism-based reasoning
What will happen if we do not add a therapy? (Prognosis)	Systematic review of inception cohort studies	Inception cohort studies	Cohort study or control arm of randomized trial*	Case-series or case-control studies, or poor quality prognostic cohort study**	n/a
Does this intervention help? (Treatment Benefits)	Systematic review of randomized trials or *n*-of-1 trials	Randomized trial or observational study with dramatic effect	Non-randomized controlled cohort/follow-up study**	Case-series, case-control studies, or historically controlled studies**	Mechanism-based reasoning
What are the COMMON harms? (Treatment Harms)	Systematic review of randomized trials, systematic review of nested case-control studies, *n*-of-1 trial with the patient you are raising the question about, or observational study with dramatic effect	Individual randomized trial or (exceptionally) observational study with dramatic effect	Non-randomized controlled cohort/follow-up study (post-marketing surveillance) provided there are sufficient numbers to rule out a common harm. (For long-term harms the duration of follow-up must be sufficient.)**	Case-series, case-control, or historically controlled studies**	Mechanism-based reasoning
What are the RARE harms? (Treatment Harms)	Systematic review of randomized trials or *n*-of-1 trial	Randomized trial or (exceptionally) observational study with dramatic effect			
Is this (early detection) test worthwhile? (Screening)	Systematic review of randomized trials	Randomized trial	Non -randomized controlled cohort/follow-up study**	Case-series, case-control, or historically controlled studies**	Mechanism-based reasoning

*** Level may be graded down on the basis of study quality, imprecision, indirectness (study PICO does not match questions PICO), because of inconsistency between studies, or because the absolute effect size is very small; Level may be graded up if there is a large or very large effect size.**

**** As always, a systematic review is generally better than an individual study.**

How to cite the Levels of Evidence Table

OCEBM Levels of Evidence Working Group*. "The Oxford 2011 Levels of Evidence".

Oxford Centre for Evidence-Based Medicine. http://www.cebm.net/index.aspx?o=5653

** OCEBM Table of Evidence Working Group = Jeremy Howick, Iain Chalmers (James Lind Library), Paul Glasziou, Trish Greenhalgh, Carl Heneghan, Alessandro Liberati, Ivan Moschetti, Bob Phillips, Hazel Thornton, Olive Goddard and Mary Hodgkinson*

Appendix 13 Medical scenarios:

Case 1:

Presentation: A 70 year old female patient, unconscious post arrest with chest pain prior to arrest to be transported by a ground ambulance from a local hospital to a tertiary hospital. The distance is 32 miles.

Relevant medical history: The patient has a history of diabetes mellitus hypertension, hyperlipidaemia and a pervious myocardial infarction (2 years ago).

Medications: The patient is on insulin, Atorvastain and Candesartan, Isosorbide nitrate (PRN) and Warfarin.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 114, Pain score: unknown, RR: 47, SPO2: 80%, BP: not measurable, Glasgow Coma Scale (GCS): 3, 12 lead ECG: sinus tachycardia with no ectopic or heart blocks and no ST abnormalities, Temp: 37.2, Capillary refill: >2 sec, Pupils: PEARL at 3mm,Glucose: 7.8 mmol/l.

Interventions (done by sending facility): Right and left anterior cubital IV access, Normal saline infusion at 100cc/h, Isosorbide nitrate 5mg SL, Aspirin 300mg orally and nebulization (Salbutamol 5mg and ipratropium 0.5mg). Patient arrested and had a CPR for 10 minutes.

Time	Event
00:00	Arriving to examine a 70 year old female post arrest.
00:01	Initial physical examination: unconscious female patient with chest pain. Vital signs: HR: 114, Pain score: unknown, RR: 48, SPO2: 80% on 15L non-rebreather mask, BP: not measurable, GCS: 3, 12 lead ECG: sinus tachycardia with no ectopic or heart blocks and no ST abnormalities, Temp: 37.2, Capillary refill: >2 sec, Pupils: PEARL at 3mm, Glucose: 7.8 mmol/l. Patient is transported to EMS monitor, starting intubation ETT 8 at 23cm with good air entry bilateral loading to ambulance.
00:05	Patient on cardiac monitor with SPO2 increased to 91%
00:10	Patient developed sinus bradycardia at 42, 0.5 mg atropine IV given (Incident Bradycardia)
00:14	Patient HR: 62 monitor shows sinus rhythm.
00:18	Patient developed Ventricular fibrillation (V-fib), CPR initiated (Incident Arrest)
00:20	Monitor shows V-fib, 200J defibrillation given 1mg Epinephrine IV given, no changes CPR continues
00:22	Monitor shows V-fib, 200J defibrillation given CPR continues and monitor shoes asystole rhythm
00:24	Monitor shows asystole CPR continues and 1mg epinephrine IV given
00:26	Monitor shows asystole CPR continues
~~00:28~~	~~Monitor shows asystole CPR continues 1mg epinephrine IV given~~

00:29	Arriving main hospital
00:30	Receiving facility data: 70 years old female in cardiac arrest with previous episode of arrest in another facility 45 min ago, revived successfully by sending facility and rearrested in the way to our hospital. Patient intubated size 8 at 23cm by ambulance staff (tube position was confirmed by our ER physician). Patient received 0.5mg atropine, 2 defibrillations at 200j and a total of 3 mg epinephrine and 20 minutes of CPR prior to arrival. Patient was pronounced dead on arrival by ER consultant on duty.

Case 2:

Presentation: A 59 year old male patient, unconscious post arrest with ARDS to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: The patient has a history of diabetes mellitus hypertension and chronic renal failure.

Medications: The patient is on insulin, renal dialysis and Amlodipine.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 60, Pain score: unknown, RR: 12, lung sound: rales bilateral SPO2: 98%, BP: 103/57, Glasgow Coma Scale (GCS): 5, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 37.0, Capillary refill: <2 sec, Pupils: PEARL at 3mm,Glucose: 5.9 mmol/l. Vent setting: Fio2: 30 PEEP 5

Interventions (done by sending facility): Right subclavian central IV access, Normal saline infusion at 100cc/h, Dopamine infusion at 8mcg/kg

Time	Event
00:00	Arriving to examine a 59 year old male post arrest.
00:01	Initial physical examination: unconscious male patient post arrest with ARDS diagnosed at sending facility. Vital signs: HR: 60, Pain score: unknown, RR: 12 on vent, trackstomy size 8 FIO2 30 and PEEP 5, SPO2: 99%, BP:103/57, GCS:5, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:37.0, Capillary refill: <2, Pupils: PEARL at 3mm, Glucose:5.9 mmol/l Patient is transported to EMS monitor, switched to EMS vent FIO2 50 PEEP 5.
00:05	Patient on cardiac monitor with SPO2 increased to 100%
00:54	Patient HR:58 BP:83/40. A fluid bolus of 200 cc was given and dopamine infusion to be increased to 10mcg/kg (incident hypotension)
01:15	Patient HR:64 BP:99/60
01:58	Arriving main hospital
01:59	Receiving facility data: 50 years male direct ICU admission. Unconscious male GCS of 5 on track size 8 vent setting RR:12 Fio2 50 PEEP 5. Spo2 99% rales bilaterally. HR:71 BP: 94/64 on dopamine infusion 10mcg/min. Patient has a central IV confirmed by portable chest X-ray. Patient to be switched to norepinephrine as per ICU consultant.

Case 3:

Presentation: A 74 year old male patient, unconscious post arrest to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: The patient has a history of CVA and hear failure.

Medications: The patient is on Candesartan, Furosemide and Warfarin.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 100, Pain score: unknown, RR: 14 on mechanical ventilation, lung sound: clear, SPO2: 95%, BP: 153/77, Glasgow Coma Scale (GCS): 3, ECG: sinus rhythm and no ST abnormalities, Temp: 37.2, Capillary refill: <2 sec, Pupils: Fixed at 5mm,Glucose: 7.9 mmol/l. Vent setting: Fio2: 50 PEEP 8

Interventions (done by sending facility): Right internal jugular central IV access, ETT size 7.5 at 22cm, Normal saline infusion at 60cc/h, Dopamine infusion 10mcg/kg/min

Time	Event
00:00	Arriving to examine a 74 year old male post arrest.
00:01	Initial physical examination: unconscious male patient post arrest. Vital signs: HR: 100, Pain score: unknown, RR: 14 on vent, ETT size 7.5 at 22cm, FIO2 50 and PEEP 8, SPO2: 95%, BP: 153/77, GCS: 3, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 37.2, Capillary refill: <2 sec, Pupils: fixed at 3mm, Glucose: 7.9 mmol/l Patient is transported to EMS monitor, switched to EMS vent FIO2 50 PEEP 8.
00:27	Patient SPO2: 89% HR: 119 and FIO2 increased to 100% (Desaturation)
00:32	Patient HR: 109 SPOO2: 94%
01:41	Patient SPO2: 96% HR: 104
01:46	Arriving main hospital
01:46	Receiving facility data: 74 years male direct ICU admission. Unconscious GCS of 3 male on ETT size 7.5 at 22cm vent setting RR: 14 Fio2 100 PEEP 8. Spo2 95% and lung sounds are clear bilateral. HR: 104 BP: 144/70 on dopamine infusion 10mcg/min. Patient has a central IV confirmed by portable chest X-ray.

Case 4:

Presentation: A 53 year old female patient, unconscious post appendectomy and arrest to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles. (Brain dead confirmed by sending facility)

Relevant medical history: The patient had a cardiac arrest post appendectomy.

Medications: No known medication,

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 82, Pain score: unknown, RR: 17 on mechanical ventilation, lung sound: rales bilateral, SPO2: 91%, BP: 110/65, Glasgow Coma Scale (GCS): 3, ECG: sinus rhythm and no ST abnormalities, Temp: 35.9, Capillary refill: <2 sec, Pupils: Fixed at 6mm,Glucose: 18.6 mmol/l. Vent setting: Fio2: 100 PEEP 10

Interventions (done by sending facility): Right subclavian central IV access, Normal saline infusion at 60cc/h, norepinephrine infusion at 2mcg/min, OGT size 18F and Foley catheter 16F

Time	Event
00:00	Arriving to examine a 53 year old female post arrest.
00:01	Initial physical examination: unconscious female patient post arrest. Vital signs: HR: 82, Pain score: unknown, RR: 17 on vent, ETT size 7 at 19cm, FIO2 100 and PEEP 10, SPO2: 91%, BP: 110/65, GCS: 3, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 35.9, Capillary refill: <2, Pupils: fixed at 3mm, Glucose: 18.6 mmol/l Patient is transported to EMS monitor, switched to EMS vent FIO2 100 PEEP 10.
00:18	Patient SPO2: 81% (incident desaturation) HR: 84 and patient switched to BVM
00:22	Patient HR: 76 SPOO2: 89% BVM at 18 per minute
00:32	Patient HR 84 SPO2: 86% BVM at 18 per minutes
00:49	Arriving main hospital
00:49	Receiving facility data: 53 years female direct ICU admission. Unconscious female, GCS of 3 on ETT size 7 at 19cm on BVM. Spo2 86% and lung sounds are rales bilateral. HR: 81 BP: 111/53 on norepinephrine infusion 2mcg/min. Pupils fixed at 5mm. Glucose 14.8 mmol/l. Patient has a central IV confirmed by portable chest X-ray. Foley catheter 16F and OGT.

Case 5:

Presentation: An 85 year old female patient, unconscious post arrest to be transported by a ground ambulance from a local ER to a tertiary hospital. The distance is 19 miles.

Relevant medical history: The patient had a history of diabetes mellitus, hypertension, pervious CVA and congestive heart failure.

Medications: unknown medication.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 54, Pain score: unknown, RR: 8 on BVM, lung sound: rales bilateral, SPO2: 79%, BP: unmeasurable, Glasgow Coma Scale (GCS): 3, ECG: sinus Brady with no heart blocks and no ST abnormalities, Temp: 36.9, Capillary refill: >2 sec, Pupils: PEARL, Glucose: 7.4 mmol/l.

Interventions (done by sending facility): Right and left anterior cubital (AC) IV access, Normal saline infusion at 100cc/h. ETT size 7 at22 cm. Patient has received 2 cycles of CPR and 1mg epinephrine IV.

Time	Event
00:00	Arriving to examine an 85 year old female post arrest.
00:01	Initial physical examination: unconscious female patient post arrest. Vital signs: HR: 54, Pain score: unknown, RR: 8 on BVM, ETT size 7 at 22cm, SPO2: 91%, BP: 81/66, GCS: 3, ECG: sinus bradycardia with no ectopic or heart blocks and no ST abnormalities, Temp: 36.9, Capillary refill: >2 sec, Pupils: PEARL and left cataract, Glucose: 7.4 mmol/l Patient is transported to EMS monitor.
00:07	Patient SPO2: 92% HR: 20 and BVM at12. Patient is given 500 cc IV normal saline bolus and 0.5mg atropine (Bradycardia)
00:12	Patient HR: 130 BP: 138/78
00:26	Patient BP: 94/67 and 250cc normal saline bolus is given
00:31	BP: 100/62
00:35	Receiving facility data:85 years old female post arrest. GCS of 8, on ETT size 7 at 22cm spontaneous breathing at 36. Spo2 91% and lung sounds are rales bilateral. HR: 132 BP: 90/53, Pupils: Right is Briskly and Left has a cataract. Glucose 7.2 mmol/l. Patient has 2 AC IV. Patient to be shifted to resuscitation room.

Case 6:

Presentation: An 88 year old female patient, unconscious post Acute Myocardial Infarction (AMI) to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: The patient has diabetes mellitus, hypertension, previous CVA, Asthma and aspiration pneumonia.

