Exploring and improving the escalation of care process for deteriorating patients on surgical wards in UK hospitals

Maximilian Joseph Johnston

MB BCh, MRCS

Imperial College London

Department of Surgery & Cancer

Thesis presented for the degree of Doctorate of Philosophy (PhD)

April 2015

Abstract

Despite impressive progress in technical skills, the rate of adverse events in surgery remains unfavourably high. The variation seen in surgical outcomes may be dependent on the quality of ward-based surgical care provided to post-operative patients with complications, specifically, the recognition, communication and response to patient deterioration. This process can be termed escalation of care and is an underexplored area of surgical research.

This thesis demonstrates the impact of delays in the escalation of care process on patient outcome. The facilitators of, and barriers to, escalation of care are then identified and described in the context of the UK surgical department. In order to prioritise areas within the escalation of care process amenable to intervention, a systematic risk assessment was conducted revealing suboptimal communication technology and a lack of human factors education as key failures. To ensure that communication technology intervention was conducted based on evidence, several exploratory studies describe the current methods of communication in surgery and explore areas of innovation and intervention. Following this, a human factors intervention bundle was implemented within a busy surgical department, which successfully improved supervision, escalation of care and safety culture.

This thesis describes, for the first time, escalation of care in surgery and outlines important strategies for intervention in this safety-critical process. To date, ward-based care has been one of the most under-researched areas in

surgery, despite its clear importance. The tools to improve escalation of care in surgery have been described and initial attempts at implementation have demonstrated great promise. Future use of these strategies should benefit surgeons and other clinical staff of all grades and ultimately, the surgical patient.

Contents

Declarations

I declare that I am the sole author of this thesis and that the work within it was undertaken by me, under the supervision of Professor Ara Darzi, Mr Dominic King and Miss Sonal Arora. Instances where others have contributed are appropriately referenced or acknowledged.

The copyright of this thesis rests with the author and is made available under a Creative Commons Attribution Non-Commercial No Derivatives licence. Researchers are free to copy, distribute or transmit the thesis on the condition that they attribute it, that they do not use it for commercial purposes and that they do not alter, transform or build upon it. For any reuse or redistribution, researchers must make clear to others the licence terms of this work.

Acknowledgements

The only reason I have managed to complete this thesis in a timely manner is due to the wide-ranging and expert sources of help and support I have benefited from during these 3 years. My family, colleagues and friends have all helped me immeasurably and this acknowledgements section will go a very tiny way in repaying you all for your generosity.

I would first like to thank my supervisors. Professor Ara Darzi put his trust in me and afforded me the opportunity to pursue this thesis. His expert-advice and incisive feedback has improved the quality of this work and I am very grateful. Secondly I would like to thank Ms Sonal Arora and Mr Dominic King who co-supervised me closely and expertly throughout this process. They are both different people, for Sonal, the devil is in the methodological detail, whereas Dominic is more of a blue-sky thinker and entrepreneur but I count myself so fortunate to have been supervised by both of them, the combination worked brilliantly. Their generosity with their knowledge, time, skills and advice has been invaluable and I look forward to continuing to work together in the future. Doing a PhD is a labour of love and I wouldn't have got through it without my colleagues and friends. Firstly those in room 1029 who put up with my moaning and, poor taste in music and even worse taste in fashion! Chris Nicolay, Dan Cohen, Mark Bagnall, Ann-Marie Howell, Phil Pucher, Laura Muirhead, George Bouras and Jeremy Huddy, I owe you all a pint. I also thank Pritam Aruna, Sejal, Karen, Beth, Renata and Caroline for their assistance and patience with me. I moved offices when starting to write-up due to departmental changes and also enjoyed the company of the psychologists in room 5.03.

For helping me with the design and/or implementation of various studies in this thesis I would like to thank Luke Stroman, Rachel Davis, Yannis Reissis, my five business BSc students, Nebil Behar, Gary Davies, Benita Cox, Nick Sevdalis, Louise Hull, Thanos Athanasiou and the Helix team of innovative designers.

Last but not least I would like to thank my friends and family. My Dad originally persuaded me that I had the ability to do a PhD and my Mum has been a great source of support. My wife Cat has put up with me being away frequently, stressing about deadlines, checking emails at strange times and generally being sleep-deprived and insufferable. It can't have been too bad as we got married two-thirds of the way through my years at Imperial! She is currently training in Obstetrics & Gynaecology and will be extremely successful in the future I am sure. This is for you – enjoy!

Peer-reviewed publications arising from this thesis

---

1. **M Johnston**, S Arora, O Anderson, D King, N Behar, A Darzi. Escalation of care in surgery: A systematic risk assessment to prevent avoidable harm in hospitalized patients. **Annals of Surgery.** Accepted article in press.

2. **MJ Johnston,** S Arora, D King, G Bouras, A Almoudaris, R Davis, A Darzi. A systematic review to identify the factors that affect failure to rescue and escalation of care in surgery. **Surgery.** Accepted article in press.

3. **MJ Johnston**, S Arora, PH Pucher, L Hull, J Huddy, Y Reissis, D King, A Darzi. Improving Escalation of Care: Development and validation of the QUality of Information Transfer (QUIT) Tool. **Annals of Surgery**. Accepted article in press.

4. **M Johnston**, M Mobasheri, D King, A Darzi. The Clarify, Design and Evaluate (CDE) approach to mHealth app development. **BMJ Innovations.** Accepted article in press.

5. **M Johnston**, S Arora, D King, L Stroman, A Darzi. Escalation of care and failure to rescue: A multicentre, multiprofessional qualitative study. **Surgery**. 2014 Jun; 155(6): 989-94.

6. **M Johnston**, D King, S Arora, K Cooper, N Panda, R Gosling, K Singh, B Sanders, B Cox, A Darzi. Requirements of a new communication technology for handover and the escalation of patient care: a multi-stakeholder analysis. **Journal of Evaluation in Clinical Practice.** 2014 Aug; 20(4): 486-97.

7. **MJ Johnston**, D King, S Arora, N Behar, T Athanasiou, N Sevdalis, A Darzi. Smartphones Let Surgeons Know WhatsApp: An Analysis of Communication in Emergency Surgical Teams. **American Journal of Surgery**. 2015 Jan; 209(1):45-51.

8. **MJ Johnston,** R Davis, S Arora, Y Reissis, D King, A Darzi. Raising the alarm: A cross-sectional study exploring the factors affecting patients' willingness to escalate care on surgical wards. **World Journal of Surgery** (under review).

Presentations to learned societies arising from this thesis

---

1. **M Johnston,** S Arora, D King, L Stroman, A Darzi. Preventing failure to rescue by improving the escalation of care process; an intervention study. The American College of Surgeons Clinical Congress, Washington DC, USA, 2013 (Oral).

2. **M Johnston,** D King, S Arora, N Behar, N Sevdalis, A Darzi. Smartphones let Surgeons Know WhatsApp. Association for Surgical Education Annual Meeting, Chicago, USA, 2014 (Oral).

3. **M Johnston,** S Arora, D King, N Behar, A Darzi. Escalation of Care in Surgery: a Systematic, Pro-active Risk Assessment of Clinical Supervision. American College of Surgeons Accredited Education Institutes Consortium Meeting, Chicago, USA, 2014 (Oral).

4. **M Johnston,** D King, S Arora, N Behar, N Sevdalis, A Darzi. Communication and supervision of juniors in emergency surgery can be improved by smartphone messaging services. International Conference on Surgical Education & Training, Harrogate, UK, 2014 (Oral).

5. **M Johnston,** S Arora, D King, N Behar, A Darzi. Uncovering failures in the recognition and management of post-operative complications: a

systematic risk assessment of a safety-critical process. Association of Surgeons of Great Britain and Ireland International Surgical Congress, Harrogate, UK, 2014 (Oral).

6. **M Johnston,** S Arora, D King L Stroman, A Darzi. Can a human factors intervention improve institutional safety culture and outcomes for surgical patients? Association of Surgeons of Great Britain and Ireland International Surgical Congress, Harrogate, UK, 2014 (Oral).

7. **MJ Johnston,** D King, S Arora, K Cooper, N Panda, R Gosling, K Singh, B Sanders, B Cox, A Dari. Innovation of communication technology to improve information transfer during handover. International Digital Health and Care Congress, London, UK, 2014 (Plenary presentation).

8. **MJ Johnston,** S Arora, P Pucher, Y Reissis, D King, A Darzi. Development, validation and evaluation of the Quality of Information Transfer tool for deteriorating post-operative patients. Behavioural Sciences Applied to Surgery & Acute Care Settings International Meeting, London, UK, 2014 (Oral).

9. **MJ Johnston,** R Davis, S Arora, Y Reissis, D King, A Darzi. Uncovering facilitators and barriers to patients calling for help on surgical wards. Behavioural Sciences Applied to Surgery & Acute Care Settings International Meeting, London, UK, 2014 (Poster).

10. **MJ Johnston**. Using simulation to enhance the perioperative system. International Meeting on Simulation in Healthcare, New Orleans, Louisiana, USA, 2015 (Invited talk on expert panel).

Impact of the work in this thesis

---

1. **Paper of distinction award** at the 2014 Association for Surgical Education meeting in Chicago.
2. **Runner-up prize** for grant proposal at the 2014 NIHR research training camp.
3. **Co-Investigator** for £34,500 Biomedical Research Council grant for Hark smartphone app.
4. **Invited onto expert panel** at the 2015 International Meeting on Simulation in Healthcare.
5. **Invited onto expert panel** at the 2015 UK Patient Safety Congress.
6. **Nominated for Breakthrough Innovation award** by Imperial Innovations.
7. **Hark smartphone app co-developed** in 2014 and selected for implementation in the Imperial NHS Trust.
8. **Excellence in patient safety award** from the Department of Surgery & Cancer at Imperial College London.
9. Commentaries in Surgery by **Drs. David Hoyt and Carlos Pellegrini of the American College of Surgeons** for the article 'Escalation of care and failure to rescue: A multicentre, multiprofessional qualitative study.'
10. Featured article in the May 2015 issue of Annals of Surgery with accompanying editorial by **Drs. Amir Ghaferi and Justin Dimick** for the article 'Escalation of care in surgery: A systematic risk assessment to prevent avoidable harm in hospitalized patients.'

List of figures

List of tables

1 Thesis introduction

In this introductory chapter the key principles of quality and safety in surgery will be outlined through the discussion of several seminal papers in this area from the last two decades. The structure of surgical training in the United Kingdom (UK) will then be described alongside the structure and roles of each individual within a typical surgical team. The clinical environments and patients that a junior surgeon will typically encounter during their initial training will then be explored. Following this, the escalation of care process and its application to surgery will be introduced. Lastly, the role of important ward-based surgical care stakeholders such as the doctor, nurse and patient will be described in the context of patient safety and escalation of care.

1.1 Quality and safety in surgery

Primum non nocere or 'first, do no harm' is the principle which underpins modern medical practice. Doctors spend a minimum of five years at university; the majority of time is spent learning disease processes and how to intervene in that process to preserve or improve the patient's quality of life (e.g. medication or surgery). Whilst this knowledge should inherently help doctors to avoid causing harm, it is not explicit. An adverse event can be defined as an "instance that indicates that a patient has received poor quality care"; therefore, according to this definition all adverse events are, to some degree, preventable[1].

It was only within the last quarter of a century that the sheer scale of preventable harm suffered by patients became apparent[2]. In 1991 Brennan et al.

reviewed the medical records of 30,195 patients and found that 3.7% of patients suffered an adverse event in hospital and that over a quarter of these were due to medical negligence. Another decade passed and in 2001 Vincent et al. reported a retrospective record review of 1,014 British patients. They found that that 10.8% of hospital patients suffered an in-hospital adverse event and that half of these events could be considered preventable[3].

Around this time, research in surgery reached a turning point. High-impact reports from the USA[4,5] and UK[6,7] were published and encouraged a culture with accountability but without blame. The realisation came that a different approach was needed, the 'systems approach to surgery' was born[8]. Vincent et al. postulated that high-quality surgical skill, team performance and equipment would enable a surgeon to achieve a 90% success rate for a high-risk operation. However, they argued that improvement of surgical skill would only play a small part in reducing mortality from that high-risk operation from 10% down to 1%. They advocated optimisation of decision-making, teamwork and communication to achieve true high-performance. In order to optimise these critical facets of surgical performance, a deep understanding of surgical training and team structure is required.