Medications: Insulin, amlodipine and Warfarin.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 107, Pain score: unknown, RR: 10 on mechanical ventilation, lung sound: clear, SPO2: 98%, BP: 115/45, Glasgow Coma Scale (GCS): 3, ECG: sinus rhythm and no ST abnormalities, Temp: 37.9, Capillary refill: <2 sec, Pupils: Bilateral cataract, Glucose: 16.8 mmol/l. Vent setting: Fio2: 60 PEEP 5

Interventions (done by sending facility): ETT size 7at 22cm.Foley catheter 14F and normal saline 80cc/h, midazolam 5mg/h

Time	Event
00:00	Arriving to examine an 88 years old female post AMI.
00:01	Initial physical examination: unconscious female patient post AMI. Vital signs: HR: 107. Pain score: unknown, RR: 10 on vent, ETT size 7 at 22cm, FIO2 60 and PEEP 5, SPO2: 98%, BP: 115/52, GCS: 3, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 37.9, Capillary refill: <2, Pupils: bilateral cataract, Glucose: 16.8 mmol/l Patient is transported to EMS monitor, switched to EMS vent FIO2 100 PEEP 5.
00:35	Patient BP: 81/28 HR: 118 500cc normal saline bolus given (hypotension)
00:40	Patient HR: 110 BP: 115/30 and patient is agitated 100mcg fentanyl is given (agitated)
00:42	Patient is tolerating tube and BP108/39
01:15	Arriving main hospital
01:15	Receiving facility data: 88 years female direct ICU admission. Unconscious GCS of 3 female on ETT size 7 at 24cm on mechanical ventilation FIO2 100 PEEP 5. RR: 10 Spo2 100% and lung sounds are clear bilateral. HR: 107 BP: 152/63 on midazolam infusion 5mg/h. Pupils bilateral cataract. Glucose 15.5 mmol/l. Foley catheter 14F.

Case 7:

Presentation: A 79 year old female patient, unconscious with shortness of breath (SOB) (congestive heart failure and pulmonary oedema) to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 17 miles.

Relevant medical history: The patient has diabetes mellitus hypertension and cardiac history.

Medications: unknown medication.

Allergies: No known allergies.

Observations (sending facility report): semi-conscious female with SOB. Vital signs: HR: 101, Pain score: unknown, RR: 30, lung sound: rales bilateral, SPO2: 84%, BP: 124/67, Glasgow Coma Scale (GCS): 10, ECG: sinus rhythm and no ST abnormalities, Temp: 37.1, Capillary refill: <2, Pupils: PEARL, Glucose: 9.5 mmol/l.

Interventions (done by sending facility): Right peripheral IV access, Normal saline infusion at 80cc/h. Patient received Isosorbide nitrate 5mg Sub Lingual (SL) and morphine 1mg.

Time	Event
00:00	Arriving to examine a 79 year old female with SOB.
00:01	Initial physical examination: semi-conscious female patient with SOB. Vital signs: HR: 101, Pain score: unknown, RR: 30, SPO2: 88%, BP: 100/80, GCS:8, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:37.1, Capillary refill: <2, Pupils: PEARL, Glucose:9.5 mmol/l Patient is transported to EMS monitor, and start bagging at 12/min.
00:04	Patient SPO2: 90% HR: 125 and morphine 3 mg is given (Incident pulmonary oedema)
00:10	Patient HR: 130 SPOO2: 93% BVM at 12 per minute
01:28	Arriving main hospital
01:28	Receiving facility data: 79 years female with SOB Inquiry pulmonary edema. Unconscious GCS of 3 on BVM. Spo2 93% and lung sounds are rales bilateral. HR: 119 BP: 99/59, Pupils: constricted. Glucose 9.5 mmol/l. Patient to be intubated immediately as per ER consultant.

Case 8:

Presentation: A 57 year old male patient, unconscious with meningitis/viral encephalitis and hydrocephalus to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: No significant past history.

Medications: No known medication,

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 68, Pain score: unknown, RR: 14 on mechanical ventilation, lung sound: clear bilateral, SPO2: 100%, BP: 80/49, Glasgow Coma Scale (GCS): 3, ECG: sinus rhythm and no ST abnormalities, Temp: 36.7, Capillary refill: <2 sec, Pupils: sluggish, Glucose: 6.8 mmol/l. Vent setting: Fio2: 100 PEEP 5

Interventions (done by sending facility): Right subclavian central IV access, Normal saline infusion at 80cc/h, adrenaline infusion at 5mcg/min, midazolam 5mg/h and fentanyl 100mcg/h, ETT 7.5 at 23 cm

Time	Event
00:00	Arriving to examine a 57 years old male with encephalitis and hydrocephalus.
00:01	Initial physical examination: unconscious male. Vital signs: HR: 68, Pain score: unknown, RR: 14 on vent, ETT size 7.5 at 23cm, FIO2 100 and PEEP 5, SPO2: 100%, BP: 80/45, GCS: 3, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 36.7, Capillary refill: <2, Pupils: Sluggish at 3mm, Glucose: 6.8 mmol/l Patient is transported to EMS monitor, switched to EMS vent FIO2 100 PEEP 5.
00:05	Patient BP: 76/40 Stopped midazolam infusion and increased adrenaline infusion to 10mcg/min
00:10	Patient BP: 97/60
01:19	Arriving main hospital
01:20	Receiving facility data: 57 years male direct ICU admission. Unconscious GCS of 3 on ETT size 7.5 at 23cm on mechanical ventilation. Spo2 100% and lung sounds are clear bilateral. HR: 70 BP: 118/68 on adrenaline infusion 10mcg/min and Fentanyl 100mcg/h. Pupils sluggish at 3mm. Glucose 6.8 mmol/l. Patient has a right subclavian central IV confirmed by portable chest X-ray.

Case 9:

Presentation: A 43 year old male patient with new onset of palpitation and dizziness. Conscious, alert and oriented male is to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: No significant past history.

Medications: No known medication,

Allergies: No known allergies.

Observations (sending facility report): Conscious with severe dizziness. Vital signs: HR: 166, Pain score: unknown, RR: 28, lung sound: clear bilateral, SPO2: 100%, BP: 110/79, Glasgow Coma Scale (GCS): 15, ECG: Atrial fibrillation and no ST abnormalities, Temp: 36.9, Capillary refill: <2, Pupils: PEARL, Glucose: 5.2 mmol/l.

Interventions (done by sending facility): Right and left anterior cubital (AC) IV access, Normal saline infusion at 80cc/h, patient received 2 doses of diltiazem (25mg and 35mg), fentanyl 100mcg and 3 cardioversions at 50, 100,100 joules, Aspirin 324 mg

Time	Event
00:00	Arriving to examine a 43 year old male with palpitation and dizziness.
00:01	Initial physical examination: conscious, alert and oriented male complaining of severe dizziness and palpitation. Vital signs: HR: 152, Pain score: unknown, RR: 24, SPO2: 100% on 10L non-rebreather mask, BP: 108/63, GCS: 15, ECG: atrial fibrillation at 155 and no ST abnormalities, Temp: 36.7, Capillary refill: <2, Pupils: PEARL, Glucose: 5.9 mmol/l Patient is transported to EMS monitor.
00:27	Patient BP: 73/53 and patient is semi-conscious, a normal saline bolus of 1000cc is given (Incident hypotension)
00:32	Patient BP: 104/71 and patient complain of dizziness and palpitation HR: 151
00:40	Patient HR: 172 ECG: Atrial fibrillation
00:47	Arriving main hospital
01:20	Receiving facility data: a 43 years old male with palpitation and dizziness. Conscious GCS of 15 on 10L non-rebreather mask. Spo2 100% and lung sounds are clear bilateral. HR: 187 BP: 114/68. Pupils PEARL. Glucose 5.1 mmol/l. Patient to be moved to resuscitation area.

Case 10:

Presentation: A 72 year old male patient, unconscious for heart valve replacement to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: The patient is obese with history of diabetes mellitus and hypertension.

Medications: Metformin, Gliclazide, Amlodipine, and Aspirin.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 67, Pain score: unknown, RR: 16 on mechanical ventilation, lung sound: clear, SPO2: 91%, BP: 132/57, Glasgow Coma Scale (GCS): 3, ECG: sinus rhythm and no ST abnormalities, Temp: 36.9, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 6.0 mmol/l. Vent setting: Fio2: 50 PEEP 5

Interventions (done by sending facility): ETT size 8at 22cm. Normal saline 80cc/h, midazolam 5mg/h and dopamine 8mcg/kg/min

Time	Event
00:00	Arriving to examine a 72 year old male.
00:01	Initial physical examination: unconscious male patient. Vital signs: HR: 67. Pain score: unknown, RR: 16 on vent, ETT size 8 at 22cm, FIO2 50 and PEEP 5, SPO2: 91%, BP: 132/57, GCS: 3, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 36.9, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 6.0 mmol/l Patient is transported to EMS monitor, switched to EMS vent FIO2 100 PEEP 5.
00:01	After switching patient to EMS ventilator, patient started desaturation SPO2: 86%, HR: 85, patient switched to BVM at 18 per minutes SPO2: 90% (Desaturation)
00:06	Patient HR: 66 BP: 156/99 and SPO2: 96%
01:09	Arriving main hospital
01:15	Receiving facility data: 72 years male obese direct CCU admission. Unconscious GCS of 3 male on ETT size 8 at 22cm with BVM. RR: 13 according to paramedic. Spo2 97% and lung sounds are clear bilateral. HR: 62 BP: 152/63 on midazolam infusion 5mg/h and dopamine 8mcg/kg/min. Pupils PEARL. Glucose 7.4 mmol/l.

Case 11:

Presentation: A 48 year old male patient with chest pain. Conscious, alert and oriented male is to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: No significant past history.

Medications: No known medication,

Allergies: No known allergies.

Observations (sending facility report): Conscious with chest pain. Vital signs: HR: 72, Pain score: 6/10, RR: 22, lung sound: clear bilateral, SPO2: 99% on 10 L non-rebreather mask, BP: 100/72, Glasgow Coma Scale (GCS): 15, ECG: Sinus rhythm with ST elevation lead II, III and aVF 3 small boxes, Temp: 36.5, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 8.1 mmol/l.

Interventions (done by sending facility): Right and left anterior cubital (AC) IV access, Normal saline infusion at 80cc/h, patient have received Aspirin 324 mg. Patient received Isosorbide nitrate 5mg Sub Lingual (SL).

Time	Event
00:00	Arriving to examine a 48 year old male with chest pain.
00:01	Initial physical examination: conscious, alert and oriented male complaining of chest pain. Vital signs: HR: 69, Pain score: 3/10, RR: 19, SPO2: 100% on 10L non-rebreather mask, BP: 100/72, GCS: 15, ECG: Sinus rhythm with ST elevation lead II, III and aVF 3 small boxes, Temp: 36.7, Capillary refill: <2, Pupils: PEARL, Glucose: 8.1 mmol/l Patient is transported to EMS monitor.
00:17	Patient HR: 42 GCS=15 no change in chest pain and BP: 95/64 (Bradycardia)
00:18	0.5 mg atropine given
00:19	HR: 49 and a second 0.5mg atropine given
00:21	HR: 62 BP: 128/112 GCS: 15
00:38	Receiving facility data: a 48 years old male with chest pain. Conscious GCS of 15 on 10L non rebreather mask. Spo2 100% and lung sounds are clear bilateral. HR: 64 BP: 124/70. Pupils PEARL. Glucose 8.3 mmol/l. Patient to be transferred directly to catheterization lab.

Case 12:

Presentation: A 33 year old female patient with new onset of palpitation and dizziness. Conscious, alert and oriented female is to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: No significant past history.

Medications: No known medication,

Allergies: No known allergies.

Observations (sending facility report): Conscious with dizziness. Vital signs: HR: 103, Pain score: 1, RR: 19, lung sound: clear bilateral, SPO2: 99%, BP: 94/50, Glasgow Coma Scale (GCS): 15, ECG: Atrial fibrillation and no ST abnormalities, Temp: 36.8, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 7.6 mmol/l.

Interventions (done by sending facility): Right (AC) IV access, Normal saline infusion at 80cc/h, patient received 1 dose metoprolol 5mg, 1 synchronized cardioversion at 50 joules, Aspirin 324 mg

Time	Event
00:00	Arriving to examine a 33 year old female with palpitation and dizziness.
00:01	Initial physical examination: conscious, alert and oriented female complaining of dizziness and mild palpitation. Vital signs: HR: 103, Pain score: 1, RR: 19, SPO2: 100% on 10L non-rebreather mask, BP: 90/50, GCS: 15, ECG: sinus rhythm at 103 and no ST abnormalities, Temp: 36.7, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 7.6 mmol/l Patient is transported to EMS monitor. Bolus 200cc normal saline is given.
00:05	Patient HR: 91 BP: 136/63
00:18	Patient glucose: 8.1 mmol/l
01:04	Patient HR: 200 BP: 110/66 ECG: Atrial fibrillation (Incident Arrhythmia) NO TREATMENT given and paramedic documented that patient developed Atrial fibrillation after passing the hospital gate.
01:06	Arriving main hospital
01:07	Receiving facility data: a 33 years old female with palpitation and dizziness. Conscious GCS of 15 on 10L non-rebreather mask. Spo2 100% and lung sounds are clear bilateral. HR: 197 BP: 128/65. Pupils PEARL. Glucose 8.1 mmol/l. ECG: Atrial fibrillation at 197. Patient to be moved to resuscitation area.

Case 13:

Presentation: A 90 year old male patient, unconscious post Road Traffic Accident (RTA) to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: The patient has diabetes mellitus.

Medications: Insulin.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Polytrauma including Traumatic Brain Injury (TBI) Vital signs: HR: 102, Pain score: unknown, RR: 18 on mechanical ventilation, lung sound: clear, SPO2: 93%, BP: 116/80, Glasgow Coma Scale (GCS): 3, ECG: sinus rhythm and no ST abnormalities, Capillary refill: <2 sec, Pupils: Fixed bilateral, Glucose: 8.9 mmol/l. Vent setting: Fio2: 75 PEEP 8. Haemoglobin:19 g/dl

Interventions (done by sending facility): ETT size 8at 24cm.Foley catheter 14F and normal saline 80cc/h, midazolam 5mg/h and Fentanyl 100mcg/h

Time	Event
00:00	Arriving to examine a 90 year old male post RTA.
00:01	Initial physical examination: unconscious male patient post RTA with polytrauma on backboard and fully immobilized. Vital signs: HR: 102. Pain score: unknown, RR: 18 on vent, ETT size 8 at 24cm, FIO2 75 and PEEP 8, SPO2: 93%, BP: 116/80, GCS: 3, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Capillary refill: <2 sec, Pupils: fixed bilateral, Glucose: 8.9 mmol/l Patient is transported to EMS monitor, switched to EMS vent FIO2 100 PEEP 8.
00:27	Patient SPO2: 87% patients need suction (Desaturation) HR: 118
00:27	Suctioning with soft catheter thick mucus. Increasing RR: 20
00:28	SPO2: 91% HR: 93 and BP: 112/57
01:01	Arriving main hospital
01:15	Receiving facility data: 90 years male direct ICU admission. Unconscious GCS of 3 male on ETT size 8 at 24cm on mechanical ventilation FIO2 100 PEEP 8. RR: 22 Spo2 92% and lung sounds are clear bilateral. HR: 72 BP: 104/78 on midazolam infusion 5mg/h and fentanyl 100mcg/h. Pupils bilateral sluggish. Foley catheter 14F.

Case 14:

Presentation: An 82 year old male patient post cardiac arrest possible upper GI bleed. Unconscious male to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: previous stroke 3 years ago. Bedridden patient.

Medications: Unknown medication,

Allergies: No known allergies.

Observations (sending facility report): Unconscious male post arrest (CPR 18 minutes). Vital signs: HR: 67 weak, Pain score: unknown, RR: 12 via Bag Valve Mask (BVM), lung sound: rales bilateral. SPO2: 100%, BP: 64/35, Glasgow Coma Scale (GCS):3, ECG: Sinus rhythm with no ST abnormalities, Temp:36.2, Pupils: Fixed and dilated bilateral, Glucose:16.2 mmol/l. Haemoglobin: 3.3 g/dl

Interventions (done by sending facility): Right and left (AC) IV access, Normal saline infusion at 100cc/h, patient received 6 doses of epinephrine 1mg and 2 defibrillations with 200 joules patient also received 50meq sodium bicarbonate.

Time	Event
00:00	Arriving to examine an 82 year old male post arrest.
00:01	Initial physical examination: unconscious, Vital signs: HR: 67, RR: 12 on BVM, SPO2: 100%, BP: 64/35, GCS: 3, ECG: sinus rhythm at 67 and no ST abnormalities, Pulse is weak. Temp: 36.2, Pupils: Fixed and dilated bilateral, Glucose: 16.2 mmol/l Patient is transported to EMS monitor.
00:01	Before leaving the hospital patient had no pulse. ECG: sinus rhythm at 63. (Incident arrest) CPR initiated. Instructed the driver to not leave the sending facility and informing sending ER staff.
00:03	CPR is continued. 1 mg Epinephrine. ECG: PEA at 48 and 2L of normal saline fluid is being infused.
00:05	CPR is continued ECG: PEA at 42
00:07	CPR is continued 1mg Epinephrine is given. 50meq sodium bicarbonate is given.
00:09	Weak pulse at 47. A 2L of fluid is being infused. Ambulance on road.
00:11	HR: 43, BP: 85/49 and 0.5mg atropine is given and 2 Liter normal saline has been infused and 1L is being infused
00:13	HR: 51 and intubating with ETT size7 at 23cm. Confirmed air entry by auscultation.
00:36	Receiving facility data: an 82 year old male post arrest. Unconscious GCS of 3. Intubated with ETT size 7 at 23 cm. Spo2 100% and lung sounds are rales bilateral. HR: 40 weak pulses, BP: 89/50. Pupils fixed and dilated. Glucose 17.9 mmol/l. ECG: sinus Brady at 40. Patient had an arrest during the transfer,

	received 2mg epinephrine, 3.5L of normal saline fluid and 50meq sodium bicarbonate.

Case 15:

Presentation: A 57 year old male patient with myeloblastoma and aspiration. Unconscious male to be transported from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: Myeloblastoma. Hypertension.

Medications: Amlodipine.

Allergies: No known allergies.

Observations (sending facility report): Unconscious male with aspiration. Vital signs: HR: 73, Pain score: unknown, RR: 14 on mechanical ventilation ETT size 8 at 24cm, Fio2: 30 PEEP: 5, lung sound: clear bilateral. SPO2: 100%, skin condition: Diaphoretic, BP: 133/82, Glasgow Coma Scale (GCS):3, ECG: Sinus rhythm with no ST abnormalities, Temp:37.2, Pupils: Briskly to light at 3mm, Glucose: 7.8mmol/l. Haemoglobin: 71 g/dl

Interventions (done by sending facility): Right IV access, Normal saline infusion at 100cc/h, Midazolam 5mg/h and Fentanyl 150mcg/h

Time	Event
00:00	Arriving to examine a 57 year old male.
00:01	Initial physical examination: unconscious, Vital signs: HR: 73, RR: 14 on Mechanical ventilation Fio2: 30 and PEEP: 5, SPO2: 100%, BP: 133/82, GCS: 3, ECG: sinus rhythm at 73 and no ST abnormalities, Temp: 37.2, Pupils: sluggish, Glucose: 7.8 mmol/l Patient is transported to EMS monitor and EMS ventilator setting Fio2 50 and PEEP: 5
00:17	SPO2: 94%, Increased Fio2 to 100
00:19	Spo2: 91 increased RR to 20
00:24	SPO2: 87 (Desaturation) Paramedic documented ‘possible’ vent malfunction and switched to BVM RR: 20
00:36	Receiving facility data: a 57 years old mal. Unconscious GCS of 3. Intubated with ETT size 8 at 24 cm. Spo2 100% and lung sounds are clear bilateral. HR: 74, BP: 132/86. Pupils sluggish at 3mm. Glucose 7.8 mmol/l. ECG: sinus rhythm at 74. Patient on BVM RR: 20. To be transferred to ICU.

Case 16:

Presentation: A 78 year old male patient with acute necrotic pancreatitis. Unconscious male to be transported from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: Acute necrotic pancreatitis. Diabetes and hypertension.

Medications: Insulin, Amlodipine.

Allergies: No known allergies.

Observations (sending facility report): Unconscious male acute necrotic pancreatitis. Vital signs: HR: 110, Pain score: unknown, RR: 12 on mechanical ventilation ETT size 8 at 23cm, Fio2: 60 PEEP: 8, lung sound: clear bilateral. SPO2: 100%, skin condition: warm, BP: 158/78, Glasgow Coma Scale (GCS):3, ECG: Sinus rhythm with no ST abnormalities, Temp:38.6, Pupils: cataract bilateral, Glucose: 8.4mmol/l.

Interventions (done by sending facility): Right internal jugular IV access, Ringer lactate at 100cc/h, Midazolam 8mg/h and Dopamine 5mcg/kg/min

Time	Event
00:00	Arriving to examine a 78 years old male.
00:01	Initial physical examination: unconscious, Vital signs: HR: 110, RR: 12 on Mechanical ventilation Fio2: 60 and PEEP: 8, SPO2: 100%, BP: 150/78, GCS: 3, ECG: sinus rhythm at 110 and no ST abnormalities, Temp: 38.6, Pupils: cataract, Glucose: 8.4 mmol/l Patient is transported to EMS monitor and EMS ventilator setting Fio2 100 and PEEP: 8
00:32	Patient is agitated BP: 181/64 HR: 124 (Agitation)
00:32	A bolus of 5mg Midazolam is given.
00:36	HR: 89 BP: 174/68
00:53	Receiving facility data: a 78 years old mal. Unconscious GCS of 3. Intubated with ETT size 8 at 23 cm. Spo2 100% and lung sounds are clear bilateral. HR: 80, BP: 162/73. Pupils cataract. ECG: sinus rhythm at 74. Patient on vent RR: 12, Fio2: 100 and PEEP: 8. To be transferred to ICU.

Case 17:

Presentation: A 43 year old male with chest pain. Patient to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: No known medical history.

Medications: No known medication.

Allergies: No known allergies.

Observations (sending facility report): A 43 years old male with stabbing chest pain started around 120 minutes. Vital signs: HR: 54, Pain score: 7, RR: 16, lung sound: clear bilateral. SPO2: 100% on O2 via nasal cannula 3L, BP: 103/64, Glasgow Coma Scale (GCS): 15, ECG: Sinus rhythm with ST elevation II, III, aVF and V1-V4, Temp: 36.8, Pupils: PEARL, Glucose: 7.6 mmol/l.

Interventions (done by sending facility): Right and left (AC) IV access, Normal saline infusion at 100cc/h, patient received Aspirin 300mg orally and 5 mg morphine (IV).

Time	Event
00:00	Arriving to examine a 43 years old male with chest pain.
00:01	Initial physical examination: conscious, alert and oriented complaining of mild central chest paint, Vital signs: HR: 54, RR: 18 on nasal cannula 3L, SPO2: 100%, BP: 103/62, GCS: 15, ECG: Sinus rhythm with ST elevation II, III, aVF and V1-V4. Temp: 36.8, Pupils: PEARL, Glucose: 7.6 mmol/l Patient is transported to EMS monitor.
00:42	Patent is complaining of light headed and dizziness. HR: 69 BP: 76/42 (Hypotension)
00:43	Patient is receiving a bolus of 500cc normal saline.
00:47	BP: 98/68 HR: 57
00:57	HR: 53 BP: 119/77
00:36	Receiving facility data: a 43 years old male with chest pain. Patient is conscious alert and oriented. Currently, No chest pain. HR: 56 BP: 114/72, RR: 21 on nasal cannula 3L, SPO2 100%. ECG: ECG: Sinus rhythm with ST elevation II, III, aVF and V1-V4. Patient is sent to Cath lab.

Case 18:

Presentation: A 60 year old male patient post RTA with TBI. Unconscious male to be transported from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: TBI post RTA.

Medications: No know medications.

Allergies: No known allergies.

Observations (sending facility report): Unconscious male post RTA. Vital signs: HR: 128, Pain score: unknown, RR: 12 on mechanical ventilation ETT size 7.5 at 23cm, Fio2: 50 PEEP: 8, lung sound: decreased on the left side. SPO2: 100%, skin condition: unremarkable, BP: 156/72, Glasgow Coma Scale (GCS):3, ECG: Sinus rhythm with no ST abnormalities, Temp:38, Pupils: briskly to light, Glucose: 13.2 mmol/l.

Interventions (done by sending facility): Right internal jugular IV access, left side chest drainage and Left side arterial line. Normal saline at 100cc/h, Midazolam 5mg/h and Rocuronium 0.01mcg/kg/min

Time	Event
00:00	Arriving to examine a 60 year old male post RTA.
00:01	Initial physical examination: Unconscious male post RTA. Vital signs: HR: 128, Pain score: unknown, RR: 12 on mechanical ventilation ETT size 7.5 at 23cm, Fio2: 50 PEEP: 8, lung sound: decreased on the left side. SPO2: 100%, skin condition: unremarkable, BP: 156/72, Glasgow Coma Scale (GCS): 3, ECG: Sinus rhythm with no ST abnormalities, Temp: 38, Pupils: briskly to light, Glucose: 13.2 mmol/l. patient has a Right internal jugular IV access, Left side chest drainage and Left side arterial line. Patient is receiving Normal saline at 100cc/h, Midazolam 5mg/h and Rocuronium 0.01mcg/kg/min. Patient is transported to EMS monitor and EMS ventilator setting Fio2 100 and PEEP: 8
00:47	Patient is agitated BP: 188/96, HR: 143 (Agitation)
00:47	A bolus of 2mg Midazolam and 100 mcg of Fentanyl is given.
00:51	HR: 106 BP: 149/83
01:25	Receiving facility data: a 60 years old male post RTA. Unconscious GCS of 3. Intubated with ETT size 7.5 at 22cm. CXR good position of ETT. Spo2 100% and lung sounds are decreased on the left side. Left side chest tube with no swinging. Right internal jugular IV access and Left arterial line. HR: 108, BP: 130/69. Pupils sluggish. ECG: sinus rhythm at 108 with ST

	abnormalities. Patient on vent RR: 12, Fio2: 100 and PEEP: 8. To be transferred to ICU.

Case 19:

Presentation: A 30 year old female patient post RTA with transcutaneous emphysema. Unconscious female to be transported from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: Post RTA.

Medications: No know medications.

Allergies: No known allergies.