1.2 Structure of surgical training in the UK

The first step on the road to becoming a surgeon is to graduate from medical school with a degree in medicine. In the UK, medical schools typically offer two types of medical degree, undergraduate and postgraduate. An undergraduate degree is awarded to a successful student who entered a medical course directly from secondary school and is typically a five-year course. A postgraduate degree is awarded to a student who attends medical school after achieving a previous degree, usually a Bachelor of Science (BSc). Postgraduate medical courses are typically four years in length. When studying for a medical degree the student is exposed to one to two years of pre-clinical lectures and seminars before two to three years of clinical studies in both hospitals and primary care (general practice surgeries and the community). To graduate from medical school, students must be successful in their "finals " examinations (with the addition of modular examinations and coursework for some institutions). These examinations typically include a mixture of written papers and role-playing assessments (known as Objective Structured Clinical Examinations or OSCEs)[9].

Once a graduate has successfully completed medical school they will undertake two years of foundation training. Newly qualified doctors are eligible to begin practice with provisional registration from the General Medical Council (GMC). Provisional registration allows the newly qualified doctor to apply to pre-approved Foundation Year 1 (FY1) training posts only and there are some limitations to their practice (such as restricted prescribing)[10]. An FY1 doctor is also referred to as a House Officer (HO) in the UK.

Progression from FY1 to the second year of foundation training (FY2) is competency based with the doctor being assessed using an electronic portfolio and annual review of their progress. Once the first foundation year of training has been completed a doctor is then eligible for full registration with the GMC and can also register as an independent prescriber. For the surgically minded candidate, progression from FY2 is dependent on a competitive application to a training region through a national scheme. If a candidate is successful they become a Core Surgical Trainee (CT) for two years. Depending on the region within which the doctor is appointed they may participate in a themed or un-themed two-year core-training scheme (CT1 and CT2). A combination of four and six-month rotations in any of the nine surgical specialties [11] readies the doctor to apply for specialist training in surgery. An FY2, CT1 or CT2 doctor is colloquially referred to as a Senior House Officer (SHO). Core and foundation training are both relatively recent phenomena, prior to this medical training was less firmly structured until the 'Modernising Medical Careers' programme was introduced in 2005 and remains current.

A further competitive application process follows and if the candidate is successful they are assigned to a training region for a further period of specialist training (ST). The length of training depends on the specialty but is not less than six years; the clinical grades are denoted numbers according to the year of training (e.g. ST4). To be eligible for specialist training, a trainee must have gained membership of one of the Royal Colleges of Surgeons in the UK (MRCS). Membership is attained through passing a series of written and oral examinations in anatomy, pathology, critical care, history taking, clinical examination, communication and practical procedural skills.

To achieve independent practice privileges a specialist trainee must pass a final exam to achieve the status of Fellowship of the Royal College of Surgeons (FRCS). After the exam has been passed and the specialist-training programme has been completed successfully the surgeon is awarded a certificate of completion of training (CCT). This certificate allows the surgeon to begin independent practice as a consultant and enter himself or herself on the specialist register, held by the GMC.

During the course of their career, a surgeon is expected to keep up to date with evidence based medicine and practical procedural skills. To this end, there are several courses most surgeons will attend during the different stages of their career. Foundation doctors will attend the Advanced Life Support (ALS) course to teach them how to participate in medical emergency scenarios and a Basic Surgical Skills (BSS) course, which covers the basics of open and endoscopic surgery. The core-trainee will usually attend a course to enable them to pass the MRCS exam, alongside the Advanced Trauma Life Support (ATLS course), which introduces the principles of trauma care, and the Care of the Critically Ill Surgical Patient (CCrISP) course, which teaches surgeons how to care for patients in a high-dependency or intensive care setting. The specialty-trainee will usually attend courses relevant to their surgical subspecialty (e.g. a colorectal trainee may attend a colorectal anastomosis course), however, the uptake of minimally invasive and laparoscopic surgery over the last two decades[12] has meant that endoscopic courses are also commonly attended by trainees wanting to hone their skills. Consultant surgeons are obliged to attend courses to keep up to date with advances in their specialty and to maintain their technical and non-technical skills. Indeed, all licensed doctors in the UK must revalidate their fitness to practice every 5 years; this process is overseen by the GMC.

1.3 Surgical team roles

The surgical team refers to a multidisciplinary group of healthcare professionals charged with ensuring that the pre-operative, intra-operative and post-operative care of a patient is conducted safely. A large group of people are involved with this including nurses, surgeons, anaesthetists and theatre staff. In this thesis I will principally focus on the surgeons.

Each general surgical patient in a UK hospital has a consultant surgeon who holds overall responsibility for their care; this consultant and his/her team look after their patients during normal hours (usually 8am-5pm), they are known as the day team. Outside of these hours an on-call team is responsible for the emergency care of all general surgical patients in the hospital[13].

The day surgical team usually consists of one or more FY1 doctors, one or more SHO doctors, one or more ST surgeons and a consultant. Medical students are commonly assigned to a consultant's team for training and learning. The on-call team consists of similar grades of doctor, with a consultant in charge.

The make-up of the on-call team is decided on a rota basis in most surgical departments. However, there is a push from the Royal Colleges of Surgeons (England, Edinburgh and Glasgow) and various surgical associations (e.g. the Association of Surgeons of Great Britain and Ireland) for Emergency General Surgery (EGS) teams to become the norm and handle emergency service provision for surgical care, this phenomenon is not confined to the UK[14]. An EGS team consists of similar members to a standard on-call team, the difference being that the members of the team in EGS are on-call throughout normal working hours during the week. This leads to greater continuity of care for patients and training for surgeons[15] as the emergency and elective surgical commitments of the consultant are kept separate[16].

One of the principal reasons that EGS teams have been implemented is the European Working Time Directive (EWTD). The EWTD is a European Union initiative designed to combat the effects of doctors working long hours and becoming fatigued so as to improve safety for patients[17,18]. This approach is not unique to Europe; in the United States of America (USA) there has also been a reduction of duty hours for trainee doctors, though it is less restrictive[18]. Whilst the rationale behind implementation of the EWTD was sound, there have been allegations that it negatively impacts on the continuity of patient care and the quality of surgical training[19,20]. As such, the roles of members of the surgical on-call team have been the subject of increased scrutiny[21].

The role of the FY1 doctor on the surgical team is to learn the basic ward-based skills required to look after surgical patients. The FY1 supports the rest of the team by performing tasks such as organising scans, placing intravenous lines and documenting the plan from ward rounds in the clinical notes. In addition they attend structured teaching, training and audit sessions. When on-call, the FY1 doctor may also be tasked with assessing and admitting patients from general practitioners to the surgical ward depending on the policy of the department they work within[15].

The SHO on the surgical team continues to consolidate the ward-based skills they acquired during their FY1 appointment by supporting the FY1 with ward tasks. However, the SHO is also commonly required to participate in outpatient clinics and operating theatre lists so their role is more varied than that of the FY1 doctor. When on-call, the SHO is responsible for receiving patient referrals from the emergency department (ED) and also participates in emergency operations (usually as an assistant)[15].

ST surgeons are more commonly known as registrars. They lead the daily ward round if the consultant is absent, consent patients for operations and then either assist in or perform the surgical procedure in the operating theatre. They also participate in outpatient clinics and the multidisciplinary team (MDT) meeting for cancer patients[22]. Furthermore, the registrar needs to be available to junior team members for advice about patient care, especially if a junior surgeon wants to escalate the care of a deteriorating patient to the registrar[23]. The registrar usually acts as the link between the consultant and the more junior members of the team; as such they have a crucial co-ordination role within the team and help to decide on daily activities and supervision of the juniors.

Consultant surgeons are the senior members of the team. They have gained a license to practice independently and have admission rights to the hospital(s) they hold a contract with. Consultants have a managerial as well as clinical role. Their clinical role is similar to the registrar in that they lead ward rounds when available, run operating lists, outpatient clinics and MDT meetings. However, they are also responsible for ensuring that patients are operated upon and investigated within government defined waiting list periods and ensuring that the clinical team functions smoothly. When the registrar or consultant are on-call they remain responsible for the care of their ward patients but usually are removed from clinic and/or theatre lists to see patients in the Emergency Department (ED) or Surgical Assessment Unit (SAU)[24].

1.4 Junior surgeons experience of the wards and of patients

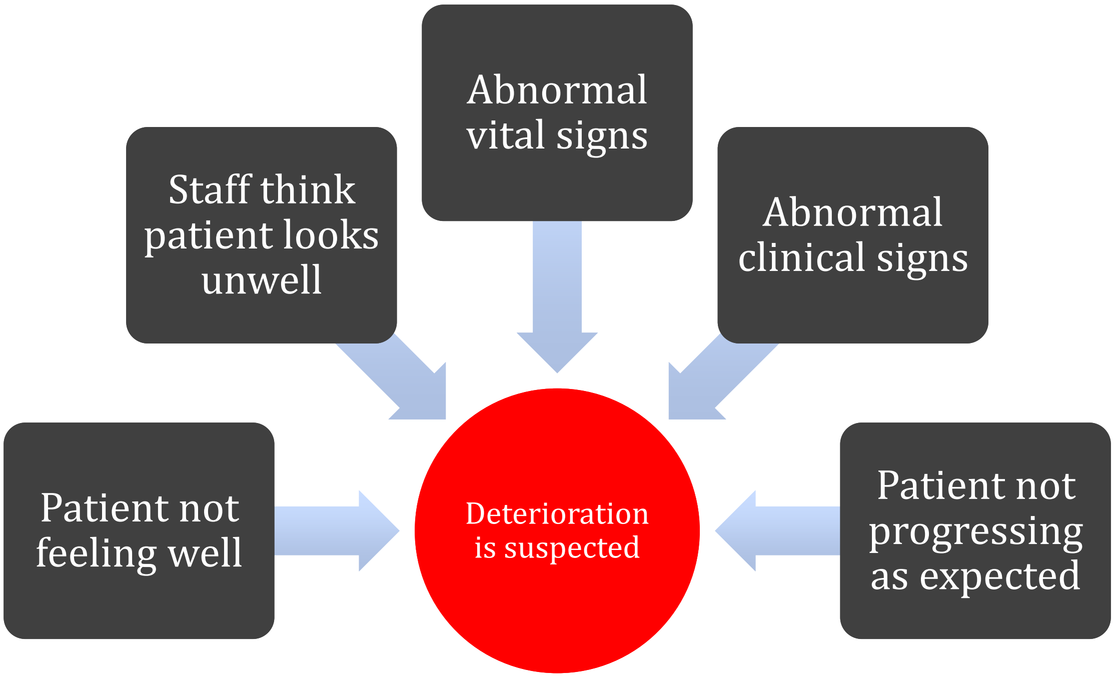
One day a final year medical student, the next day a doctor. Junior surgeons begin life as an FY1 after an induction period at the hospital where they are doing their first rotation. Their predecessor introduces them to the wards and staff at the hospital and helps to prepare them for their first day of work. On their first day the SHOs and registrars supervise them very closely. Initially, their tasks are ward-based: documentation in the medical notes, patient discharge prescriptions and basic procedures (such as venepuncture).

The phenomenon called the "August effect" is routinely discussed in the media and medical literature. It is the hypothesis that the increase in morbidity and mortality in UK hospitals coincides with the commencement of new FY1s starting their clinical career[25,26]. This situation is not unique to the UK, in USA the new doctors start in July and the term "July effect" has been coined[27]. As well as the more administration based tasks; junior surgeons (FY1s and SHOs) may be asked to see deteriorating patients under their consultant's care during normal working hours. If they are on-call they may be asked to assess any surgical patient so it is imperative that junior surgeons know how to recognise and initially treat deteriorating patients.

1.5 Context of escalation of care

The process of recognizing patient deterioration and communicating this to a senior colleague who is in a position to implement definitive treatment is termed escalation of care. Escalation of care is a critical process in the promotion of patient safety. For the escalation of care process to start for a ward patient, a ward nurse needs to recognise the signs of initial deterioration, which should then be communicated to a doctor; although, there are many different potential routes to escalation which may be subjective or objective in nature (shown in **Figure 1A**). Nurses may base their concerns on abnormal physiological values (e.g. tachycardia or hypotension) or the patient may complain of symptoms (e.g. difficulty breathing or abdominal pain)[28].