Observations (sending facility report): Unconscious female post RTA. Vital signs: HR: 120, Pain score: unknown, RR: 12 on mechanical ventilation ETT size 7 at 22cm, Fio2: 60 PEEP: 5, lung sound: Clear. SPO2: 100%, skin condition: warm, BP: 131/75, Glasgow Coma Scale (GCS):3, ECG: Sinus rhythm with no ST abnormalities, Temp:36.9, Pupils: PEARL, Glucose: 12.0 mmol/l.

Interventions (done by sending facility): Right internal jugular IV access, two chest drainage and a Foley catheter. Normal saline at 100cc/h, Midazolam 5mg/h and Fentanyl 100mcg/h

Time	Event
00:00	Arriving to examine a 30 year old female post RTA.
00:01	Initial physical examination: Unconscious female post RTA. Vital signs: HR: 120, Pain score: unknown, RR: 12 on mechanical ventilation ETT size 7 at 22cm, Fio2: 60 PEEP: 5, lung sound: Clear. SPO2: 100%, skin condition: warm, BP: 131/75, Glasgow Coma Scale (GCS): 3, ECG: Sinus rhythm with no ST abnormalities, Temp: 36.9, Pupils: PEARL, Glucose: 12.0 mmol/l. patient has a Right internal jugular IV access, two chest drainage and a Foley catheter. Patient is receiving Normal saline at 100cc/h, Midazolam 5mg/h and Fentanyl 100mcg/h. Patient is transported to EMS monitor and EMS ventilator setting Fio2 100 and PEEP: 5
00:23	Patient is agitated HR: 134 and GCS: 7 (Agitation)
00:23	A bolus of 5mg Midazolam and 30mg Rocuronium is given.
00:25	HR: 117 and GCS: 3
01:25	Receiving facility data: a 30 years old female post RTA. Unconscious GCS of 3. Intubated with ETT size 7 at 21cm. CXR good position of ETT. Spo2 100% and lung sounds are clear bilateral. Bilateral chest tube with no swinging. Right internal jugular IV access and a Foley catheter with clear urine output. HR: 110, BP: 137/92. Pupils: PEARL. ECG: sinus rhythm at 110 with ST abnormalities. Patient on vent RR: 12, Fio2: 100 and PEEP: 5. To be transferred to ICU.

Case 20:

Presentation: A 17 year old male patient with multiple gunshots to the left back, left chest, left buttocks and right humorous. Unconscious male to be transported from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: No past medical history.

Medications: No know medications.

Allergies: No known allergies.

Observations (sending facility report): Unconscious male with gunshots. Vital signs: HR: 138, Pain score: unknown, RR: 12 on mechanical ventilation ETT size 7.5 at 23cm, Fio2: 80 PEEP: 5, lung sound: rales and decreased bilateral. SPO2: 93%, skin condition: normal, BP: 152/89, Glasgow Coma Scale (GCS):3, ECG: Sinus rhythm with no ST abnormalities, Temp:38.9, Pupils: PEARL, Glucose: 7.0 mmol/l.

Interventions (done by sending facility): Right subclavian IV access. Foley catheter. Normal saline at 100cc/h, Midazolam 5mg/h and Fentanyl 100mcg/h and Esmeron (Rocuronium) 0.01mg/kg/min

Time	Event
00:00	Arriving to examine a 17 year old male with multiple gunshots.
00:01	Initial physical examination: Unconscious male with gunshots. Vital signs: HR: 138, Pain score: unknown, RR: 12 on mechanical ventilation ETT size 7.5 at 23cm, Fio2: 80 PEEP: 5, lung sound: rales and decreased bilateral. SPO2: 93% (sending facility reported that this level is the patient baseline!), skin condition: normal, BP: 152/89, Glasgow Coma Scale (GCS):3, ECG: Sinus rhythm with no ST abnormalities, Temp:38.9, Pupils: PEARL, Glucose: 7.0 mmol/l. Patient has a Right subclavian IV access, and a Foley catheter. Patient is receiving Normal saline at 100cc/h, Midazolam 5mg/h and Fentanyl 100mcg/h and Esmeron (Rocuronium) 0.01mg/kg/min. Patient is transported to EMS monitor and EMS ventilator setting Fio2 100 and PEEP: 5.
00:53	Spo2: 84% (Desaturation), HR: 142
00:53	Patient is switched BVM at 18 bpm suctioning with soft catheter and thick mucus is noticed.
00:55	SPO2: 89% HR: 140
01:03	SPO2:87% HR: 137, patient is on BVM at 18 and suctioning, thick mucus!
01:12	SPO2: 91% patient is on BVM at 18 and suctioning, thick mucus!
01:24	Receiving facility data: a 17 years old with multiple gunshots. unconscious GCS of 3. Intubated with ETT size 7.5 at 24cm. CXR good position of ETT no signs of pneumo/hemothorax. Spo2 91% and lung sounds are rales and decreased bilateral.

	Right subclavian IV access and a Foley catheter with clear urine output. HR:132, BP: 156/88. Pupils: PEARL. ECG: sinus rhythm at 132 with no ST abnormalities. Patient on BVM. To be transferred to ICU.

Case 21:

Presentation: A 52 year old male patient post cardiac arrest. Unconscious male to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: Diabetes mellitus and hypertension.

Medications: amlodipine and insulin.

Allergies: No known allergies.

Observations (sending facility report): Unconscious male post arrest (CPR 4 minutes and 1 defibrillation). Vital signs: HR: 87 weak, Pain score: unknown, RR: 10 via Bag Valve Mask (BVM), lung sound: clear bilateral. SPO2: 87%, BP: unmeasurable, Glasgow Coma Scale (GCS):3, ECG: Sinus rhythm with no ST abnormalities, Temp:36.3, Pupils: PEARL, Glucose:10.1 mmol/l. Haemoglobin: 149 g/dl

Interventions (done by sending facility): Right and left (AC) IV access., Normal saline infusion at 200cc/h, patient received 2L of normal saline and 1 defibrillation with 200 joules.

Time	Event
00:00	Arriving to examine a 52 year old male post arrest.
00:01	Initial physical examination: unconscious, Vital signs: HR: 87 weak, RR:10 on BVM, SPO2: 100%, BP: unmeasurable, GCS:3, ECG: sinus rhythm at 87 and no ST abnormalities, Pulse is weak. Temp:37, Pupils: PEARL, Glucose:10.1 mmol/l. Patient is to be intubated be paramedic ETT size 7.5 at 23 and transported to EMS monitor.
00:07	SPO2:97%
00:23	Patient in cardiac arrest CPR is initiated. Monitor show V-fib (arrest)
00:25	CPR is continued. 1 mg Epinephrine. Defibrillation at 200J.
00:27	CPR is continued ECG: V-fib, defibrillation 200J and CPR continues.
00:29	ECG: sinus rhythm at 98. BP: unmeasurable, SPO2:100%. 1L of Normal saline is given.
00:30	Patient is started on dopamine 10mcq/kg/min
00:35	HR: 92. BP: unmeasurable, SPO2:100%. Patient is ventilated with BVM at 14

00:56	Receiving facility data: a 52 year old male post arrest. unconscious GCS of 3. Intubated with ETT size 7.5 at 23 cm. Spo2 100% and lung sounds are clear bilateral. HR:100, BP: 94/61. Pupils: PEARL. Glucose 10.4 mmol/l. ECG: sinus rhythm at 100 with no ST abnormalities. Patient had an arrest during the transfer, received 1mg epinephrine, 2 defibrillations at 200 joules and 1L of normal saline fluid. Patient is on dopamine infusion 10mcq/kg/min to be admitted to resuscitation room.

Case 22:

Presentation: A 21 year old male patient with cardiac arrest is to be transported by a ground ambulance from local doctor office to a tertiary hospital. The distance is 10 miles.

Relevant medical history: Epilepsy.

Medications: carbamazepine.

Allergies: No known allergies.

Observations (sending facility report): Unconscious male in cardiac arrest. ECG: asystole. SPO2: 96% ventilated via BVM at 12. Pupils: fixed.

Interventions (done by sending facility): CPR (15 minutes) Right and left anterior cubital (AC) IV access, Normal saline infusion 1L. patient had received 2 doses of epinephrine.

Time	Event
00:00	Arriving to examine a 21 year old male in cardiac arrest. Patient arrived to the doctor's office in cardiac arrest. Unconscious male in cardiac arrest. ECG: asystole. SPO2: 96% ventilated via BVM at 12. Pupils: Fixed. Right and left anterior cubital (AC) IV access, Normal saline infusion 1L. patient had received 2 doses of epinephrine. Patient is intubated by paramedic ETT size 7.5 at 23 cm. Confirmed by visualization and auscultation. Patient is transported to EMS monitor and CPR in progress.
00:01	CPR in progress. ECG: asystole. SPO2: 100%
00:03	1 mg epinephrine is given CPR is continued. ECG: asystole
00:05	CPR in progress. ECG: asystole. SPO2: 100%
00:07	1 mg epinephrine is given CPR is continued. ECG: asystole
00:10	Arriving main hospital
00:11	Receiving facility data: a 21 years old male in cardiac arrest. Patient had received a total of 4mg of epinephrine and intubated by paramedics, ETT size 7.5at 23cm with good air entry. ECG: asystole. SPO2: 100%. Patient was pronounced dead 30 minutes post arrival by ER consultant.

Case 23:

Presentation: A 58 year old female patient post traumatic cardiac arrest (RTA blunt trauma). Unconscious female to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 19 miles.

Relevant medical history: No known medical history (post traumatic arrest)

Medications: No known medication

Allergies: No known allergies.

Observations (sending facility report): Unconscious female patient. Vital signs: HR: 90, Pain score: unknown, RR: 12 on mechanical ventilation, lung sound: clear, SPO2: 95%, BP: 117/84, Glasgow Coma Scale (GCS):3, ECG: sinus rhythm and no ST abnormalities, Capillary refill: <2, Pupils: Sluggish, Glucose:11.0 mmol/l. Vent setting: Fio2:50 PEEP 5.

Interventions (done by sending facility): Right femoral central IV. ETT size 7.5at 21cm.Foley catheter 14F and normal saline 80cc/h, midazolam 5mg/h and Fentanyl 100mcq/h

Time	Event
00:00	Arriving to examine A 58 year old female patient post cardiac arrest.
00:01	Initial physical examination: Unconscious female patient. Vital signs: HR: 90, Pain score: unknown, RR: 12 on mechanical ventilation, lung sound: clear SPO2: 95%, BP: 117/84, Glasgow Coma Scale (GCS):3, ECG: sinus rhythm and no ST abnormalities, Capillary refill: <2, Pupils: Sluggish, Glucose:11.0 mmol/l. Vent setting: Fio2:50 PEEP 5. Patient is transported to EMS monitor, switched to EMS vent FIO2 100 PEEP 5.
00:13	Patient SPO2: 95% patient HR: 98 and patient is agitated (Agitation)
00:14	Midazolam 2mg bolus is given, 50mcq fentanyl is given and 30 mg Rocuronium is given.
00:19	Patient is paralyzed and sedated. HR: 91, BP: 114/64 and SPO2:97%
00:48	Arriving main hospital
00:49	Receiving facility data: A 58 year old female patient post cardiac arrest. Unconscious female, GCS of 3, female on ETT size 7.5 at 21cm on mechanical ventilation FIO2 100 PEEP 5. RR:12 Spo2 96% and lung sounds are clear bilateral. HR:75 BP: 128/62 on midazolam infusion 5mg/h and fentanyl 100mcq/h. Pupils bilateral

	sluggish. Foley catheter 14F. Right femoral central IV. Patient to be shifted to ICU. CXR showed good ETT position.

Case 24:

Presentation: A 49 years old male patient with chest pain. Conscious, alert and oriented male to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: No known medical history.

Medications: No known medication,

Allergies: No known allergies.

Observations (sending facility report): Conscious alert and oriented male. Vital signs: HR: 46, Pain score: 6, RR: 26, lung sound: clear bilateral. SPO2: 100%, BP: 106/63, Glasgow Coma Scale (GCS):15, ECG: Sinus Brady rhythm with 2nd degree AV block and no ST abnormalities, Temp:36.8, Pupils: PEARL, Glucose:12.2 mmol/l.

Interventions (done by sending facility): Right and left (AC) IV access, Normal saline infusion at 100cc/h. Isosorbide nitrate 5mg Sub Lingual (SL) , Aspirin 300mg orally.

Time	Event
00:00	Arriving to examine a 49 years old male.
00:01	Initial physical examination: Conscious alert and oriented male. Vital signs: HR: 47, Pain score: 6, RR: 26, lung sound: clear bilateral. SPO2: 100%, BP: 106/63, Glasgow Coma Scale (GCS):15, ECG: Sinus Brady rhythm with 2nd degree AV block and no ST abnormalities, Temp:36.8, Pupils: PEARL, Glucose:12.2 mmol/l. Patient is transported to EMS monitor.
00:25	Patient is complaining of chest pain and dizziness. HR: 32, BP: 86/65 and diaphoretic skin. (Bradycardia)
00:26	Transcutaneous pacing is applied 70 PPM and 70mA. Good electrical and mechanical capture is observed.
00:28	HR: 70 on pacer. BP: 128/76 and midazolam 3mg, fentanyl 100mcq are given
00:37	Receiving facility data: A 49 years old male with chest pain. Conscious alert and oriented male. Vital signs: HR: 70 on external pacer, Pain score: 0 patient received analgesia Fentanyl 100mcq, RR: 18, lung sound: clear bilateral. SPO2: 100%, BP: 120/73, Glasgow Coma Scale (GCS):15, ECG: Pacing rhythm with capture, rate 70 and 70mA. Temp:37, Pupils: PEARL, Glucose:10.7 mmol/l.