Figure 1A Routes to escalation of care



Junior surgeons are often the first doctor asked to assess deteriorating ward patients[29]. The junior surgeon is not expected to provide definitive treatment in most instances (e.g. they wouldn't be expected to take a patient for emergency surgery); however, it is vital that they possess the skills required to recognise a post-operative complication and clearly communicate the patients' current status to a registrar or consultant who can implement definitive treatment. It is also vital that the senior colleague contacted by the junior recognises the need for an urgent opinion and goes to the patient swiftly. Both junior and senior surgeons need multiple skills to ensure escalation of care is successful.

Most of the focus of surgical research in the 1990s and first half of the 2000s was the exploration of technical (i.e. procedural) skills and patient outcomes[30,31]. However, since 2005, the non-technical skills (NTS) of surgeons and other operating theatre staff (e.g. anaesthetists, nurses) have come into focus. This is because technical skills in surgery are now not thought be sufficient to maintain a high-quality of performance over time[32]. The roles of communication, leadership, situational awareness, stress management and teamwork in surgical performance have been the subject of recent research with reports commonly concluding that NTS have a significant impact on the quality of patient care.

Similarly, after a period of surgical research focusing on the operating theatre, more recent research has branched into exploring the surgical ward and other environments[33,34]. There remains a drive to improve care in the operating theatre through education of NTS[35], however, the realisation has come that no matter how good the intraoperative care of a patient is, complications may still occur. It is the recognition and management of post-operative complications that is now the cornerstone of the movement to improve surgical patient safety.

As well as better care for the individual patient, well-performed escalation of care may produce significant efficiency savings for healthcare providers.

Consider the case of a splenic trauma patient, if splenic bleeding is swiftly recognised the patient can have urgent radiological embolization. If successful this patient can be subsequently managed on a surgical ward. If the bleeding is not noted quickly the patient may need emergency anaesthesia followed by laparotomy (opening of the abdominal cavity) and removal of the spleen. After major surgery the incidence of complications is much higher than with minimally invasive techniques[36] and the length of stay is longer, meaning the health burden to the patient and the financial burden to the health provider is much higher.

Furthermore, if the patient requires admission to an intensive care unit (ICU) or high-dependency unit (HDU) there are further cost implications.

1.6 What if escalation of care isn't successful?

The delayed recognition of bleeding in the hypothetical case detailed previously illustrates the implications to the patients, staff and healthcare providers. However, not all patients recover from a post-operative complication, no matter how early it is recognised and treated. Mortality rates have long been reported as the primary outcome measure in high-impact interventional research studies[37]. Whilst inpatient mortality is a very useful indicator of care quality and patient safety it does not have the ability to discriminate between patients who were critically unwell on their arrival at a hospital and those who suffered a complication during their inpatient stay. Because of this, a quality indicator termed 'failure to rescue' is increasingly being reported in surgical research.

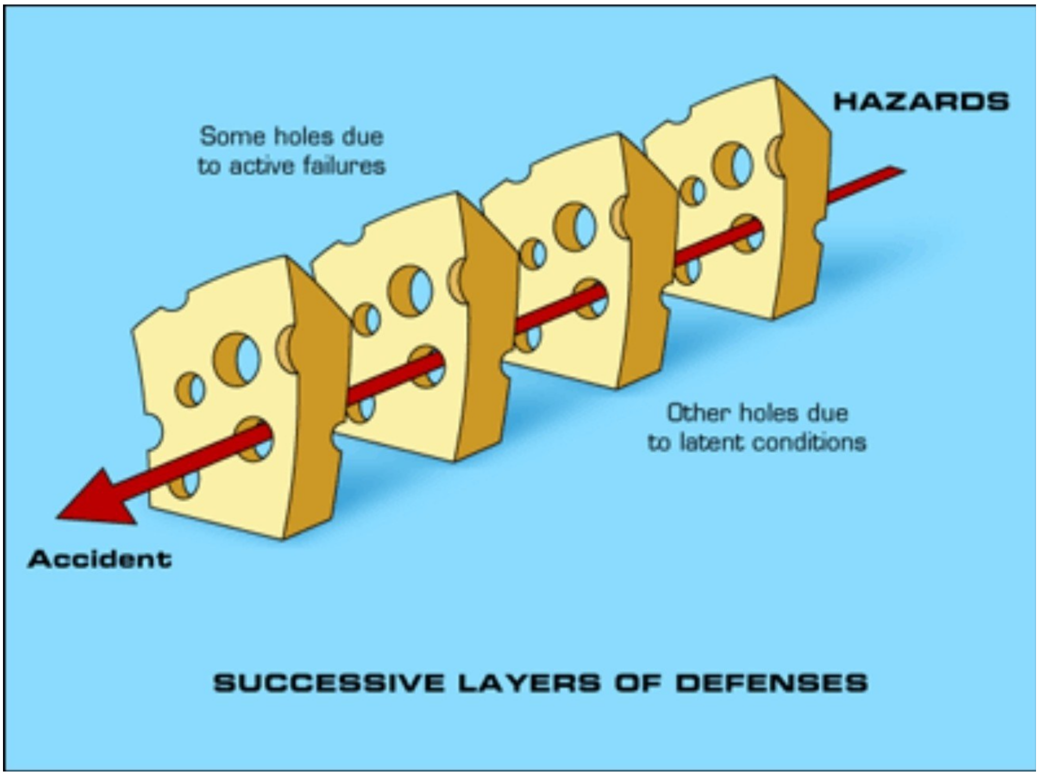
Failure to rescue, conceived by Silber at al. in 1992, can be defined as the death of a patient following a post-operative complication[38]. Failure to rescue may be a more sensitive quality indicator than mortality rates as it only takes the care of the patient following the occurrence of a complication into account. The quality of care provided to patients on the surgical ward[39], and the quality of postoperative handover[40] are beginning to be investigated in surgery and may play an important role in the variation of patient outcomes between different hospitals and geographical areas. This relationship will be explored within this thesis. In order to further understand the contribution of escalation of care to failure to rescue and other patient outcome measures we must first understand the systems approach to surgery and define the roles of healthcare professionals and patients in escalation of care and patient safety.

1.7 The systems approach to surgery and adverse events

The roles of doctors (and allied health professionals) cannot be understood until the role of human error in adverse events has been explained. An error describes an act, which is, in hindsight, realised to be potentially detrimental to a person or group of people. In healthcare an error can lead to patient harm, hence why the study of error in surgery has become such a focus in recent years[41]. Brennan et al. have shown us how common errors and adverse events are in healthcare but it is important to clearly distinguish between errors and adverse events. An error presents the potential for patient harm to occur; an adverse event defines the patient harm that has occurred. For example, a surgeon who forgets to prescribe prophylactic antibiotics prior to major abdominal surgery has committed an error; the patient has suffered an adverse event when they develop a wound infection. What is important to realise is that an error will not always result in an adverse event. The patient in this scenario may not develop a wound infection, despite the error occurring. Furthermore, the error may not propagate through the whole clinical team. Even though the surgeon has forgotten the antibiotics the anaesthetist may remember to do so.

This analogy introduces us to Reason's "Swiss cheese model" of accident causation[42]. Reason argued that all high technology systems (including healthcare) have several layers of defences against accidents and errors. These may take the form of administrative defences against lapses such as the safety checklists introduced into operating theatres from the aviation industry, technological defences such as alarms or may simply be reliant on healthcare staff. If one of these defences should fail, the others should prevent the error progressing to an adverse event. However, if all the defences fail (Reason described this as the holes in the Swiss cheese lining up) errors can propagate through the missing defences and cause an adverse event (see **Figure 1B**).

Figure 1B Reason's model of accident causation



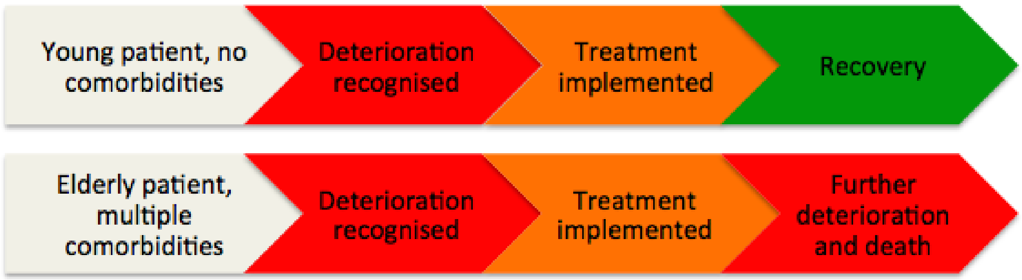
Reproduced from: Reason, J. (1990) Human Error: University Press, Cambridge.

This model is one of the cornerstones of the systems approach to surgery described above. Reason advocated that multiple healthcare professionals and systems should be responsible for high-quality patient care. The Swiss cheese model acknowledges the inevitability of occasional human error and mitigates for it by desiring multiple layers of defence and shared accountability.

The importance of this model to escalation of care cannot be underestimated. Studies have shown that patient deterioration can be detectable for extended periods of time before any permanent harm occurs, especially if there are changes in the patients vital signs[43]. This means that there are multiple opportunities for deterioration to be recognised and acted upon prior to any harm. The patient, nursing staff and medical staff of varying grades will all have the opportunity to do this, however, if all the holes line-up (i.e. they all miss this opportunity) the complication may go undiagnosed and deterioration be allowed to continue, resulting in harm to the patient. The holes in the system may be due to human error or latent failures (inadequately designed procedures or equipment failure). The reason this is so important in healthcare is that patient deterioration is a dynamic process with uncertain transition points. Some deteriorating patients may be very resilient and escape permanent harm despite prolonged deterioration. Other patients with multiple comorbidities (such as renal failure or diabetes) may deteriorate far more rapidly and suffer permanent harm more quickly, despite the correct management being implemented (see **Figure 1C**).

Other safety-critical industries such as aviation have more static processes. For example, if there is a mechanical fault with an aircraft that would cause it to crash after takeoff, as long as this fault is discovered prior to takeoff then the adverse event will be prevented (though this would still be classified as a near miss). In healthcare, even if the fault is discovered, the process that eventually leads to patient harm may already have started.

Figure 1C Importance of patient comorbidities to odds of recovery



The potential role of clinical human factors and technology in improving surgical patient safety cannot be ignored as they have been successful in several other industries[44]. Technology has revolutionised many areas of medicine in recent years and the potential for improved patient monitoring devices and communication technology is very exciting. Clinical human factors can be defined as "enhancing clinical performance through an understanding of the effects of teamwork, tasks, equipment, workspace, culture, organisation on human behaviour and abilities, and application of that knowledge in clinical settings[45]." The integral role of human factors in escalation of care and attempts to improve it through a combination of human factors and technological innovation will be described in this thesis. Furthermore, an understanding of the roles of the main stakeholders in the escalation of care process should produce a better comprehension of the human and technological factors that can facilitate or impede it.

1.8 The role of patients in patient safety and escalation of care

Whilst patients are not bound by any professional responsibility to raise concerns with a health professional when they feel unwell, they will not infrequently be the first person aware that they are not well. Symptoms of illness usually precede reliable signs and physiological deterioration (i.e. changes in the vital signs) may be further delayed due to compensatory mechanisms. As the central theme of healthcare the patient should be placed at the centre of the escalation of care process and be involved in research exploring it[46]. Sir Robert Francis published a wide-ranging enquiry exploring the failings of a single NHS Trust in response to reports of high-mortality and frequent episodes of medical negligence. Francis reported, among other things, that patients were not being listened to sufficiently and recommended that a common culture of 'putting the patient first' was needed. Patients should be encouraged to swiftly contact a nurse or doctor should they feel unwell but the factors that make this more or less likely are not yet known, they will be explored in this thesis.

1.9 The role of nurses and other allied healthcare professionals in patient safety and escalation of care

Nurses and other allied healthcare professionals (e.g. Health Care Assistants or HCAs) are responsible for the day-to-day care of ward-based patients. They are assigned to one particular ward and take part in a rota-based shift-working system. HCAs, staff nurses and senior staff nurses work two types of shift, a night and a day shift. Charge Nurses and Sisters are in a charge of a ward and tend to work fewer long days and night shifts in exchange for managing their staff. One of the most crucial jobs assigned to nurses is the monitoring and care of patients post-operatively, especially the regular recording and interpretation of vital signs and calculation of an early warning score[47].