Case 25:

Presentation: A 23 year old female patient, unconscious to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: The patient has polymyositis/ dermatomyositis/ pemphigus/aspiration pneumonia and acute kidney injury.

Medications: Prednisone

Allergies: No known allergies.

Observations (sending facility report): Unconscious. A 23 years old female. Vital signs: HR: 119, Pain score: unknown, RR: 12 on mechanical ventilation, lung sound: clear but decreased on left side. SPO2: 98%, BP: 103/63, Glasgow Coma Scale (GCS):3, ECG: sinus rhythm and no ST abnormalities, Capillary refill: <2, Pupils: PEARL , Glucose:6.3 mmol/l. Vent setting: Fio2:50 PEEP 5. Haemoglobin:92 g/dl

Interventions (done by sending facility): ETT size 7.5 at 23cm.Noroepinephrine 4mcg/min. Midazolam 5mg/h and Fentanyl 100mcg/h

Time	Event
00:00	Arriving to examine a 23 years old female.
00:01	Initial physical examination: Vital signs: HR: 119, Pain score: unknown, RR: 12 on mechanical ventilation, lung sound: clear but decreased on left side lower lobe. SPO2: 98%, BP: 103/63, Glasgow Coma Scale (GCS):3, ECG: sinus rhythm and no ST abnormalities, Capillary refill: <2, Pupils: PEARL, Glucose:6.3 mmol/l. Vent setting: Fio2:50 PEEP 5. Haemoglobin:92 g/dl. Patient is on Norepinephrine 4mcg/min. Midazolam 5mg/h and Fentanyl 100mcg/h. Patient is transported to EMS monitor, switched to EMS vent FIO2 100 PEEP 5.
00:14	Patient SPO2: 93%, HR:128 patients need suction (Desaturation)
00:15	Suctioning with soft catheter thick mucus. Increasing RR:18
00:17	SPO2:92% HR:126. Patient is switched to BVM at 18 bpm
00:19	SPO2: 99% HR: 123
00:53	Receiving facility data: A 23 years old female direct ICU admission. Unconscious GCS of on ETT size 7.5 at 21cm on BVM. RR:14 Spo2 100% and lung sounds are decreased on the left side. HR:116 BP: 151/94 on midazolam infusion 5mg/h, norepinephrine 4mcg/min and fentanyl 100mcg/h. Pupils PEARL. Transferred to ICU. CXR ICU (ETT in good position at 21cm)

Case 26:

Presentation: A 20 year old female patient postictal is to be transported by a ground ambulance from local doctor office to a tertiary hospital. The distance is 10 miles.

Relevant medical history: Epilepsy.

Medications: carbamazepine.

Allergies: No known allergies.

Observations (sending facility report): semi-conscious female postictal. Vital signs: HR: 98. RR: 24, SPO2: 98%, BP: 116/72, GCS: 7. Glucose: 6.5 mmol/l. Skin: cold. Pupils: PEARL. Hgb: 13.3 g/dl. Temp: 36.6. ECG: Sinus rhythm with no ST abnormalities. Capillary refill: <2 sec.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion 80cc/h. patient had received 5mg of Valium (diazepam).

Time	Event
00:00	Arriving to examine a 20 year old female postictal. Patient had a seizure episode at the doctors office. Semi-conscious male NOT oriented Vital signs: HR: 98. RR: 24, SPO2: 98%, BP: 116/72, GCS: 7. Glucose: 6.5 mmol/l. Skin: cold. Pupils: PEARL. Hgb: 13.3 g/dl. Temp: 36.6. ECG: Sinus rhythm with no ST abnormalities. Capillary refill: <2 sec. Patient had received 5mg diazepam. Patient is transported to EMS monitor.
00:09	Patient is having tonic-colonic seizure and mouth secretions are noticed. Patient is turned on his left side. (Seizure)
00:11	Patient is still in tonic-colonic seizure 10mg of Diazepam is given IV.
00:13	Patient is in postictal phase. Suctioned. HR: 124, BP: 100/67 and 200 cc bolus is given. GCS: 9.
00:20	Receiving facility data: a 20 year old female known epileptic patient with active seizure. Patient had received a total of 15mg of diazepam. Patient is confused. GCS: 10. RR: 18, HR: 86. Glucose: 6.8. Temp:36.8 BP: 130/60.

Case 27:

Presentation: A 66 year old male patient with chest pain. Conscious, alert and oriented male is to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 17 miles.

Relevant medical history: Patient is diabetic.

Medications: Insulin.

Allergies: No known allergies.

Observations (sending facility report): Conscious with chest pain. Vital signs: HR: 95, Pain score: 6, RR: 22, lung sound: clear bilateral, SPO2: 99% on nasal cannula 3L, BP: 122/66, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:36.8, Capillary refill: <2, Pupils: PEARL, Glucose:8.2 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion at 80cc/h, patient received Isosorbide nitrate 5mg Sub Lingual (SL). Aspirin 324 mg.

Time	Event
00:00	Arriving to examine a 66 year old male with chest pain.
00:01	Initial physical examination: conscious, alert and oriented male complaining of chest pain. Vital signs: HR: 95, Pain score: 6, RR: 22, lung sound: clear bilateral SPO2: 99% on nasal cannula 3L, BP: 122/66, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:36.8, Capillary refill: <2, Pupils: PEARL,Glucose:8.2 mmol/l. Patient is transported to EMS monitor.
00:07	Patient with chest pain, pain score 10. BP:122/66
00:08	Isosorbide nitrate 5mg Sub Lingual (SL) and morphine 2 mg is given
00:11	Patient HR: 89 BP:103/65. Pain free. 100 cc normal saline bolus is given
00:37	Arriving main hospital
01:20	Receiving facility data: a 66 year old male with chest pain. Conscious GCS of 15 on 3L nasal cannula. Spo2 100% and lung sounds are clear bilateral. HR:92 BP: 120/54. Pupils PEARL. Glucose 8.5 mmol/l.

Case 28:

Presentation: A 44 years old female patient with chest pain. Conscious, alert and oriented male is to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: Patient has hypertension.

Medications: Amlodipine

Allergies: No known allergies.

Observations (sending facility report): Conscious with chest pain. Vital signs: HR: 130, Pain score: 7, RR: 28, lung sound: clear bilateral, SPO2: 100% on nasal cannula 3L, BP: 142/86, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with ST elevation V1-V4, Temp:36.5, Capillary refill: <2, Pupils: PEARL, Glucose:6.8 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access., Normal saline infusion at 80cc/h, patient received Isosorbide nitrate (2 doses) 5mg Sub Lingual (SL). Aspirin 324 mg and morphine 2mg.

Time	Event
00:00	Arriving to examine a 44 years old female with chest pain.
00:01	Initial physical examination: conscious, alert and oriented female complaining of chest pain. Vital signs: HR: 130, Pain score: 7, RR: 28, lung sound: clear bilateral SPO2: 100% on nasal cannula 3L, BP: 142/86, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with ST elevation V1-V4, Temp:36.8, Capillary refill: <2, Pupils: PEARL,Glucose:6.8 mmol/l. Patient is transported to EMS monitor.
00:26	Patient is complaining of severe chest pain. BP: 150/85 RR: 29. Pain score 9/10
00:26	Isosorbide nitrate 5mg Sub Lingual (SL) and morphine 2 mg is given
00:29	Patient HR: 121 BP:147/77. Pain score 7.
00:31	Patient is complaining of chest pain. Isosorbide nitrate 5mg Sub Lingual (SL)
00:34	Patient HR: 114 BP:140/79 and pain score 3/10
00:42	Arriving main hospital.
00:43	Receiving facility data: a 44 years old female with chest pain. conscious, alert and oriented female complaining of chest pain. Vital signs: HR: 114, Pain score: 3, RR: 24, lung sound: clear bilateral, SPO2: 100% on nasal cannula 3L, BP: 127/86, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with ST elevation V1-V4, Temp:36.8, Capillary refill: <2, Pupils: constricted, Glucose:6.5 mmol/l. Patient is shifted to catheterization lab.

Case 29:

Presentation: A 72 year old male patient with shortness of breath. Conscious, alert and oriented male is to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: Patient has hypertension, Diabetes and Congestive heart failure.

Medications: Insulin, Candesartan, Furosemide, Isosorbide nitrate (SL PRN) and Warfarin

Allergies: No known allergies.

Observations (sending facility report): Conscious with shortness of breath. Vital signs: HR: 83, RR: 35, lung sound: fine crackles bilateral, SPO2: 92% on room air and with nasal cannula 3L is 97%, BP: 197/91, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with no ST abnormalities, Temp:36.6, Capillary refill: <2, Pupils: PEARL, Glucose:10.7 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, patient received Isosorbide nitrate (2 doses) 5mg Sub Lingual (SL). Furosemide 60mg and morphine 2mg.

Time	Event
00:00	Arriving to examine a 72 year old male with shortness of breath.
00:01	Initial examination: Conscious with shortness of breath. Vital signs: HR: 83, RR: 35, lung sound: fine crackles bilateral, SPO2: 92% on room air and with nasal cannula 3L is 97%, BP: 197/91, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with no ST abnormalities, Temp:36.6, Capillary refill: <2, Pupils: PEARL,Glucose:10.7 mmol/l. Patient is transported to EMS monitor.
00:13	Patient is complaining of shortness of breath. SPO2: 94% on 3L. Lung sounds: crackles bilateral. CPAP is initiated.
00:14	Patient is refusing CPAP and 40 mg Furosemide is given. SPO2:95%
00:24	Patient BP: 170/88. SPO2:99%
00:38	Arriving main hospital.
00:39	Receiving facility data: a 72 year old male. Conscious with shortness of breath. Vital signs: HR: 78, RR: 20, lung sound: crackles bilateral, SPO2: 100% with nasal cannula 3L, BP: 130/53, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with no ST abnormalities, Temp:36.6, Capillary refill: <2, Pupils: PEARL,Glucose:11.4 mmol/l.

Case 30:

Presentation: A 69 year old female patient with Tuberculosis (TB) ?ARDS. Conscious, alert and oriented to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: The patient has a history of diabetes mellitus and chronic renal failure.

Medications: The patient is on insulin and renal dialysis.

Allergies: No known allergies.

Observations (sending facility report): Conscious, alert and oriented. Vital signs: HR: 102, RR: 44, lung sound: Wheezing, SPO2: 98% on 15L non-rebreather, BP: 100./73, Glasgow Coma Scale (GCS): 15, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:36.5, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm,Glucose:14.5 mmol/l.

Interventions (done by sending facility): Right subclavian central IV access, left fistula, Normal saline infusion at 80cc/min.

Time	Event
00:00	Arriving to examine a 69 year old female with TB.
00:01	Initial physical examination: Conscious, alert and oriented. Vital signs: HR: 102, RR: 44, lung sound: Wheezing, SPO2: 98% on 15L non-rebreather, BP: 100 /73, Glasgow Coma Scale (GCS): 15, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:36.5, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm, Glucose:14.5 mmol/l. Patient is transported to EMS monitor.
00:47	Patient on cardiac monitor BP: 90/50 (hypotension)
00:47	Patient has received a bolus of 200 cc normal saline
00:52	Patient BP: 103/63
01:36	Arriving main hospital
01:59	Receiving facility data: 60 year female direct ICU admission. Conscious, alert and oriented. Vital signs: HR: 100, RR: 41, lung sound: Wheezing, SPO2: 99% on 15L non-rebreather, BP: 95/60, Glasgow Coma Scale (GCS): 15, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:36.5, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm, Glucose:14.0 mmol/l.

Case 31:

Presentation: A 68 year old female patient with chest pain. Conscious, alert and oriented female is to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: Patient has hypertension and Diabetes.

Medications: Insulin, amlodipine and Aspirin

Allergies: No known allergies.

Observations (sending facility report): Conscious with chest pain. Vital signs: HR: 97, RR: 21, lung sound: clear bilateral, SPO2: 95% on nasal cannula 3L, Pain score:6, BP: 120/79, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with ST elevation V1-V4, Temp:36.8, Capillary refill: <2, Pupils: PEARL,Glucose:19.9 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline (NS) 80cc/h patient received Isosorbide nitrate (2 doses) 5mg Sub Lingual (SL). Aspirin 324mg and Plavix (clopidogrel 600mg).

Time	Event
00:00	Arriving to examine a 68 year old female with chest pain.
00:01	Initial examination: Conscious with chest pain. Vital signs: HR: 97, RR: 21, lung sound: clear bilateral, SPO2: 95% on nasal cannula 3L, BP: 120/79, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with ST elevation V1-V4, Temp:36.8, Capillary refill: <2, Pupils: PEARL,Glucose:19.9 mmol/l. Patient is transported to EMS monitor.
00:03	Patient is to be on Nitroglycerin infusion 5mcg/min. (Nitro drip)
00:17	Patient BP: 112/41. A bolus of 100 cc NS is given.
00:19	Patient BP: 126/54
00:53	Arriving main hospital.
00:53	Receiving facility data: a 68 year old female. Conscious with chest pain. Vital signs: HR: 95, RR: 20, lung sound: clear bilateral, SPO2: 98% with nasal cannula 3L, BP: 132/52, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with ST elevation V1-V4, Temp:36.9, Capillary refill: <2, Pupils: PEARL,Glucose:19.7 mmol/l.

Case 32:

Presentation: A 105 year old male patient with shortness of breath ?pneumonia. Conscious, alert and oriented male is to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: Patient has hypertension.

Medications: amlodipine and Aspirin

Allergies: No known allergies.

Observations (sending facility report): Conscious with shortness of breath. Vital signs: HR: 88, RR: 22, lung sound: clear bilateral, SPO2: 94% on face mask 6L, BP: 129/58, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with no ST abnormalities, Temp:37.9, Capillary refill: <2, Pupils: PEARL,Glucose: 7.4 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline 80cc/h

Time	Event
00:00	Arriving to examine a 105 year old male with shortness of breath.
00:01	Initial examination: Conscious with shortness of breath. Vital signs: HR: , RR: 21, lung sound: clear bilateral, SPO2: 95% on face mask 6L, BP: 129/58, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with no ST abnormalities, Temp:37.9, Capillary refill: <2, Pupils: PEARL, Glucose: 7.4 mmol/l. Patient is transported to EMS monitor.
00:33	Patient is SPO2: 92% on 6L face mask
00:33	Patient is switched to non-rebreather mask 15L
00:38	Patient SPO2: 99%
00:56	Arriving main hospital.
00:56	Receiving facility data: a 105 year old male with shortness of breath. Conscious, alert and oriented. Vital signs: HR: 79, RR: 20, lung sound: clear bilateral, SPO2: 98% with non-rebreather mask, BP: 119/82, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with no ST abnormalities, Temp:38.3, Capillary refill: <2, Pupils: PEARL,Glucose:7.4 mmol/l.

Case 33:

Presentation: A 76 year old female patient, conscious, alert, and oriented. Patient is complaining of dyspnoea and dizziness to be transported by a ground ambulance from a local hospital to a tertiary hospital. The distance is 32 miles.

Relevant medical history: The patient has Asthma and diabetes.

Medications: The patient is on insulin and Salbutamol.

Allergies: No known allergies.

Observations (sending facility report): Conscious, alert and oriented. Vital signs: HR: 97, Pain score: unknown, RR: 29 lung sound: wheezes bilateral, SPO2: 89% on 15L non-rebreather mask, BP: 136/104, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:36.8, Capillary refill: <2, Pupils: PEARL, Glucose:13.9 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion at 60cc/h, patient have received 2 doses of Ventolin (salbutamol 5mg) and 1 dose Ipratropium 0.5mg via nebulizer.

Time	Event
00:00	Arriving to examine a 76 year old female with dyspnea.
00:01	Initial physical examination: Conscious, alert and oriented. Vital signs: HR: 97, Pain score: unknown, RR: 29 lung sound: wheezes bilateral, SPO2: 89% on 15L non-rebreather mask, BP: 136/104, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:36.8, Capillary refill: <2, Pupils: PEARL, Glucose:13.9 mmol/l. Patient is transported to EMS monitor. A nebulizer of 5mg Ventolin is continued. Methylprednisolone 150 mg (150mg is standard adult dose as per protocol) is given by paramedic.
00:18	Patient SPO2: 91% HR:102 and Another dose of Ventolin 5mg and Ipratropium 0.5mg via nebulizer
00:24	Patient HR: 92, SPOO2: 90%
01:46	Arriving main hospital
01:46	Receiving facility data: 76 year female known asthmatic. Conscious, alert and oriented. Vital signs: HR: 92, Pain score: unknown, RR: 22 lung sound: wheezes bilateral, SPO2: 90% on 15L non-rebreather mask, BP: 140/78, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:37.0, Capillary refill: <2, Pupils: PEARL, Glucose:13.1

	mmol/l. Patient received a total of 3 Ventolin doses and 2 Ipratropium 0.5mg, also Methylprednisolone 150 mg was given.

Case 34:

Presentation: A 66 year old female patient, conscious, alert, and oriented. Patient is complaining of chest pain to be transported by a ground ambulance from a local hospital to a tertiary hospital. The distance is 32 miles.

Relevant medical history: The patient has diabetes and hypertension.

Medications: The patient is on insulin and Amlodipine.

Allergies: No known allergies.

Observations (sending facility report): Conscious, alert and oriented. Vital signs: HR: 58, Pain score: 2, RR: 20 lung sound: clear bilateral, SPO2: 98% on room air, BP: 205/51, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:36.8, Capillary refill: <2, Pupils: PEARL, Glucose:24.3 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion at 60cc/h, patient have received 2 doses Isosorbide nitrate 5mg (SL).

Time	Event
00:00	Arriving to examine a 66 year old female with chest pain.
00:01	Initial physical examination: Conscious, alert and oriented. Vital signs: HR: 58, Pain score: 2, RR: 20 lung sound: clear bilateral, SPO2: 98% on room air, BP: 205/51, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:36.8, Capillary refill: <2, Pupils: PEARL, Glucose: HIGH. Patient is transported to EMS monitor. Nasal cannula is applied 2L
00:21	Patient HR:38 and patient is complaining of dizziness. BP:174/64
00:22	Patient have received 0.5mg Atropine
00:27	Patient HR: 44 and complaining of chest pain, pain score:7.
00:28	Patient received 0.5mg Atropine
00:31	Patient HR: 47
00:38	Receiving facility data: 66 years female with chest pain. Conscious, alert and oriented. Vital signs: HR: 42, Pain score: 4, RR: 19 lung sound: clear bilateral, SPO2: 100% on nasal cannula 2L, BP: 136/65, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:36.5, Capillary refill: <2, Pupils: PEARL, Glucose:24.8 mmol/l. Patient received two doses of atropine 0.5mg.

Case 35:

Presentation: A 36 year old female patient, conscious, alert, and oriented. Patient is complaining of a new onset of palpitation to be transported by a ground ambulance from a local doctor's office to a tertiary hospital. The distance is 10 miles.

Relevant medical history: No known medical history.

Medications: No known medication.

Allergies: No known allergies.

Observations (sending facility report): Conscious, alert and oriented. Vital signs: HR: 188, Pain score: none, RR: 18 lung sound: clear bilateral, SPO2: 99% on 2L nasal cannula, BP: 129/57, Glasgow Coma Scale (GCS):15, ECG: supraventricular tachycardia, Temp:36.8, Capillary refill: <2, Pupils: PEARL, Glucose:6.1 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion at 80cc/h, patient have received diltiazem 20mg.

Time	Event
00:00	Arriving to examine a 36 year old female with palpitation.
00:01	Initial physical examination: Conscious, alert and oriented. Vital signs: HR: 128, Pain score: none, RR: 22 lung sound: clear bilateral, SPO2: 100% on 2L nasal cannula, BP: 121/57, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:36.8, Capillary refill: <2, Pupils: PEARL, Glucose: 6.1 mmol/l. Patient is transported to EMS monitor.
00:05	Patient BP: 102/47
00:06	Patient have received 200cc Normal saline bolus
00:08	Patient BP:113/54
00:23	Receiving facility data: 36 year old female with palpitation. Conscious, alert and oriented. Vital signs: HR: 120, Pain score: none, RR: 19 lung sound: clear bilateral, SPO2: 100% on nasal cannula 2L, BP: 118/50, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:36.7, Capillary refill: <2, Pupils: PEARL, Glucose:6.1 mmol/l.

Case 36:

Presentation: A 51 year old female patient, conscious, alert, and oriented. Patient is complaining of severe abdominal pain to be transported by a ground ambulance from a local doctor office to a tertiary hospital. The distance is 32 miles.

Relevant medical history: No known history.

Medications: No known medications.

Allergies: No known allergies.

Observations (sending facility report): Conscious, alert and oriented. Vital signs: HR: 87 Pain score: 4, RR: 18 lung sound: clear bilateral, SPO2: 99% on 2L nasal cannula, BP: 148/88, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:36.8, Capillary refill: <2, Pupils: PEARL, Glucose:5.3 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion at 80cc/h, patient have received 1 dose of morphine 4mg.

Time	Event
00:00	Arriving to examine a 51 year old female with abdominal pain.
00:01	Initial physical examination: Vital signs: HR: 87 Pain score: 4, RR: 18 lung sound: clear bilateral, SPO2: 99% on 2L nasal cannula, BP: 148/88, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:36.8, Capillary refill: <2, Pupils: constricted, Glucose:5.3 mmol/l. Patient is transported to EMS monitor.
00:07	Patient is complaining of severe abdominal pain and crying. Pain score:10
00:08	Patient have received 4 mg of morphine and 10 mg metoclopramide
00:40	Arriving main hospital
00:41	Receiving facility data: A 51 yeas old female Conscious, alert and oriented complaining of abdominal pain. Vital signs: HR: 82 Pain score: 2, RR: 18 lung sound: clear bilateral, SPO2: 100% on 2L nasal cannula, BP: 120/80, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Temp:36.8, Capillary refill: <2, Pupils: constricted, Glucose:5.3 mmol/l. Patient have received a total of 8mg morphine and 10mg metoclopramide.

Case 37:

Presentation: A 45 year old female patient, conscious, alert and oriented to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: The patient has a history of diabetes mellitus and hypertension.

Medications: The patient is on insulin and Amlodipine.

Allergies: No known allergies.

Observations (sending facility report): conscious. Vital signs: HR: 58, Pain score: none, RR: 20, lung sound: clear bilateral SPO2: 100% on 6L facemask, BP: 158./76, Glasgow Coma Scale (GCS):5, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:37.9, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm,Glucose:10.6 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion at 60cc/h.

Time	Event
00:00	Arriving to examine a 45 year old female patient.
00:01	Initial physical examination: conscious. Vital signs: HR: 58, Pain score: none, RR: 20, lung sound: clear bilateral SPO2: 100% on 6L facemask, BP: 158/76, Glasgow Coma Scale (GCS):5, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:37.9, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm ,Glucose:10.6 mmol/l. Patient is transported to EMS monitor.
00:48	Patient HR: 38
00:49	Atropine 0.5mg is given
00:51	Patient HR: 51
01:25	Arriving main hospital
01:26	Receiving facility data: 45 year female direct CCU admission. Conscious, alert and oriented. Vital signs: HR: 45, Pain score: none, RR: 18, lung sound: clear bilateral SPO2: 100% on 6L facemask, BP: 153/72, Glasgow Coma Scale (GCS):15, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:38.8, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm, Glucose:10.6 mmol/l. Patient has received 0.5mg atropine. Patient is known to have bradycardia.

Case 38:

Presentation: A 63 year old female patient, unconscious post arrest to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: The patient has a history of End stage renal failure and diabetes.

Medications: The patient is on insulin and renal dialysis.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 116, Pain score: unknown, RR: 16 on mechanical ventilation, lung sound: clear bilateral SPO2: 100%, BP: 200/69, Glasgow Coma Scale (GCS):3, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:37.0, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm, Glucose:15.9 mmol/l. Vent setting: Fio2:60 PEEP 8

Interventions (done by sending facility): Right subclavian central IV access, ETT tube size 7.5at 22cm Normal saline infusion at 100cc/h, Midazolam 5mg/h

Time	Event
00:00	Arriving to examine a 63 year old female post arrest.
00:01	Initial physical examination: Unconscious. Vital signs: HR: 116, Pain score: unknown, RR: 16 on mechanical ventilation, lung sound: clear bilateral SPO2: 100%, BP: 200/69, Glasgow Coma Scale (GCS):3, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:37.0, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm, Glucose:15.9 mmol/l. Vent setting: Fio2:60 PEEP 8. Patient is transported to EMS monitor, switched to EMS vent FIO2 100 PEEP 8.
00:22	Patient is agitated and fighting the ETT tube. BP:184/74, HR:120
00:23	Patient received 100mcq Fentanyl and midazolam bolus 3 mg
00:24	Patient is sedated. HR:118 BP:182/77
00:55	Arriving main hospital
00:56	Receiving facility data: 63 years old female direct ICU admission. Unconscious, GCS of 3 with ETT size 7.5 at 22cm, vent setting RR:16 Fio2 100 PEEP 8. Spo2 100% clear and good air entry bilaterally. HR:114 BP: 180/71 on midazolam infusion 5mg/h. Patient has a right subclavian central IV.

Case 39:

Presentation: A 39 year old female patient with chest pain. Conscious, alert and oriented female is to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: No significant past history.

Medications: No known medication,

Allergies: No known allergies.

Observations (sending facility report): Conscious, alert and oriented. Vital signs: HR: 65, Pain score: 1, RR: 19, lung sound: clear bilateral, SPO2: 99%, BP: 109/56, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with pathological q wave, skin: diaphoretic. Temp:36.8, Capillary refill: <2, Pupils: PEARL, Glucose:5.5 mmol/l.

Interventions (done by sending facility): Right (AC) IV access, Normal saline infusion at 80cc/h, patient received Isosorbide nitrate (2 doses) 5mg Sub Lingual (SL) and Aspirin 324 mg

Time	Event
00:00	Arriving to examine a 39 year old female with chest pain.
00:01	Initial physical examination: Conscious, alert and oriented. Vital signs: HR: 65, Pain score: 1, RR: 19, lung sound: clear bilateral, SPO2: 99%, BP: 109/56, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with pathological q wave, skin: diaphoretic. Temp:36.8, Capillary refill: <2, Pupils: PEARL, Glucose:5.5 mmol/l. Patient is transported to EMS monitor.
00:09	Patient HR:92 BP:88/41
00:10	500 cc normal saline bolus is given
00:14	Patient HR: 73 BP: 100/54
00:23	Arriving main hospital
00:24	Receiving facility data: a 39 year old female with chest pain. Conscious, alert and oriented. Vital signs: HR: 67, Pain score: none, RR: 22, lung sound: clear bilateral, SPO2: 100%, BP: 120/63, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm with pathological q wave, skin: diaphoretic. Temp:37.1, Capillary refill: <2, Pupils: PEARL,Glucose:5.5 mmol/l.