Whilst there are protocols in place to ensure that deteriorating patients are recognised and that this recognition is acted upon, these protocols have had mixed success[48]. When a patient is deteriorating a nurse is tasked with ensuring basic measures are in place (e.g. oxygen therapy in the setting of decreased saturations or analgesia for post-operative pain). However, they must also ensure that help is sought from a doctor in a position to treat the patient, this is escalation of care. In the UK, this is often done by initially contacting a junior surgeon (such as the HO or SHO) who may either decide that they can manage the patient or re-escalate up the chain of seniority.

The decision to escalate care is not always as simple as protocols would suggest. Nurses care for multiple patients at the same time and the importance of distinguishing chronic disease with an acute complication is very important (e.g. low oxygen saturations in a COPD patient versus a young, post-operative patient with a chest infection). Nurses' standards of conduct and performance are defined by The Code, which dictates that nurses must recognise and work within the limits of their competence[49]. Recognising the limits of competence is something that can be done with experience; however, more junior staff members do not have this to fall back on. The ALERT™ course (Acute Life-Threatening Events, Recognition and Treatment) was founded in 1999, to train staff in recognising patient deterioration and treatment of the acutely unwell patient. Some NHS Trusts have made this course mandatory for nurses so (along with training from senior nurses and clinicians) nurses should be comfortable escalating care to a senior colleague. Whilst this thesis will principally focus on the role of surgeons in escalation of care, the overall process is so complex and requires interprofessional care, so the role of nurses will be carefully considered in several of the chapters.

1.10 The roles of doctors in patient safety and escalation of care

Doctors hold overall responsibility for maintaining high-quality care for patients in hospital. Their general role is defined by the GMC guidance in Good Medical Practice and the role of surgeons is more closely described in the Royal College of Surgeons of England's Good Surgical Practice[50,51]. Regarding patient safety, doctors must promote a culture of openness and safety in clinical care. Multiple demands are placed on doctors and they can range from clinical (escalation of care referral from a nurse) to administrative (create audit presentation or complete patient discharge papers), the complexity in the doctor's role is prioritisation of these multiple demands. The doctor must complete the most clinically urgent task first and the ability to prioritise tasks in this manner is a crucial skill. This is especially true in the care of surgical patients, where the time to intervention for a patient with a post-operative complication can be the difference between mortality and survival[52].

In order for the escalation of care process to be successful for a deteriorating patient, a combination of technical and non-technical skills are required (one of the most important skills is good communication). Good Surgical Practice instructs surgeons to listen to the views of colleagues and respond to any concerns they may have. This means a doctor is duty-bound to promptly assess a deteriorating patient when asked to by a nurse or more junior surgeon. However, this doesn't mean they will always be free to do so. It is crucial therefore, to have accurate knowledge of the skills and experience levels of all colleagues working together in the surgical team[53]. Junior surgeons will not be experienced enough to make critical management decisions (e.g. return a patient to the operating theatre) but vital temporising measures such as fluid administration, oxygen therapy and key investigations (radiological and pathological tests) are within their remit. These skills can determine the outcome for the patient and their future quality of life so it is vital that surgeons are trained in the recognition, communication and management of deteriorating patients.

1.11 Thesis aims

The over-arching aim of this thesis is to conduct a comprehensive examination of the escalation of care process in surgery and implement strategies aiming to improve safety for the surgical patient.

The specific aims of this thesis are:

1. To explore the link between the quality of escalation of care and patient outcome measures including failure to rescue (chapter 2)
2. To identify facilitators and barriers to escalation of care in surgery (chapters 3 and 4)
3. To risk assess escalation of care in surgery so as to identify areas with potential for intervention (chapter 5)
4. To investigate communication pathways and the role of communication technology in escalation of care (chapters 6 and 7)
5. To develop and validate a metric aiming to assess and improve information transfer during escalation of care (chapter 8)
6. To develop a human factors intervention bundle and assess its impact on supervision, escalation of care and safety culture in a UK surgical department (chapter 9).

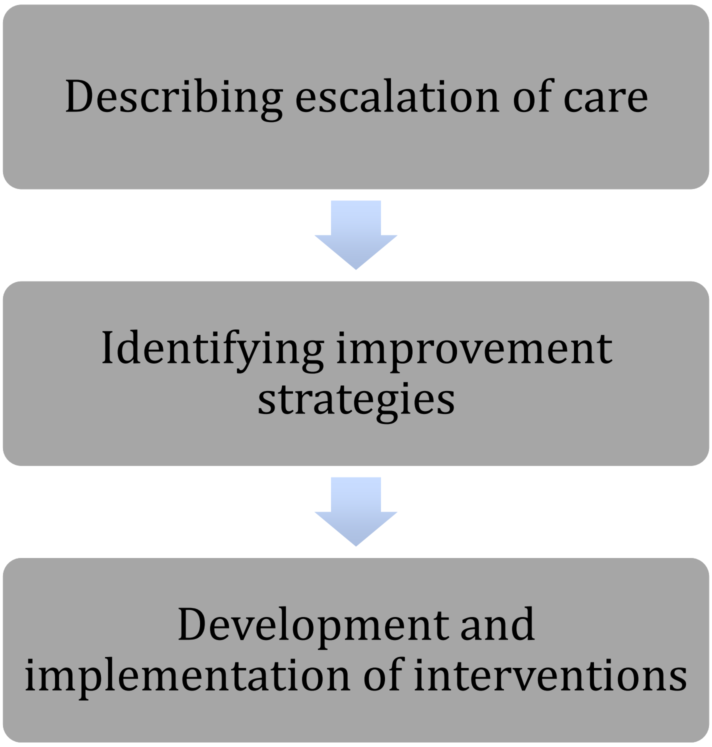
In order to address these aims, the structure of this thesis is further separated into three key phases:

1. Describing the escalation of care process, its current landscape in healthcare and problems with the process

2. Understanding the problems with escalation of care and identifying improvement strategies
3. Development and implementation of interventions to address the problems with escalation of care

A schematic representation of the thesis structure is presented in **Figure 1D**.

Figure 1D Thesis structure



1.12 Phase 1

Describing escalation of care and its current landscape in surgery

It is initially important to develop an understanding of what is involved in the escalation of care process and how deviations from good practice can impact on patient outcomes. A literature review that comprehensively explores escalation of care and patient outcomes in surgery is therefore the first study presented in this thesis in chapter 2. Following this, in chapter 3, a qualitative interview study builds on the literature review to give us an understanding of the facilitators and barriers to escalation of care in surgery. Lastly, in chapter 4 a cross-sectional questionnaire study of the factors that affect patients' willingness to call for help on surgical wards (thereby commencing the escalation of care process) will be presented.

2 A systematic review to investigate the impact of escalation of care on patient safety and failure to rescue in surgery

2.1 Introduction

As discussed in Chapter 1, the hypothesis for this study is that delayed or inadequately performed escalation of care may result in avoidable patient harm and ultimately, increased mortality for deteriorating surgical patients. This reflects the important role of variability in the provision of post-operative care on patient outcomes. A recent systematic review by Pucher et al. investigated the impact of enhanced recovery protocols (ERPs) and other structural, and process factors, on failure to rescue rates in surgery[54]. They found that 21 of 23 studies exploring enhanced recovery protocols found reduced length of stay and six reported decreased morbidity, none reported decreased mortality. Furthermore they found that nursing ratios were strongly associated with failure to rescue rates.

However, whilst this study explored failure to rescue in surgery, many of the interventions it investigated were resource-intensive. The hiring of staff and maintenance of (ERPs) are resource-heavy alterations to make within a healthcare system. The review failed to consider the important role of human factors and escalation of care in failure to rescue. Given that the culture of any healthcare institution is so important to how it functions and how safe its patients are, this paucity within the literature is worthy of additional exploration[55].

2.2 Aims

The aims of this review are to:

(1) Determine the incidence of failure to rescue events,

(2) Identify the factors that contribute to high failure to rescue rates and delayed escalation of care, and;

(3) Summarize outcomes of interventions aiming to reduce failure to rescue rates and improve escalation of care.

2.2.1 Rationale for selecting failure to rescue as the primary outcome measure

Failure to rescue is defined as postoperative mortality following a complication. It has been reported as an outcome measure in surgery since 1992 and was conceived in an attempt to increase the sensitivity of outcome measures and quality indicators reported in surgical research. Previous to FTR, mortality rates were usually the primary outcome measure reported. However, even when performed with case mix adjustment, mortality can be a very crude measure of quality. By reporting only patients who die following a complication, FTR is more sensitive than mortality as it eliminates those patients who die due to premorbid conditions (i.e. death occurs in spite of, not due to the surgery and postoperative course).

2.3 Methods

Data sources

Databases searched included Ovid MEDLINE (1980 to week 2, November 2012), EMBASE (1980 to week 2, November 2012), PsycINFO (1987 to week 2, November 2012), the Cochrane Database of Systematic Reviews (Issue 10, 2012) and the Cochrane Central Register of Controlled Trials (Issue 10, 2012). Conference abstracts and reference lists of included articles were hand-searched to identify additional relevant data. The grey literature (work lacking bibliographic control) was searched using the Google website.

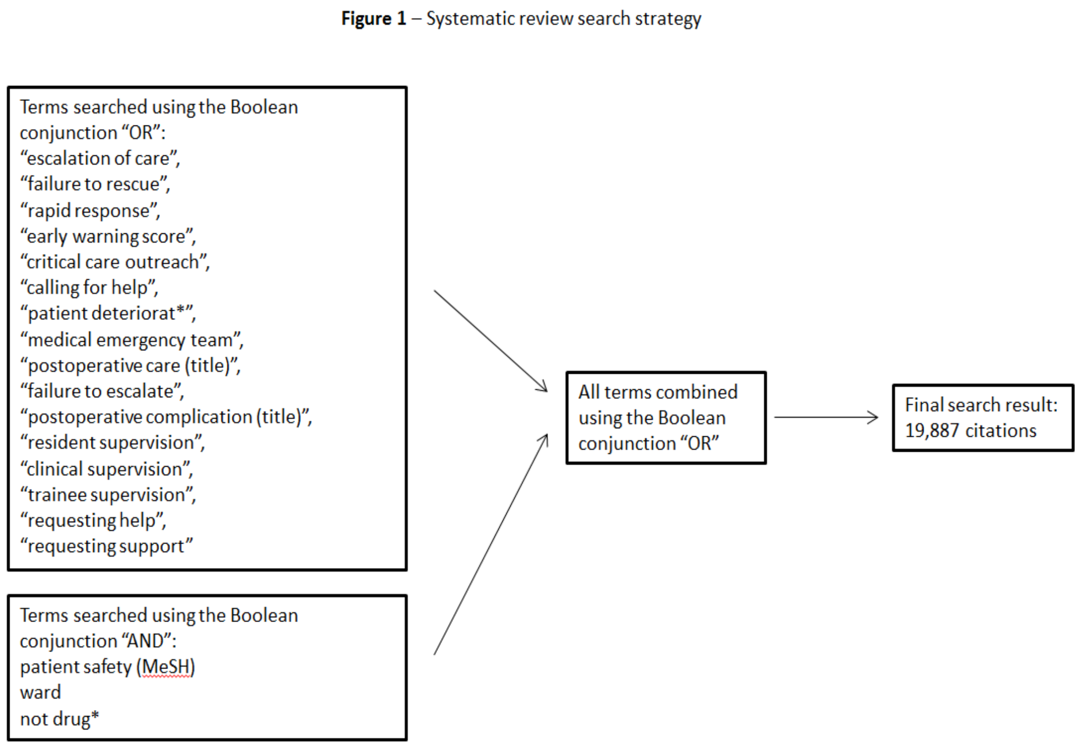
2.3.1 Search strategy

The search strategy employed the following terms (all searched as a keyword unless indicated): escalation of care, failure to rescue, rapid response, early warning score, critical care outreach, calling for help, patient deteriorat*, medical emergency team, postoperative care (title search), failure to escalate, postoperative complication (title search), registrar supervision, clinical supervision, trainee supervision, requesting help and requesting support. The terms ‘patient safety/’ (medical subject heading) and ‘ward’ were combined using the Boolean operator “AND”.

An initial review of this combination revealed a large number of studies reporting escalation of drug dosage; therefore to tighten the search specificity, the additional limit ‘NOT drug*’ was applied. All of the above terms were then combined using the Boolean operator “OR” before limits were applied. Studies were restricted to those reporting human subjects in the English language published from 1980 onwards. The last search was conducted on the 15th

November 2012 (see **Figure 2A** for a schematic presentation of the search strategy)[56]. All retrieved articles underwent title review by two independent researchers to screen for relevance. Letters, commentaries, review articles, conference abstracts and articles not fitting in with the aims of the review were excluded.

Figure 2A Search strategy for systematic review



2.3.2 Inclusion criteria

Failure to rescue – Articles highlighting the incidence of patient mortality following a complication, expressed as a failure to rescue rate

Escalation of care – Articles investigating the recognition of patient deterioration and/or steps taken to escalate care to healthcare colleagues. The efficacy of clinical prediction tools based on physiological parameters were excluded due to previous systematic reviews in this area.

Hospital based – Articles reporting community-based interventions or mental health team services were excluded.

Adult patients – Articles were only selected if the focus was on adult rather than paediatric patients.

Two independent researchers ensured reliability by reviewing a subset of the abstracts before independent selection of articles for full text evaluation. Any disagreements during selection of articles for full-text review were resolved after discussion with a third researcher. The grey literature and reference lists of the included articles were also hand-searched to allow identification of additional articles warranting inclusion.

2.3.3 Data extraction

A data extraction form was produced with consensus from all researchers. This form was structured to allow consistent evaluation of the selected articles. Prior to extraction of data, two researchers reviewed five selected articles to ensure methodological rigour. Data regarding the study setting, subjects, design, measures and key findings were extracted and each study was subjected to critical appraisal.

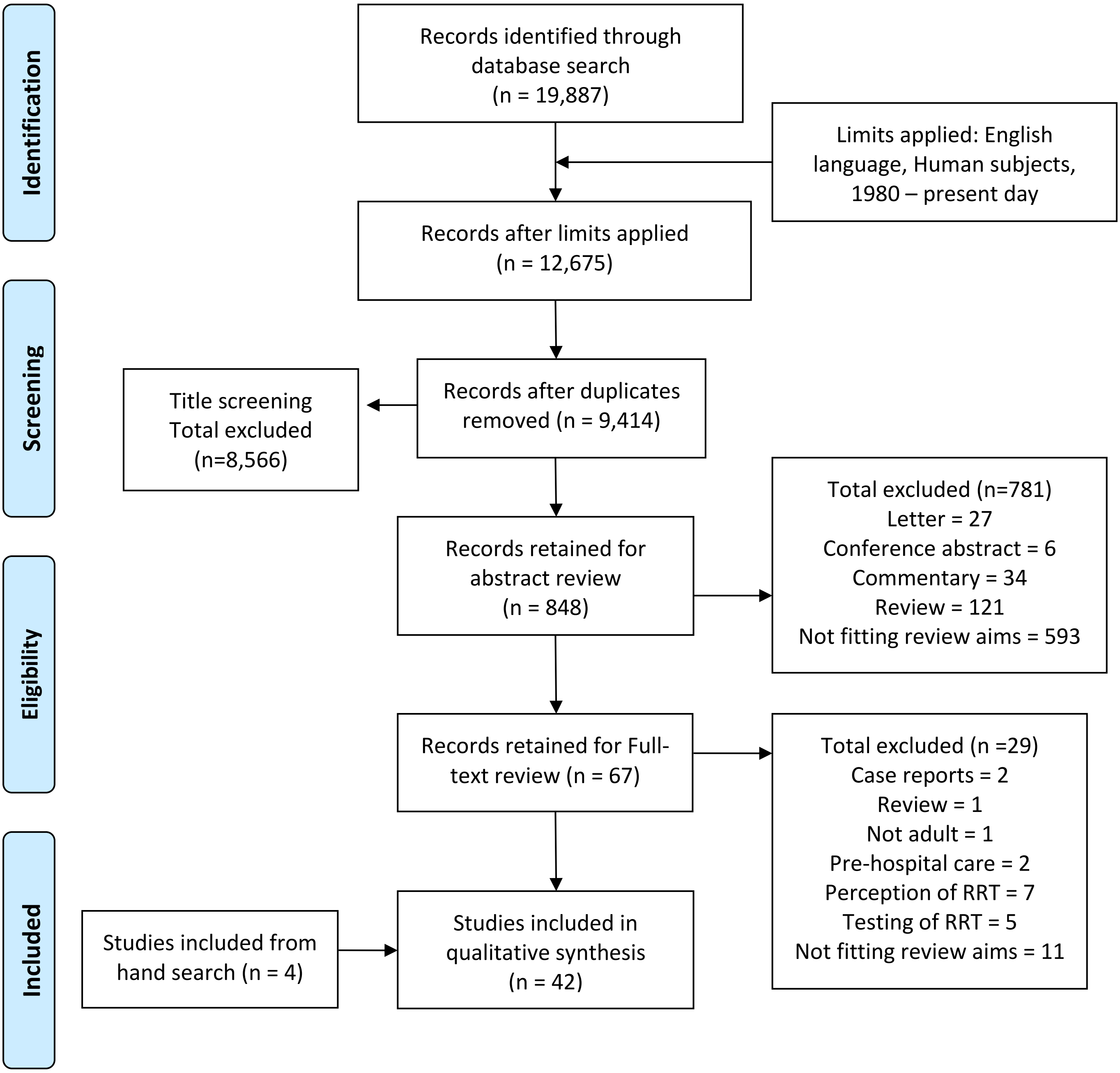
2.3.4 Assessment of study quality

Quality assessment of each of the studies was independently evaluated by two researchers using the Standard Quality Assessment Criteria for Evaluating Primary Research Papers[57]. These criteria were chosen as they included a rating scale for both qualitative and quantitative research, thereby allowing a degree of direct comparison between articles, as there are some matching items on each rating scale. Mixed-methods studies were given quality assessment scores based on both the quantitative and qualitative quality criteria. Articles were not excluded based on their quality to ensure comprehensive capture of as many studies exploring escalation of care and failure to rescue as possible. Had low scoring studies been excluded, some valuable qualitative and descriptive data may have been lost.

2.4 Results

The search produced 19,887 citations with 9,414 remaining after limits were applied and duplicates removed. Of these, 8,566 were excluded during the title review leaving 848 abstracts for further scrutiny. Evaluation of these abstracts lead to exclusion of a further 781 leaving 67 articles for full-text evaluation, of which 38 were considered to meet the inclusion criteria. Agreement between the two researchers was high, the inter-rater reliability was found to be high (kappa=0.87) for the abstract evaluation stage. A hand search of relevant article references and associated literature identified four additional articles fitting the inclusion criteria. The flow of articles through the selection process can be seen in **Figure 2B**.

Figure 2B Study selection process



2.4.1 Study characteristics

A total of 42 articles were included in this systematic review, 25 studies were conducted retrospectively and 12 prospectively. Of these, 24 were cohort studies, 10 were observational, four were mixed-methods and four were qualitative studies. In addition, three studies were conducted in the simulated setting. The studies were conducted in several different continents including North America (n=17), Australasia (n=15), Europe (n=9) and Asia (n=1) reflecting the global relevance of the research question. The primary focus of 26 articles was escalation of care. These articles were categorised into groups: those reporting factors affecting the decision to escalate care, those reporting escalation delay and those reporting interventions in the escalation process. The remaining 16 articles reported on mortality, complications and failure to rescue rates. Subjects included as units of analysis in the articles varied from whole hospitals to individual doctors, nurses and patients.

2.4.2 Quality assessment of included articles

Inter-rater agreement for the quality assessment of included studies was high: quantitative studies (kappa=0.70); qualitative studies (kappa=0.71); mixed-methods papers (kappa=0.73). Quality scores ranged from 6-22 (mean19.2/22, SD 2.74) for the quantitative studies, 15-18 (mean 16.3/20, SD 1.04) for the qualitative studies and 35-36 (mean 35.5/42, SD 0.58) for the mixed-methods studies. The breakdown of quality scores are offered in **Tables 2A and 2B**.

Table 2A Quality assessment scores for quantitative studies

Maximum score =22. The original criteria 5, 6 & 7 were not applicable for any of the studies so were excluded. The maximum possible score has been reduced from 28 to 22.

	Criterion										
Study author (year)	1	2	3	4	8	9	10	11	12	13	14	**Total score**
Adelstein[58]	2	1	2	2	2	2	1	0	2	1	2	17
Almoudaris[59]	2	2	2	2	2	2	2	2	2	1	2	21
ANZICS investigators[60]	1	1	2	1	1	2	2	2	2	1	2	17
Bapoje[61]	2	2	2	2	2	2	1	2	2	1	2	20
Bobay[62]	1	2	2	2	2	2	2	1	2	1	2	19
Brooke[63]	0	2	2	2	2	2	2	2	2	1	2	19
Cabrini[64]	0	2	2	2	1	2	2	2	2	1	2	18
Calzavacca[65]	2	2	2	2	1	2	2	1	2	1	2	19
Chen[66]	2	2	2	1	1	2	2	0	2	1	2	17
Cooper[67]	2	1	2	1	1	2	2	2	2	2	2	19
Downey[68]	2	2	2	2	2	2	2	2	2	1	2	21
Endacott[69]	2	2	2	1	1	2	2	2	2	2	1	20
Friese[70]	2	2	2	2	2	2	2	2	2	2	2	22
Ghaferi (2011)[71]	2	2	2	2	2	2	2	2	2	1	2	21
Ghaferi (2010)[72]	2	2	2	2	2	2	2	2	2	1	2	21
Ghaferi (2009)[73]	2	2	2	2	2	2	2	2	2	1	2	21
Glance (2011)[74]	2	2	2	2	2	2	2	2	2	2	2	22
Glance (2012)[75]	2	2	2	2	2	2	2	2	2	1	2	21
Haas[76]	2	2	2	2	2	2	2	1	2	1	2	19
Jones[77]	2	2	2	1	1	2	1	1	2	2	2	19
Kansal[78]	2	2	2	2	2	2	2	2	2	1	2	21
Kaplan[79]	0	2	2	1	1	2	2	2	2	2	2	18
Kendall-Gallagher[80]	2	1	2	2	2	2	2	1	2	1	2	19
Ludikhuize[81]	2	2	2	2	1	2	2	1	2	1	2	19
Mitchell[82]	2	2	2	2	2	2	2	2	2	2	2	22
Moriarty[83]	2	2	2	1	2	2	2	0	2	1	2	18
Pattison[84]	2	2	2	1	1	2	2	2	2	2	2	20
Peebles[85]	2	2	1	2	2	2	0	1	2	2	1	17
Quach[86]	2	2	2	2	2	2	2	1	2	2	2	21
Rattray[87]	2	2	2	2	1	1	2	1	2	2	2	19
Robb[88]	1	2	0	0	2	0	0	0	0	1	0	6
Shearer[89]	2	2	2	1	2	2	1	2	2	2	2	20
Silber[38]	2	2	2	2	2	2	2	2	2	1	2	21
Trinh[90]	2	2	2	2	2	2	2	1	2	1	2	20
Wright[91]	1	2	2	2	2	2	2	2	2	2	2	21
Wong[92]	1	2	2	2	1	2	0	0	2	1	2	15
Wynn[93]	2	2	2	2	2	2	2	1	2	1	1	19
Yasunaga[94]	2	2	2	2	2	2	2	2	1	2	2	21

Table 2B Quality assessment scores for qualitative and mixed-methods studies

Maximum score =20. * Indicates a mixed-methods study.

	Criterion									
Study author	1	2	3	4	5	6	7	8	9	10	**Total score**
Andrews[95]	2	2	2	2	1	2	2	0	2	2	17
Donohue[96]	2	2	2	2	2	2	2	0	2	2	18
Cioffi[97]	2	2	2	2	2	2	1	0	2	2	17
Endacott*[69]	2	2	2	2	1	1	2	2	2	1	16
Mackintosh[98]	0	2	2	2	1	1	2	2	2	1	15
Pattison*[84]	2	2	2	2	1	1	2	0	2	2	16
Shearer*[89]	2	2	2	2	1	1	1	0	2	2	15
Jones*[77]	2	2	2	2	2	1	1	0	2	2	16

2.4.3 Measures of process and outcome

Studies reported both process and outcome measures in their results. Regarding process measures, ITU admission acted as a proxy measure for complications in eight articles[58,64,79,82,84,86,88,89]. Other studies used delays in activation of the medical emergency team (MET) or rapid response team (RRT) (eight articles)[58,61,68,84,86,89], cardiac arrest rates (four articles)[58,78,88,99] and documentation of vital signs (four articles)[69,82,88,92] as process measures of interest. Additional process measures included adherence to protocols and care guidelines[99,63,100].