Case 40:

Presentation: A 58 year old male patient, unconscious with liver cirrhosis and ARDS to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: The patient has a history of Hepatitis C.

Medications: No known medication.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 90, Pain score: unknown, RR: 15 on mechanical ventilation, lung sound: clear bilateral SPO2: 99%, BP: 141/80, Glasgow Coma Scale (GCS):3, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:37.0, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm, Glucose:5.9 mmol/l. Vent setting: Fio2:50 PEEP 5

Interventions (done by sending facility): Right subclavian central IV access, Normal saline infusion at 100cc/h, norepinephrine infusion at 10mcg/kg/min, precede (dexmedetomidine 0.5mg/kg/min), ETT size 7.5 at 22 cm

Time	Event
00:00	Arriving to examine a 58 year old male with cirrhosis.
00:01	Initial physical examination: Unconscious. Vital signs: HR: 90, Pain score: unknown, RR: 15 on mechanical ventilation, lung sound: clear bilateral SPO2: 99%, BP: 141/80, Glasgow Coma Scale (GCS):3, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:37.0, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm, Glucose:5.9 mmol/l. Patient is transported to EMS monitor, switched to EMS vent FIO2 50 PEEP 5.
00:05	Patient on cardiac monitor with SPO2 increased to 100%
01:42	Patient is agitated. Fighting tube. HR: 110 BP: 146/81
01:43	Patient is given Fentanyl 100mcg and midazolam 4mg IV bolus.
01:49	Patient is calm. HR:86
02:14	Arriving main hospital

01:59	Receiving facility data: 58 years male direct ICU admission. Unconscious. Vital signs: HR: 77, Pain score: unknown, RR: 15 on mechanical ventilation, lung sound: clear bilateral SPO2: 100%, BP: 120/68, Glasgow Coma Scale (GCS):3, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:37.0, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm, Glucose:5.9 mmol/l. ETT tube size 7.5at 21cm. CXR good tube position. Patient is transferred to ICU.

Case 41:

Presentation: A 32 year old female patient, unconscious post smoke inhalation to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: The patient is pregnant 20 weeks

Medications: No known medication.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 95, Pain score: unknown, RR: 12 on mechanical ventilation, lung sound: clear bilateral SPO2: 100%, BP: 141/97, Glasgow Coma Scale (GCS):3, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:37.0, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm, Glucose:5.4 mmol/l. Vent setting: Fio2:30 PEEP 5

Interventions (done by sending facility): Right subclavian central IV access, Normal saline infusion at 100cc/h, Propofol 100mg/h. ETT size 7 at 21cm

Time	Event
00:00	Arriving to examine a 32 year old female pregnant post smoke inhalation.
00:01	Initial physical examination: Unconscious. Vital signs: HR: 95, Pain score: unknown, RR: 12 on mechanical ventilation, lung sound: clear bilateral SPO2: 100%, BP: 147/97, Glasgow Coma Scale (GCS):3, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:37.0, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm, Glucose:5.4 mmol/l. Patient is transported to EMS monitor, switched to EMS vent FIO2 50 PEEP 5.
00:11	Patient is agitated. HR: 121. Patient is fighting the ETT
00:12	Midazolam 3 mg and Fentanyl 50mcg are given IV bolus
00:18	Patient is calm HR: 108
00:50	Arriving main hospital
01:59	Receiving facility data: 32 years old female, unconscious. Vital signs: HR: 105, Pain score: unknown, RR: 12 on mechanical ventilation, lung sound: clear bilateral SPO2: 100%, BP: 147/97, Glasgow Coma Scale (GCS):3, 12 lead ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp:37.0, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at

	3mm, Glucose:5.4 mmol/l. ETT size 7 at 23 cm. CXR good ETT position.

Case 42:

Presentation: A 72 year old female patient complaining of shortness of breath to be transported by a ground ambulance from local doctors office to a tertiary hospital. The distance is 10 miles.

Relevant medical history: The patient has diabetes and hypertension.

Medications: Insulin and amlodipine

Allergies: No known allergies.

Observations (sending facility report): Conscious, alert and oriented. Vital signs: HR: 117, Pain score: none, RR: 32 on 6L facemask, lung sound: Wheezing. SPO2: 96%, BP: 127/66, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Capillary refill: <2, Pupils: PEARL, Glucose:16.6 mmol/l.

Interventions (done by sending facility): Patient have received 2 nebulization Salbutamol 5mg and Ipratropium 0.5mg, also Solu-Medrol (Methylprednisolone 150mg IV)

Time	Event
00:00	Arriving to examine a 72 year old female with shortness of breath.
00:01	Initial physical examination: Conscious, alert and oriented. Vital signs: HR: 117, Pain score: none, RR: 32 on 6L facemask, lung sound: Wheezing. SPO2: 96%, BP: 127/66, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Capillary refill: <2, Pupils: PEARL, Glucose:16.6 mmol/l. Patient is transported to EMS monitor.
00:03	Patient SPO2: 91%, a nebulizer of Salbutamol 5mg and Ipratropium 0.5mg is given.
00:08	RR:26 SPO2:98%
00:11	Arriving main hospital
00:11	Receiving facility data: A 72 year old female with shortness of breath. Conscious, alert and oriented. Vital signs: HR: 113, Pain score: none, RR: 23 on 6L facemask, lung sound: Wheezing. SPO2: 99%, BP: 140/71, Glasgow Coma Scale (GCS):15, ECG: sinus rhythm and no ST abnormalities, Capillary refill: <2, Pupils: PEARL ,Glucose:16.6 mmol/l.

Case 43:

Presentation: A 20 years old female patient with 2nd degree burn is to be transported by a ground ambulance from local doctor office to a tertiary hospital. The distance is 10 miles.

Relevant medical history: No known medical history.

Medications: No known medication.

Allergies: No known allergies.

Observations (sending facility report): conscious female with 2nd degree burns, 18% facial and chest. Vital signs: HR: 109. RR: 26, SPO2: 100%, Pain score: 7 BP: 134/79, GCS: 15. Glucose: 7.2 mmol/l. Pupils: PEARL. Temp: 36.6. ECG: Sinus rhythm with no ST abnormalities. Capillary refill: <2 sec.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion 150cc/h. patient had received 2mg of morphine and 150ml normal saline bolus.

Time	Event
00:00	Arriving to examine a 20 years old female with 2nd degree burn. conscious female with 2nd degree burns, 18% facial and chest. Vital signs: HR: 109. RR: 26, SPO2: 100%, BP: 134/79, GCS: 15. Glucose: 7.2 mmol/l. Pupils: PEARL. Temp: 36.6. ECG: Sinus rhythm with no ST abnormalities. Capillary refill: <2 sec. Patient had received 2mg morphine. Patient is transported to EMS monitor.
00:01	Patient complaining of severe pain 7/10.
00:02	Patient has received 3mg morphine.
00:04	Patient HR:109, BP:147/92.
00:37	Arriving main hospital.
00:20	Receiving facility data: a 20 years old female with 2nd degree facial and chest burn (18%). Patient had received a total of 5mg of morphine. Patient is drowsy. GCS: 13. RR: 24, HR: 88. SPO2:100%, BP:121/92.

Case 44:

Presentation: A 72 year old male patient with chest discomfort and vomiting is to be transported by a ground ambulance from local doctor office to a tertiary hospital. The distance is 10 miles.

Relevant medical history: Hypertension and Asthma.

Medications: Amlodipine and salbutamol.

Allergies: No known allergies.

Observations (sending facility report): Conscious male with chest discomfort and vomiting. Vital signs: HR: 92. RR: 19, SPO2: 98%, BP: 106/70, GCS: 15. Glucose: 5.9 mmol/l. Skin: pale. Pupils: PEARL. Temp: 36.6. ECG: Sinus rhythm with no ST abnormalities. Capillary refill: <2 sec.

Interventions (done by sending facility): Right anterior cubital (AC) IV access., Normal saline infusion 80ml/h.

Time	Event
00:00	Arriving to examine a 72 year old male with chest discomfort and active vomiting. Conscious male with chest discomfort and vomiting. Vital signs: HR: 92. RR: 19, SPO2: 98%, Lung sound: clear BP: 106/70, GCS: 15. Glucose: 5.9 mmol/l. Skin: pale. Pupils: PEARL. Temp: 36.6. ECG: Sinus rhythm with no ST abnormalities. Capillary refill: <2 sec. Patient is transported to EMS monitor.
00:02	Patient is actively vomiting yellowish vomitus. BP:100/53 HR:113
00:03	Patient is given 500ml of normal saline and 10mg metoclopramide.
00:05	BP: 132/73, HR: 90. Patient is no longer vomiting.
00:25	Arriving main hospital
00:25	Receiving facility data: a 72 year old male with chest discomfort and vomiting. Vital signs: HR: 84. RR: 17, SPO2: 100%, Lung sound: clear BP: 140/79, GCS: 15. Skin: pale. Pupils: PEARL. Temp: 36.6. ECG: Sinus rhythm with no ST abnormalities. Capillary refill: <2 sec

Case 45:

Presentation: A 43 year old male patient, conscious, alert and oriented to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: Acute spinal trauma (Spinal fractures L1-L4).

Medications: No known medication.

Allergies: No known allergies.

Observations (sending facility report): conscious. Vital signs: HR: 69, Pain score: 4, RR: 20, lung sound: clear bilateral SPO2: 100%, BP: 138/91, Glasgow Coma Scale (GCS): 15, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 37.3, Capillary refill: <2, Pupils: Equal and Reactive to Light (PEARL) at 3mm,Glucose: 5.1 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion at 60cc/h.

Time	Event
00:00	Arriving to examine a 43 year old male patient.
00:01	Initial physical examination: conscious. Vital signs: HR: 84, Pain score: 7, RR: 20, lung sound: clear bilateral SPO2: 100%, BP: 138/91, Glasgow Coma Scale (GCS): 15, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 37.3, Capillary refill: <2 sec, Pupils: Equal and Reactive to Light (PEARL) at 3 mm, Glucose: 5.1 mmol/l. Patient is transported to EMS monitor. Patient has been on long backboard; he is complaining of severe back pain. (incident severe pain)
00:02	Morphine 4mg is given IV.
00:05	HR:68, BP:128/73 and pain score: 1
01:13	Arriving main hospital
01:14	Receiving facility data: 43 years male direct Neurology admission. Conscious, alert and oriented. Vital signs: HR: 70, Pain score: none, RR: 24, lung sound: clear bilateral SPO2: 100%, BP: 121/70, Glasgow Coma Scale (GCS): 15, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 36.9, Capillary refill: <2 sec, Pupils: Equal and Reactive to Light (PEARL) at 3mm,Glucose: 5.6 mmol/l. Patient has received 5 mg morphine.

Case 46:

Presentation: A 40 year old male patient, conscious, alert and oriented with chest pain to be transported by a ground ambulance from local hospital to a tertiary hospital. The distance is 31 miles.

Relevant medical history: No known history.

Medications: No known medications.

Allergies: No known allergies.

Observations (sending facility report): conscious. Vital signs: HR: 88, Pain score: 4, RR: 19, lung sound: clear bilateral SPO2: 100% on 3L Nasal cannula, BP: 121/82, Glasgow Coma Scale (GCS): 15, 12 lead ECG: Left bundle branch block and ST inversion V4-V6. Temp: 36.8, Capillary refill: <2 sec, Pupils: Equal and Reactive to Light (PEARL) at 3mm.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion at 60cc/h. Patient received Isosorbide nitrate 5mg Sub Lingual (SL). Aspirin 324 mg and 3mg morphine.

Time	Event
00:00	Arriving to examine a 40 year old male patient.
00:01	Initial physical examination: conscious. Vital signs: HR: 88, Pain score: 4, RR: 19, lung sound: clear bilateral SPO2: 100% on 3L Nasal cannula, BP: 121/82, Glasgow Coma Scale (GCS): 15, 12 lead ECG: Left bundle branch block and ST inversion V4-V6. Temp: 36.8, Capillary refill: <2 sec, Pupils: PEARL at 3mm Patient is transported to EMS monitor.
00:21	Patient is complaining of chest pain. Pain score 9 (incident pain). HR:101 BP: 119/82
00:22	Isosorbide nitrate 5mg Sub Lingual (SL) is given.
00:28	Pain did not improve. Isosorbide nitrate 5mg Sub Lingual (SL). A bolus of Normal saline 250cc is given.
00:32	Pain 3/10. HR: 91 BP: 136/84
01:07	Arriving main hospital
01:08	Receiving facility data: 40 year male. Conscious, alert and oriented. No known past history complaining of chest pain started 2 hours ago. Vital signs: HR: 89, Pain score: 2, RR: 24, lung sound: clear bilateral SPO2: 100% on 3L nasal cannula, BP: 126/78, Glasgow Coma Scale (GCS):15, 12 lead ECG: Left bundle branch block and ST inversion V4-V6, Temp:37, Capillary refill: <2, Pupils:

	PEARL at 3mm. Patient has received 2 doses Isosorbide nitrate 5mg.

Case 47:

Presentation: A 50 years old male patient trauma patient is to be transported by a ground ambulance from polyclinic to a tertiary hospital. The distance is 17 miles.

Relevant medical history: Diabetes and Asthma.

Medications: Insulin and salbutamol.

Allergies: No known allergies.

Observations (sending facility report): Conscious male involved in RTA with pelvic, right hip and right humerus fractures. Vital signs: HR: 96. RR: 22, SPO2: 95%, BP: 179/85, GCS: 15. Glucose: 12.3 mmol/l. Skin: pale. Pupils: PEARL. Temp: 36.7. ECG: Sinus rhythm with no ST abnormalities. Capillary refill: <2 sec.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion 60 ml/h. Patient is on long backboard with cervical collar.