Nine studies included organisational and structural process measures, namely hospital volume [72,90,91,94], procedural volume[71,73], staffing level[72,75,94], teaching status[72,76,90] and bed number/ratio [90,94,101]. A total of 22 articles reported patient outcome measures with 21 using mortality[38,61,63-65,68,70-76,80,84,86,90,91,94,100,101], 16 using incidence of complications (including post-operative and medical)[38,63,71-76,80,83,90,91,94,100,101] and three used 30-day survival or survival to hospital discharge[68,84,86]. Other outcome measures used were hospital-acquired infections[75], re-operation[101] and length of stay[78].

A total of 16 articles reported an FTR measure[63,71-76,83,90,91,94,100,101], however, the measure used in each study was not always the same. Of the 16 FTR studies in this review there appeared to be nine different definitions of FTR separated by the complications included in each FTR calculation. The original FTR definition is used in four studies[38,70,74,94], a modified definition incorporating fewer complications is used in three articles[71-73] and the AHRQ definition is used by another three articles[83,91,101]. The other FTR articles either specify a unique FTR definition or are classified as unique due to the different complications used to calculate FTR. **Tables 2C and 2D** display the frequency with which different complications are used in the FTR papers in this review and is evidence of the variability of FTR measures used by researchers. Two articles did not specify the complications used to calculate FTR rates within their manuscript[70,80].

2.4.4 The scale of the problem: failure to rescue rates

Higher mortality rates were associated with increased FTR rates in several studies[72-74,76,101]. Almoudaris et al.[101] found that FTR rates varied from 11.1% in low mortality centres to 16.8% in high mortality centres. The reoperation rates were similar between these centres (4.6% and 5.0% respectively) indicating that it is the mortality rate, not the complication rate that has the greatest effect on FTR rates. This finding is consistent with work by Glance et al.[74] who found that complication rates were similar for low (5.92%) and high (5.49%) mortality hospitals (OR1.08, 95% CI 0.97, 1.21) but FTR rates were significantly different (13.2% and 27.5%, OR 0.40, 95% CI 0.30, 0.53). Baseline FTR rates varied widely between the articles included in this review with the lowest rate of 0.03%[100] compared to the highest of 16.9%[74] (see **Table 2E)**. However, for high-risk surgical procedures (such as pancreatectomy or oesophagectomy) the FTR rate could be as high as 50%[73]. Five articles in this review quoted FTR rates between 5 and 20% but it is difficult to suggest an average figure due to the different measures used. Two studies demonstrated that FTR discriminated high and low volume hospitals better than morbidity[59,74].

Table 2C Individual complications included in failure to rescue definitions for each study

Individual Complication	Study first author (year)											
	Silber	Bobay	Almoudaris	Glance (2011)	Ghaferi (2010)	Wright	Ghaferi (2009)	Ghaferi (2011)	Haas	Moriarty	Yasunaga	Brooke
	38	62	59	74	72	91	73	71	76	83	94	63
Arrhythmia	✓											
Congestive cardiac failure	✓										✓	
Cardiac Arrest	✓	✓				✓				✓		
Pneumonia	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Deep vein thrombosis/pulmonary embolism	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Pneumothorax	✓											
Reoperation	✓		✓									
Cerebrovascular accident	✓			✓		✓			✓		✓	
Renal failure	✓			✓	✓	✓	✓	✓	✓	✓	✓	
Sepsis		✓		✓		✓			✓	✓	✓	
Gastrointestinal bleed/ulcer		✓			✓	✓	✓	✓		✓		
Acute Respiratory Distress Syndrome				✓					✓			
Myocardial Infarction				✓	✓	✓	✓	✓	✓		✓	
Coagulopathy				✓								
Acute Coronary Syndrome				✓								
Respiratory failure					✓	✓	✓	✓			✓	
Post-operative haemorrhage					✓	✓	✓	✓				
Surgical Site Infection	✓				✓	✓	✓	✓			✓	
Shock						✓				✓		
Abscess						✓						
Transfusion						✓						
Peritonitis											✓	
Pressure ulcer												✓
Line infection												✓
Malnutrition												✓
Total	10	5	1	9	8	14	8	8	7	7	10	5

Table 2D – Complications categorised by system used to define failure to rescue measures

Study first author and reference		Cardiac	Respiratory	Vascular	Wound	Genito-urinary	Gastrointestinal	Infection	Total
Trinh	90	✓	✓	✓	✓	✓	✓	✓	7
Glance (2012)	75							✓	1
Brooke	63	✓						✓	2

Table 2E Incidence of failure to rescue

First author, year	Reference	Total number of patients in study	FTR rate for lowest mortality (m) or volume (v) cohort	FTR rate for highest mortality (m) or volume (v) cohort	Overall FTR rate
Almoudaris, 2011	59	144,542	11.1% (m)	16.8% (m)	Not stated
Bobay, 2008	62	16,315	n/a	n/a	0.03%
Friese, 2009	70	24,618	n/a	n/a	10.5%
Ghaferi, 2009	73	269,911	6.8% (m)	16.7% (m)	Not stated
Ghaferi 2010	72	8,862	6.4% (m)	40% (m)	Not stated
Ghaferi 2011	71	37,865	13.1% (v)	30.3% (v)	Not stated
Glance 2011	74	54,713	13.2% (m)	27.5% (m)	16.9%
Haas, 2011	76	76,048	11.1% (m)	20.3% (m)	16.2%
Kendall-Gallagher, 2011	80	1,283,241	n/a	n/a	4%*
Moriarty, 2010**	83	24,633	n/a	n/a	1. 11.60% 2. 9.93%
Silber, 1992	38	5,972	n/a	n/a	8.2%
Trinh, 2013	90	16,285	n/a	n/a	5%
Wright, 2012	91	36,624	4.9% (v)	8.0% (v)	6.2%
Yasunaga, 2012	94	131,394	n/a	n/a	11.9%

* Exact rate not stated, this is the rough figure presented by the authors of the original article.
** The authors of this study used both the Agency for Healthcare Research and Quality (1) and National Quality Framework (2) definitions of FTR

2.4.5 Factors affecting failure to rescue rates

The factors affecting FTR rates are presented in **Table 2F.**

Patient characteristics: Changes in physiological parameters such as heart and respiratory rate, temperature, serum Sodium and urine output were found to be significant patient level indicators for FTR in a single study[100]. Ghaferi et al. found that medical complications (e.g. chest infection) were associated with higher FTR rates compared to surgical complications (e.g. anastomotic leak)[71]. Patients aged less than 70 years[38], with respiratory or cardiac complications or those of non-white ethnicity[90] had a decreased rate of FTR. Absence of a neoplasm or metastases was associated with lower FTR rates in two studies[38,90].

Organisational characteristics: Greater hospital volume was associated with lower FTR rates in four studies[71,72,90,91]. There were two studies that analysed the effect of NQF guidelines compliance on FTR rates; Moriarty et al. found lower FTR rates in centres using the National Quality Forum (NQF) database compared to the Agency for Healthcare Research and Quality (AHRQ) database[83] whilst Brooke et al. identified that patients with surgical site infections had a lower risk of FTR in hospitals with increased NQF guidelines compliance[63]. National Cancer Institute (NCI) centres were associated with better outcomes including FTR rates by Friese et al[70]. An increase in nurse staffing level was associated with lower FTR rates in two studies[72,94] with no significant effect in another study[75] whilst Kendall-Gallagher et al. identified no significant difference in FTR rates when comparing the level of nursing qualifications[80]. Ghaferi et al. identified several hospital characteristics that have significant effects on FTR rates including teaching status, hospital size > 200 beds, hospital daily census >50%, hospitals performing transplant/heart surgery and hospitals with increased use of technology[72].

Table 2F – Hospital and patient characteristics affecting failure to rescue

First author, year and reference		Subjects, setting and study design	Main variable(s)	Findings
Almoudaris, 2011	59	144,542 colorectal cancer patients, UK. Retrospective cohort	Reoperation	1. FTR higher in high mortality units (16·8 vs. 11·1%; p=0·002) 2. Adjusted reoperation rates similar in low and high mortality units (4.8%)
Bobay, 2008	62	16,315 elective surgical procedures, USA. Retrospective chart review	Physiological parameters	1. FTR rate 0.03% 2. Deterioration of HR, RR, Temp, serum Na and urine output significant predictors of FTR (all p<0.05)
Brooke, 2012	63	79,462 high-risk surgical procedures, USA. Cross-sectional	Compliance with NQF guidelines	1. Hospitals with full compliance had lower FTR vs. partial compliance (OR 1.13; 95% CI, 1.03–1.25) 2. FTR secondary to SSI lower in full compliance hospitals (OR, 0.66; 95% CI, 0.49–0.89)
Friese, 2009	70	24,618 surgical oncology patients, USA. Cross-sectional	Tumour type	1. Unadjusted FTR rate for all units=10.5% 2. NCI cancer centres had lower FTR (OR 0.68; 95% CI, 0.47-0.97)
Ghaferi, 2009	73	269,911 Medicare patients, USA. Retrospective cohort	Operative procedure	1. Complication rates similar between worst and best mortality quintiles (32.7 vs. 36.4%, RR 1.11; 95% CI 1.09-1.13) 2. FTR rate higher at high vs. low mortality hospitals (6.8 vs. 16.7%, RR 2.43; 95% CI 2.30-2.58)
Ghaferi 2010	72	8,862 pancreatectomy patients, USA. Retrospective cohort	Teaching status Staffing levels Use of technology	1. FTR rates higher in high compared to low mortality centres (40 vs. 6.4%, p<0.001) 2. Lower FTR rates found in centres with teaching status (OR 0.66; 95% CI 0.53-0.82), increased nurse-patient ratios (OR 0.94; 95% CI 0.89-0.99) and high use of technology (OR 0.65, 95% CI, 0.52-0.81)
Ghaferi, 2011	71	37,865 Medicare patients, USA. Retrospective cohort	Procedural volume	1. The low volume quintile had similar complication rates to high volume (42.7 vs. 38.0%, OR 1.17; 95% CI 1.03-1.33) 2. The low volume quintile had much higher FTR rates compared to high volume (30.3 vs. 13.1%, OR 2.89; 95% CI 2.40-3.48)
Glance, 2011	74	54,713 trauma patients, USA. Retrospective cohort	Mechanism of injury	1. Complications rates similar for low and high mortality centres (5.9 vs. 5.5%) 2. Gunshot wounds more common in high mortality centres (10.3 vs. 3.4%) 3. FTR lower in low mortality hospitals compared to high (OR 0.28; 95% CI 0.20-0.39)
Glance, 2012	75	70,142 trauma patients, USA. Retrospective cohort	Nurse staffing levels Nosocomial infection	1. No significant association between RN staffing and overall outcomes 2. 1% increase in LPN staffing ratios (instead of RN) associated with increased mortality (OR 1.04; 95% CI 1.02-1.06)

Haas, 2011	76	76,048 trauma patients, USA. Retrospective cohort	Injury severity	1. No significant difference in injury severity for different mortality quintiles 2. FTR higher in high compared to low mortality quintile (20.3 vs. 11.1%, p<0.001
First author, year and reference		Subjects, setting and study design	Main variable(s)	Findings
Kendall-Gallagher, 2011	80	1,283,241 surgical patients, USA. Cross-sectional	Nursing qualifications Teaching status	1. FTR lower as nursing qualification proportions increase (OR 0.94, p<0.001). 2. FTR also lower as proportion of nurse certification increases (OR 0.98, p<0.01)
Moriarty, 2010	83	24,633 FTR patients, USA. Retrospective cohort	AHRQ FTR definition NQF FTR definition Pre-existing vs. acquired FTR	1. AHRQ definition: FTR higher than pre-existing (18.5 vs. 8.9%, p<0.001) 2. Acquired FTR also higher than pre-existing according to NQF definition (12.77 vs. 9.42%, p<0.001)
Silber, 1992	38	2831 cholecystectomy and 3141 TURP patients, USA. Cross-sectional	Patient comorbidities Surgeon certification	1. Complication rate decreased in centres with higher proportion of board certified surgeons (RR 0.86; 95% CI 0.8-0.99, p<0.05) 2. FTR higher with increased presence of surgical house staff (RR 2.05; 95% CI 1.1-3.9, p<0.001) and older age (RR1.34; 95% CI 1.1-1.6, p<0.005)
Trinh, 2013	90	16,285 cyto-reductive nephrectomy patients, USA. Cross-sectional	Complication type Hospital volume Presence of metastases	1. GI complications had lower FTR rates than other complications (OR 0.15; 95% CI 0.08-0.30), cardiac (OR 6.43; 95% CI 4.44-9.31, p<0.001) and respiratory (OR 8.14; 95% CI 5.70-11.62) complications associated with higher FTR 2. Higher volume centres had lower FTR (OR 0.57; 95% CI 0.37-0.89, p=0.014)
Wright, 2012	91	36, 624 ovarian cancer resection patients, USA. Cross-sectional	Patient comorbidities Hospital volume	1. Complication rates higher at high-volume compared to low-volume centres (24.6 vs. 20.4%, p<0.001) 2. FTR rate higher at low vs. high volume centres (8.0 vs. 4.9%, p<0.001)
Yasunaga, 2012	94	131,394 surgical oncology patients, Japan. Cross-sectional	Staff to patient ratios	1. Overall FTR rate 11.9% 2. Low volume hospitals had lower staff to patient ratios 3. High compared to low staff to patient ratios (nursing and medical) associated with lower FTR (9.2 vs. 14.5%, OR 0.76; 95% CI 0.68-0.86, p<0.001)

Abbreviations:, TURP=Transurethral prostatectomy, LPN=Licensed practical nurse, RN=Registered nurse, NQF=National Quality Framework, AHRQ=Agency for Healthcare Research and Quality, GI=Gastrointestinal, HR=Heart rate,RR=Respiratory rate, Temp=Temparature, Na=Sodium, NCI=National Cancer Institute, SSI=Surgical site infection

2.4.6 Delayed escalation of care and its impact on outcome

There were eight studies that investigated the frequency of delayed escalation[58,61,65,68,69,81,84,86] and six studies that reported the duration of escalation delays[61,65,69,84,86]. The highest frequency of delay was 47.1%[85] whilst the lowest was 20.7%[65] (see **Table 2G**). The maximum duration of delayed escalation was 56 hours[65] in a study using an escalation protocol involving tracking and triggering of physiological parameters; the minimum delay was 1.15 hours[85].

Table 2G – Impact of delays in escalation of care on patient outcomes

First author, year and reference		Location subjects and setting	Design	Measures	Delay incidence	Effect of delay on ICU admission, mortality and survival
Cabrini, 2012	64	Italy, 82 patients, wards and ICU	Obs	Mortality ICU transfer delay	n/a	Mortality 20% higher in Late (60%) v Early (40%) ICU transfer
Calzavacca, 2008	65	Aus, 228 patients, wards and ICU	Obs	MET delay Mortality	20.7%	Increased mortality in those with delay (OR 2.53, 95% CI: 1.2–5.31,p=0.01)
Downey, 2008	68	Aus, 200 patients, wards and ICU	Cohort	MET delay Mortality	29.5%	Increased mortality in those with delay (OR 3.1, 95% CI: 1.4–6.6, p=0.005)
Pattison, 2011	84	UK, 407 referrals, wards and ICU	Mixed	Escalation delay ICU admission Survival to discharge	23.8%	Higher 3 (p=0.004) and 6 (p=0.026) month mortality, lower survival (p=0.004) in those with delay
Quach, 2008	86	Aus, 200 patients, wards	Cohort	MET delay Mortality Survival to discharge	44.5%	Higher mortality (OR 2.1, 95% CI: 1.01-4.34, p=0.045) and lower survival (p=0.049) in those with delay)
Peebles, 2012	85	UK, 17 patients, wards	Obs	MET delay	47.1%	n/a

Abbreviations: Obs=Observational study, Loc=Location, Aus=Australia

Mortality rates were higher in patients with escalation delay compared to no delay in three studies[68,84] with a mortality rate as high as 40% in one study[65]. Pattison et al. also calculated increased three and six-month mortality and decreased survival to discharge in patients experiencing an escalation delay[84].

Quach et al. found that patients with respiratory failure had increased mortality and worse survival compared to hypotensive patients[86] whilst Bapoje et al. found that swift ICU transfer has an association with lower mortality, which highlights the importance of prompt senior involvement[61].

2.4.7 Factors affecting escalation of care

To enable successful escalation of care three process steps must be negotiated. Firstly, patient deterioration must be identified. Secondly it must be communicated promptly to a senior colleague. Lastly, the senior colleague must respond and initiate definitive management (see **Table 2H**).

Identifying deterioration: A visual assessment of the patient was used by clinical staff to the identify patients requiring escalation in three studies[67,69,96] whilst others advocated the use of early warning scores[87]. Three studies described the use of "worried or concerned" criteria to allow staff to escalate care in the absence of objective measures of deterioration[77,93,98]. Important reasons for failure to identify deterioration were clinical inexperience[97], hierarchical barriers[97], high workload[69,85,96,97] and overconfidence[85].

Communicating with a senior colleague: Articles in this review tended to focus on the communication stage of escalation of care. Fears of hierarchy, intimidation or criticism were identified as a common barrier to escalation in four studies[77,84,89,102]. There were three studies that identified hierarchical barriers leading to communication failures[69,97,98]. Other factors that were identified included delay in reaching the correct staff member, poor communication quality, a desire for independence and frequent interruptions[89,97].

Table 2H – Factors affecting escalation of care

First author, year and reference		Location, subjects, setting	Design	Recognition of deterioration		Communication of deterioration		Management of deterioration	
				+	-	+	-	+	-
Andrews, 2005	95	UK, 44 staff, wards	Interview	n/a	n/a	High EWS Confidence Experience	Vital signs change Criticism	n/a	n/a
Cioffi, 2006	97	Italy, 18 staff, A&E	Focus group	n/a	Inexperience Hierarchy High workload	n/a	Hierarchy Independence Delayed contact	n/a	Independence Interruptions Distractions
Cooper, 2009	67	Aus, 51 nurse students, Simulated	Mixed methods	n/a	Rapid deterioration	n/a	Rapid deterioration	n/a	Rapid deterioration
Donohue, 2010	96	UK, 14 staff, wards	Interview	High EWS Handover Visual review	High workload	n/a	n/a	Calling outreach	Calling doctors Workload
Endacott, 2007	69	Aus, 32 patients and staff, wards and ICU	Mixed methods	LOC Vital signs Visual review	High workload	n/a	Poor protocol Hierarchy	n/a	Staffing
Jones, 2006	77	Aus, 351 nurses, wards	Survey	n/a	n/a	MET criteria	Criticism Worried criteria	MET teaching	n/a
Mackintosh, 2011	98	UK, 35 staff, wards	Mixed methods	Vital signs tool	n/a	High EWS Outreach team	Worried criteria Hierarchy	n/a	n/a
Rattray, 2011	87	UK, 99 nurses, wards	Factorial survey	EWS	n/a	n/a	n/a	n/a	n/a
Shearer, 2012	89	Aus, patients and staff, wards	Mixed methods	Low BP Low SPO_2	n/a	n/a	Independence Criticism Futility	n/a	n/a
Wynn, 2009	93	USA, 75 nurses, wards	Cross-sectional	Sudden change in patient state	n/a	n/a	Worried criteria	n/a	Inadequate response
Pattison, 2011	84	UK, 9 interviews	Mixed-methods	Teaching	Overconfidence	n/a	Intimidation	n/a	High workload
Peebles, 2012	85	UK, 17 patients, wards	Obs	Training	Interruptions High workload	n/a	Equipment failure	n/a	n/a

N.B '+' indicates a facilitator of escalation, '-' indicates a barrier to escalation. Abbreviations: Aus=Australia, EWS=Early Warning Score, LOC=Loss of consciousness, Obs=Observational study, BP=Blood pressure, SPO_2=Oxygen saturation

Responding to deterioration: Delayed or non-response to escalation occurred when clinicians were not willing to take responsibility for the patient or if senior doctors were busy in clinic or the operating theatre[96]. Doctors use quantifiable changes in physiological parameters to aid them in deciding whether a patient is deteriorating. Andrews et al.[102] explain that "the early warning score in itself is meaningless, information on the make-up of the score is needed."

2.4.8 Escalation of care: Solutions and interventions

Frequency of MET/RRT calls: The effects of interventions aiming to improve escalation of care were evaluated in five studies. Of these, three studies reported an increase in the number of MET/RRT calls post intervention[78,82,88]. Adelstein et al. reported a reduction in the number of missed MET/RRT events post intervention (16% pre, 7% post); however, the incidence of delayed escalation remained the same (50% in both groups)[58]. Ludikhuize et al. found that 32% of non-trained nurses would wait until the next physician ward round to communicate concerns about a deteriorating patient[81]. A further five studies evaluated the logistical aspects of MET/RRTs and ICU transfer[60,61,66,79,92]. Of these, two studies found that between 46% and 93% of MET/RRT calls were made out of normal working hours[79,92] whilst one study found that MET/RRT calls were most commonly made between 6am and 12pm[66].

Impact of interventions on patient outcomes: A new vital signs chart was introduced in three intervention studies aiming to improve escalation[78,82,88]. Two studies demonstrated significant improvements in the recording and documentation of vital signs using these new charts. Other interventions to improve vital sign documentation included the implementation of a track and trigger system, simulation-based education and a nurse led RRT coupled with ward education and new charts[82,88]. Four studies reported pre- and post-intervention outcome measures including unplanned ICU admission, cardiac arrest and mortality (details of the interventions and a summary of their impact on outcomes can be seen in **Table 2I**). Both Kansal et al.[78] and Robb et al.[88] found no significant difference in ICU admission when comparing the pre and post intervention periods whilst Adelstein et al.[58] and Mitchell et al.[82] reported statistically significant reductions in ICU admission. There were no significant differences in the cardiac arrest rate in any of the intervention studies. However, Mitchell et al. did report a significant decrease in the rate of unexpected death pre and post intervention (1% pre 0.2% post, p=0.03).

Table 2I Effect of interventions on the escalation of care process

First author, year and reference	Location, setting	Design	Intervention	Participants		No. of escalation calls (% of total patients) or median per month or per 1000 admissions			Notifying a physician of deterioration (%)			Cardiac arrest rates (%), median or per 1000 admissions			ICU admission rates (%) or per 1000 admissions			Mortality rates (%)		
				NI	I	NI	I	p	NI	I	p	NI	I	p	NI	I	p	NI	I	p
Adelstein, 2011 [58]	Aus, wards	Pre/post study	Escalation protocol	53	129	n/a			n/a			9	3	ns	46	23	<0.001	n/a		
Ludikhuize, 2011 [81]	Holland, wards	Cohort	EWS and SBAR tools	48	47	n/a			22	67	0.037	n/a			n/a			n/a		
Robb, 2010 [88]	NZ, wards	Pre/post study	EWS and new vital signs chart	+	+	27.5	70.5	+	n/a			5	5	+	No improvement+			n/a		
Kansal, 2012 [78]	Aus, wards	Pre/post study	New vital signs chart and RRT criteria	375	582	14.3	21.2	<0.001	n/a			1.3	0.95	0.25	2.7	2.5	0.61	29.6	30.9	0.87
Mitchell, 2010 [82]	Aus, wards	Pre/post study	New vital signs chart and triggering system	1157	985	2.2	3.9	0.03	n/a			n/a			1.8	0.5	0.005	2.6	0.6	<0.001

N.B. +=Numbers not reported in manuscript. Abbreviations: AUS=Australia, EWS=Early Warning Score, SBAR=Situation, Background, Assessment, Recommendation, NI=Non-intervention group, I=Intervention group.

2.5 Discussion

The specialty of surgery is complex and, by its nature, places patients at risk. Ameliorating risk to the patient through identification of the factors affecting the decision to escalate care and the impact of delayed escalation of care on patient outcome is an important approach to improving the safety of surgical patients. This review aimed to determine the incidence of failure to rescue, identify the factors that contribute to high failure to rescue rates and delayed escalation of care, and report the impact of interventions aiming to reduce failure to rescue rates and improve escalation of care. The findings will be discussed in relation to these aims. Following this the implications for the field of surgery will be discussed, taking the limitations of this review and area of research in general into account. Lastly, some conclusions will be outlined.

2.5.1 Summary of findings

Incidence of failure to rescue: FTR was found to vary widely between centres and this variation can be explained by the complexity of the surgical procedure, and the quality of post-operative care provided to the patient[71]. High-risk procedures conducted in low volume centres appear to be a dangerous combination for patients. FTR rates were typically between 8.0-16.9%.