Time	Event
00:00	Arriving to examine a 50 year old male involved in RTA. Conscious male. Vital signs: HR: 96. RR: 22, SPO2: 95%, BP: 179/85, GCS: 15. Glucose: 12.3 mmol/l. Skin: pale. Pupils: PEARL. Temp: 36.7. ECG: Sinus rhythm with no ST abnormalities. Capillary refill: <2 sec. Pain score 7/10. Patient is transported to EMS monitor. (Incident pain)
00:02	Patient is given 4mg of morphine IV. And patient is on 3L nasal cannula
00:05	Pain 1, HR: 85 and BP: 161/75
00:49	Arriving main hospital
00:50	Receiving facility data: a 50 year old received from local polyclinic. Patient was involved in RTA and seen in clinic with Right pelvic, right hip and right humerus fractures. Vital signs: HR: 94. RR: 25, SPO2: 100%, Lung sound: clear BP: 169/82, GCS: 15. Skin: pale. Pupils: PEARL. Temp: 37.1. ECG: Sinus rhythm with no ST abnormalities. Capillary refill: <2 sec. Trauma team is activated.

Case 48:

Presentation: A 65 years old male patient with chest pain. Conscious, alert and oriented male is to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: Patient has hypertension and diabetes.

Medications: Amlodipine and Insulin.

Allergies: No known allergies.

Observations (sending facility report): Conscious with chest pain. Vital signs: HR: 74, Pain score: 5, RR: 20, lung sound: clear bilateral. SPO2: 100% on nasal cannula 3L, BP: 121/74, Glasgow Coma Scale (GCS): 15, ECG: Atrial flutter with ST elevation V3-V4, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 9.2 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion at 80cc/h, patient received Isosorbide nitrate (1 dose) 5mg Sub Lingual (SL). Aspirin 324 mg.

Time	Event
00:00	Arriving to examine a 65 year old male with chest pain.
00:01	Initial physical examination: Conscious with chest pain. Vital signs: HR: 74, Pain score: 5, RR: 20, lung sound: clear bilateral. SPO2: 100% on nasal cannula 3L, BP: 121/74, Glasgow Coma Scale (GCS): 15, ECG: Atrial flutter with ST elevation V3-V4, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 6.8 mmol/l. Patient is transported to EMS monitor.
00:15	Patient is complaining of severe chest pain. BP: 109/70 RR: 21. Pain score 9/10. (incident pain)
00:16	Fentanyl 50mcg is given IV. Normal saline bolus of 200cc is given
00:21	Pain free. BP:126/80
01:05	Arriving main hospital.
01:06	Receiving facility data: 65 year old male with chest pain. Conscious, alert and oriented. Vital signs: HR: 74, Pain score: none, RR: 18, lung sound: clear bilateral SPO2: 100% on nasal cannula 3L, BP: 129/85, Glasgow Coma Scale (GCS): 15, ECG: Atrial flutter with ST elevation V3-V4. Capillary refill: <2, Pupils: constricted, Glucose: 6.8 mmol/l. Patient is shifted to catheterization lab.

Case 49:

Presentation: A 28 year old male patient, unconscious post RTA with TBI to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: The patient had RTA 3 days ago with head injury.

Medications: No known medication.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 98, Pain score: unknown, RR: 14 on mechanical ventilation, lung sound: clear bilateral, SPO2: 100%, BP: 139/89, Glasgow Coma Scale (GCS):3, ECG: sinus rhythm and no ST abnormalities, Temp:36.7, Capillary refill: <2 sec, Pupils: PEARL, Glucose:6.3 mmol/l. Vent setting: Fio2: 50 and PEEP 5

Interventions (done by sending facility): Right subclavian central IV access, Normal saline infusion at 80cc/h, Midazolam 5mg/h and Fentanyl 100mcg/h.

Time	Event
00:00	Arriving to examine a 28 year old male post RTA.
00:01	Initial physical examination: Unconscious. Vital signs: HR: 98, Pain score: unknown, RR: 14 on mechanical ventilation, lung sound: clear bilateral, SPO2: 100%, BP: 139/89, Glasgow Coma Scale (GCS):3, ECG: sinus rhythm and no ST abnormalities, Temp:36.7, Capillary refill: <2 sec, Pupils: PEARL, Glucose:6.3 mmol/l. Vent setting: Fio2:50 PEEP 5. ETT size 7.5 at 24cm. Patient is transported to EMS monitor, switched to EMS vent FIO2 100 PEEP 5.
00:23	Patient is agitated and fighting tube. Midazolam 4mg IV bolus is given. (Incident agitation)
00:27	Patient is still agitated and fighting the tube. Fentanyl 100mcg is given. BP:140/91
00:32	Patient HR 89 SPO2:100% and patient is sedated. BP:116/73
01:29	Arriving main hospital
01:30	Receiving facility data: 28 years old direct ICU admission. Unconscious GCS of 3 male on ETT size 7.5 at 24cm on mechanical ventilation Fio2: 100 and PEEP 5. Spo2 100% and lung sounds are clear bilateral. HR:85 BP: 122/79 on midazolam infusion 5 mcg/h. Pupils Right is sluggish at 2mm and Left is PEARL. Patient has a central IV confirmed by portable chest X-ray ETT is in good position.

Case 50:

Presentation: A 61 year old male patient diagnosed with metastatic gastric carcinoma to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: Diabetes, hypertension and newly diagnosed metastatic gastric carcinoma.

Medications: Insulin and amlodipine.

Allergies: No known allergies.

Observations (sending facility report): conscious. Vital signs: HR: 122, Pain score: none, RR: 23, lung sound: clear bilateral, SPO2: 100% on facemask 5L, BP: 110/89, Glasgow Coma Scale (GCS): 15, ECG: sinus rhythm and no ST abnormalities, Temp: 36.9, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 10.3 mmol/l.

Interventions (done by sending facility): Right subclavian central IV access, Normal saline infusion at 80cc/h.

Time	Event
00:00	Arriving to examine a 61 year old male with metastatic gastric carcinoma.
00:01	Initial physical examination: conscious. Vital signs: HR: 122, Pain score: none, RR: 23, lung sound: clear bilateral, SPO2: 100% on facemask 5L, BP: 110/89, Glasgow Coma Scale (GCS): 15, ECG: sinus rhythm and no ST abnormalities, Temp: 36.9, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 10.3 mmol/l. Patient is transported to EMS monitor.
00:41	Patient HR:138 BP: 90/60 (Incident drop in BP)
00:42	Patient is given 200cc bolus of normal saline.
00:54	Patient BP:99/66 HR:126
01:04	Arriving main hospital
01:30	Receiving facility data: 61 years old male direct ICU admission. conscious. Vital signs: HR: 129, Pain score: none, RR: 18, lung sound: clear bilateral, SPO2: 100% on facemask 5L, BP: 103/64, Glasgow Coma Scale (GCS): 15, ECG: sinus rhythm and no ST abnormalities, Temp: 36.9, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 10.9 mmol/l. Patient has a central IV confirmed by portable chest X-ray.

Case 51:

Presentation: A 44 year old male patient, unconscious post RTA to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: No past medical history.

Medications: No known medications.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 78, Pain score: none, RR: 12 on mechanical ventilation, lung sound: clear bilateral SPO2: 98%, BP: 113/74, Glasgow Coma Scale (GCS): 3, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 37.0, Capillary refill: <2, Pupils: PEARL at 3mm,Glucose: 5.9 mmol/l. Vent setting: Fio2: 30 PEEP 5

Interventions (done by sending facility): Right subclavian central IV access, Normal saline infusion at 100cc/h, Midazolam 5mg/h and Fentanyl 100mcg/h. ETT size 7.5 at 23 cm

Time	Event
00:00	Arriving to examine a 44 year old male post RTA.
00:01	Initial physical examination Unconscious. Vital signs: HR: 78, Pain score: none, RR: 12 on mechanical ventilation, lung sound: clear bilateral SPO2: 98%, BP: 113/74, Glasgow Coma Scale (GCS): 3, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 37.0, Capillary refill: <2, Pupils: PEARL at 3mm,Glucose: 5.9 mmol/l. Vent setting: Fio2: 30 PEEP 5. Patient is transported to EMS monitor, switched to EMS vent FIO2 50 PEEP 5.
00:14	Patient on HR: 91 SPO2: 92% (Incident desaturation)
00:14	Fio2 increased to 100% and RR: 15
00:16	HR: 82 and SPO2 100%
01:08	Arriving main hospital
01:09	Receiving facility data: 44 years male direct ICU admission. Unconscious male GCS of 3, ETT size 7.5 at 22 cm, vent setting RR: 15 Fio2 100 PEEP 5. Spo2 99% clear bilaterally. HR: 88 BP: 130/73. ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 37.0, Capillary refill: <2, Pupils: PEARL at 3mm, Patient has a central IV confirmed by portable chest X-ray. ETT in good position.

Case 52:

Presentation: An 80 year old female patient, unconscious with pneumonia to be transported by a ground ambulance from MedEvac base to a tertiary hospital. The distance is 27 miles.

Relevant medical history: Bedridden, hypertension and diabetes.

Medications: Insulin, amlodipine, candesartan and aspirin.

Allergies: No known allergies.

Observations (sending facility report): Unconscious. Vital signs: HR: 97, Pain score: none, RR: 16 on mechanical ventilation, lung sound: clear on left and decreased on the right SPO2: 100%, BP: 136/61, Glasgow Coma Scale (GCS): 3, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 36.9, Capillary refill: <2 sec, Pupils: PEARL at 3mm,Glucose: 6.4 mmol/l. Vent setting: Fio2: 50 PEEP 14

Interventions (done by sending facility): Right subclavian central IV access, Normal saline infusion at 80cc/h, Midazolam 5mg/h, Fentanyl 100mcg/h and dopamine 20mcg/kg/min. ETT size 7.5 at 21 cm

Time	Event
00:00	Arriving to examine an 80 year old female with pneumonia.
00:01	Initial physical examination Unconscious. Vital signs: HR: 97, Pain score: none, RR: 16 on mechanical ventilation, lung sound: clear on left and decreased on the right SPO2: 100%, BP: 136/61, Glasgow Coma Scale (GCS): 3, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 36.9, Capillary refill: <2 sec, Pupils: PEARL at 3mm,Glucose: 6.4 mmol/l. Vent setting: Fio2: 50 PEEP 14. Patient is transported to EMS monitor, switched to EMS vent FIO2 100 PEEP 14.
00:31	Patient on HR: 121 BP: 86/58 (Incident hypotension)
00:31	Patient is given 200cc normal saline bolus. Midazolam infusion 2mg/h
00:36	HR: 106 BP: 116/70
00:58	Arriving main hospital
01:09	Receiving facility data: 80 years female direct ICU admission. Vital signs: HR: 99, Pain score: none, RR: 16 on mechanical ventilation, lung sound: clear on left and decreased on the right SPO2: 100%, BP: 130/50, Glasgow Coma Scale (GCS): 3, ECG: sinus rhythm with no ectopic or heart blocks and no ST abnormalities, Temp: 36.6, Capillary refill: <2 sec, Pupils: PEARL at 3mm, Vent setting:

	Fio2: 100 PEEP 14 Patient has a central IV confirmed by portable chest X-ray. ETT in good position.

Case 53:

Presentation: A 46 year old male patient with chest pain. Conscious, alert and oriented male is to be transported by a ground ambulance from local ER to a tertiary hospital. The distance is 32 miles.

Relevant medical history: Patient has hypertension, epilepsy, chronic renal failure and angioplasty 3 months ago.

Medications: Amlodipine, carbamazepine, dialysis and warfarin.

Allergies: No known allergies.

Observations (sending facility report): Conscious with chest pain. Vital signs: HR: 59, Pain score: 4, RR: 22, lung sound: clear bilateral SPO2: 100% on nasal cannula 3L, BP: 126/90, Glasgow Coma Scale (GCS): 15, ECG: sinus rhythm with ST elevation V1-V4, Temp: 36.9, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 5.7 mmol/l.

Interventions (done by sending facility): Right anterior cubital (AC) IV access, Normal saline infusion at 80cc/h, patient received Isosorbide nitrate (2 doses) 5mg Sub Lingual (SL).

Time	Event
00:00	Arriving to examine a 46 year old male with chest pain.
00:01	Initial physical examination: Conscious with chest pain. Vital signs: HR: 59, Pain score: 4, RR: 22, lung sound: clear bilateral SPO2: 100% on nasal cannula 3L, BP: 126/90, Glasgow Coma Scale (GCS): 15, ECG: sinus rhythm with ST elevation V1-V4, Temp: 36.9, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 5.7 mmol/l. Patient is transported to EMS monitor.
00:47	Patient HR: 92 BP: 93/58 (incident drop in BP)
00:47	Patient is given 150cc bolus of normal saline.
00:49	Patient HR: 89 BP: 107/71.
01:15	Arriving main hospital.
01:06	Receiving facility data: 46 years old male with chest pain. Conscious with chest pain. Vital signs: HR: 66, Pain score: 2, RR: 22, lung sound: clear bilateral SPO2: 100% on nasal cannula 3L, BP: 113/74, Glasgow Coma Scale (GCS): 15, ECG: sinus rhythm with ST elevation V1-V4, Temp: 36.9, Capillary refill: <2 sec, Pupils: PEARL, Glucose: 5.7 mmol/l Patient is shifted to catheterization lab.