Factors affecting failure to rescue rates: Both patient and hospital factors were found to affect FTR. Organisational factors such as increased hospital volume, nurse staffing and compliance with national guidelines were found to decrease FTR rates, as was an increase in the use of technology. Patient factors such as increased age and disease burden were found to increase FTR rates.

Factors affecting escalation of care: The most common factors identified as barriers to escalation of care were inexperience, hierarchy and poor communication. Reflecting their exploratory nature, the studies included in this section of the review were typically qualitative or survey-based studies, which allowed some valuable analysis to be conducted regarding barriers and facilitators of escalation of care.

Impact of delayed escalation on patient outcomes: Higher mortality rates were clearly identified in several studies for patients subjected to escalation delays. Similarly, process measures such as cardiac arrest and ICU admission rates were higher in those with escalation delay.

Impact of escalation of care interventions: Several of the five intervention studies reported improved process measures such as ICU admission and the number of medical emergency calls after introduction of an EWS chart and triggering protocol. However, several of the studies also reported mixed results without improvement of process or outcome measures.

2.5.2 Implications

The literature exploring escalation of care and failure to rescue has been reported. Surgery is a complex specialty with a high-rate of adverse events so the link that has been demonstrated in this review between delayed escalation of care and poor patient outcome has wide-reaching implications. Firstly, it has highlighted the important role communication and teamwork can play in the avoidance of adverse events. Previously, this has only been done in the operating theatre or during transfer from theatre to the recovery suite, not on the surgical ward[40,103]. Furthermore, multiple studies showed that mortality rates differ significantly between different hospitals despite the rate of complications remaining equivalent[73]. This indicates that the post-complication management of the patient is important to preventing mortality. The presence, vigilance, experience and skill of healthcare personnel contribute significantly to good outcomes.

This review has shown that both systems errors and individual failures may be the root cause of avoidable patient harm; the contribution of latent factors to failed escalation of care should not be overlooked[104].
Indeed, addressing the factors that influence escalation and FTR will be an important approach to improving surgical patient safety in the future. While structural issues can be optimised, these improvements often require greater resources. Considering the financial burden currently affecting healthcare organisations, efforts to improve human factors may be an undervalued approach to addressing barriers to escalation of care and reducing FTR. The importance of teamwork and leadership in this setting cannot be underestimated. Specifically, senior surgeons should play a key role in the education of junior team members in recognition of complications (or, at the very least, deterioration), to improve patient outcome[37]. Training by a skilled nurse practitioner could also facilitate such learning and contribute towards healthy inter-professional relationships.

2.5.3 Limitations

Limitations of this review: The principal limits of this review are a result of the limitations of the primary research included within it. All of the studies reporting FTR in this review were retrospective cohort studies and therefore limit the findings. A lack of direct observation, ethnography or any engagement with patients and staff through surveys or interviews has led to very high-level analysis without any exploration of the antecedents to FTR[105]. Furthermore, the heterogeneity of FTR definitions used in the included studies not only precluded meta-analysis but also means that a good impression of a typical or benchmark FTR rate was difficult to produce. Silber at al. have encouraged clinicians and researchers to use the original FTR definition (which includes all deaths) to allow comparison of multiple centres and different geographic areas[106].

All the interventions included in this review targeted doctors or nurses at the recognition or communication phase of the escalation of care process. An intervention aiming to improve all three phases across all stakeholders was not identified. Multi-faceted interventions have successfully improved care quality in elderly and emergency medicine; they may also have a role in escalation of care[107]. This is important because it requires both individual and team skills to recognize, communicate and respond to a deteriorating post-operative patient. There was also a lack of control groups and poor reporting of data analytical techniques in some studies, reflected by a wide range of quality assessment scores within each methodological category.

Limitations of this research area in general: Whilst a small-body of research was identified exploring escalation of care, it was very heterogeneous and this vital facet of surgical care is under-explored. It is interesting to note that whilst some of the articles in this review evaluated the role of human factors in delayed escalation of care, none explored their role in FTR. Therefore, it is not currently known whether FTR rates are influenced by human factors in addition to the patient and hospital characteristics already discussed. Previous studies have explored the role of human factors in the operating theatre but have neglected to study their impact on ward-based care[35,108]. Human factor interventions have been successfully utilised in handover and patient safety[45,109]. Use of human factors interventions in prevention of FTR may be an important approach due to the prevalence of errors and adverse events on the surgical ward and should be a focus of future research[110]. In addition to this, consideration of interventions to improve the safety culture of institutions prior to attempts to improve outcomes may lead to longer-lasting entrenchment of interventions and greater success in the future. Safety culture and outcomes have been strongly linked in previous research therefore attempts to improve safety culture should be included in any safety intervention going forward[111].

The baseline work presented in this review has provided valuable information to clinicians and healthcare providers but has not adequately tackled the safety concerns that have been identified. To achieve an improvement in outcomes researchers need to start looking beyond the numbers (i.e. retrospective databases), using both qualitative techniques and front-line research methods such as direct observation, to develop targeted interventions aimed at improving the quality of surgical patient care.

2.5.4 Conclusions

Despite widespread heterogeneity in the literature, a link has been established between escalation of care and failure to rescue in surgery. Factors that contribute to the avoidance of preventable harm include the recognition and communication of deterioration to implement definitive treatment. Further research utilising targeted observational and interventional techniques is necessary to build on the evidence base and to truly determine what factors can improve safety-critical processes such as escalation of care and impact positively on outcomes. Before these studies can be conducted, greater knowledge of the factors affecting escalation of care according to staff and patients must be conducted to inform interventions, this will be gained through the use of qualitative techniques as described in the next chapter.

3 Understanding the issues with post-operative care: A qualitative study exploring escalation of care and failure to rescue

3.1 Introduction

Escalation of care can be a troublesome process as the first doctor called by the nurses to see a deteriorating patient will usually be the most junior; this is the traditional hierarchy. The junior surgeon must assess the patient and decide whether they require senior input. They must then contact their senior to explain why they need help and the urgency of response required. All of this places a premium on the value of communication between team-members. This is of concern because studies highlight that failures in communication are ubiquitous and frequently occur in the postoperative phase[112].
Studies exploring communication during the postoperative care of patients have involved development of handover protocols rather than exploring the escalation of care process[113,114]. Few have investigated the reasons underlying failure to escalate. Those few have only examined physicians or nurses[115] [88]or else focused upon the Intensive Care Unit [61] and Emergency Department[97].

The review in the previous chapter illustrated how escalation of care underpins patient safety on the surgical ward by linking delayed escalation of care with poor outcome. It also suggested several factors that may facilitate or impede escalation of care. However, exploration of these was far from comprehensive and further detail on many of the factors is required. This detail will be gained through qualitative methods and the factors that facilitator or impede escalation of care will be presented using Vincent's taxonomy of factors prevalent in adverse events in medicine[116]. No study to date has conducted a comprehensive exploration of communication and escalation of care in surgery.

3.2 Aims

This chapter aims to

1. Identify and explore facilitators and barriers to escalation of care in surgery,
2. Understand the causes of these facilitators and barriers, and;
3. Apply the information gained to develop a conceptual framework of escalation of care to guide interventions in this area.

3.3 Methods

3.3.1 Study design

A semi-structured interview study was conducted. This qualitative research methodology was selected to allow an in-depth exploration of escalation of care in surgery. With the ultimate aim of this thesis being the implementation of interventions to improve escalation of care, qualitative work was the appropriate initial approach. Had qualitative methods not been utilised it would have been difficult to gain a comprehensive understanding of escalation of care, meaning any future interventions would be limited in their design and potentially ineffective. An intervention has to be developed to solve a specific problem, if the underlying causes of the problem and potential solutions to it are not explored with those affected by it, the intervention may be fatally flawed.

The use of semi-structured interviews allows a flexible approach to data collection, which would not be possible using survey methodology, which allows a greater number of participants but limits the detail possible in their responses to questions. The semi-structured nature of the interview gives the researcher a framework to structure the interview with, but also allows the freedom necessary to explore participants' perceptions and gain the detail required to develop an effective intervention.

3.3.2 Participants and setting

Consultant and registrar-grade surgeons (seniors) and house officers (juniors) from the specialties of General, Vascular and Urological surgery from three hospitals across London were approached for recruitment into this study. These specialties were chosen as they all involve complex and major abdominal surgery where complications are frequent. Clinicians were given a one-month window to confirm participation in this study. In addition to these surgeons, a purposive sample of intensive care clinicians (consultant and registrar-grade), critical care outreach team members (senior nurses) and surgical ward nurses were also included. This ensured a multi-center, pan-stakeholder approach to the analysis of escalation of care across the surgical patient pathway from the most junior to the most senior members of the interprofessional care team[117].

3.3.3 Study procedure

A semi-structured interview topic guide was developed and piloted prior to use with eight clinicians. This topic guide provided the framework of questioning for the interviewer to follow. However, it was not rigid and a degree of flexibility was encouraged to ensure that a rich understanding of participant's perceptions of escalation of care could be gained (see **Appendix A**). Trained patient safety researchers with a background in surgery individually interviewed participants to allow for a sensitive and detailed understanding of participant's views on supervision and escalation of care. The following topics were examined:

1. The current escalation landscape. It is not currently known whether UK doctors and other healthcare providers consider escalation of care important.
2. When juniors and nurses should escalate care. One of the most difficult skills for junior surgeons and nurses to learn is how to prioritise their patients and deal with competing demands on their time.

3. Information required prior to senior review. The amount of, and quality of information transferred to a senior regarding a deteriorating patient is an important factor in the prioritisation and management of patients.
4. Barriers to successful escalation of care. In order to intervene in the escalation of care process, the problems that surgeons and nurses face when attempting to escalate care must be identified.
5. Strategies to improve the escalation process. The potential for different intervention strategies to improve escalation of care must be explored prior to implementation.

Interviews took place between December 2012 and May 2013 in the hospital where each participant was working. Interviews lasted 30-40 minutes, were audio-recorded with informed consent and then transcribed verbatim. Approval for this study as a service evaluation was granted by the institutions prior to any data collection, formal ethical approval was not required. Informed consent was gained from all participants prior to interviews.

3.3.4 Data analysis

Each interview transcript was checked for consistency and completeness with the original recordings. Three researchers with a background in surgery and patient safety then developed a coding framework after a period of reading and re-reading of the transcripts to ensure adequate immersion in the data. Transcripts were finally subjected to emergent theme analysis based upon grounded theory with interviews ceasing when thematic saturation was achieved. Emergent theme analysis is a systematic method of extracting common themes, identified by interview participants, which are considered important to the research question being asked[118]. Once themes have been reliably identified, the transcripts can be carefully coded to uncover the frequency with which each participant discusses each theme.

3.3.5 Assurance of qualitative rigour

Quality guidelines for qualitative research were strictly adhered to throughout this study[119]. A clear and transparent data collection and analysis protocol was used consistently throughout the study. Independent coding of transcripts by two researchers that were subsequently triangulated ensured reliability of theme extraction. Member checking provided evidence for the validity of our findings.

3.4 Results

A total of 41 participants were recruited for this study with 16 consultant or registrar grade surgeons, 11 house officer grade surgeons, six surgical nurses, four intensive care clinicians and four critical care outreach team members (response rate for all participants=82%). The different number of participants in each group reflected the number of interviews needed to achieve saturation (i.e. no new themes were emerging in that group). The senior clinicians, outreach team members and nurses had between 7-25 years of experience and the junior surgeons were all in the first year following graduation. **Figure 3A** and **Table 3A** display the key themes extracted from the interviews and the number of participants who identified each theme. **Figure 3B** displays the key themes extracted from the interviews in the form of a conceptual framework for escalation.

The sections below qualitatively summarise the themes that emerged during the interviews along with verbatim quotations (S = senior surgeon, J = junior surgeon, IC = intensive care clinician, CCOT = critical care outreach team and SN = surgical nurse). The term escalation ‘initiators’ refers to those participants most likely to contact senior colleagues for clinical support (junior surgeons and nurses). The term escalation ‘recipients’ refers to clinicians likely to receive regular requests for clinical support (senior surgeons, intensive care clinicians and outreach team members).

3.4.1 Current landscape of escalation of care

Most of the participants believed that escalation of care was a problem in their place of work, especially the junior surgeons and outreach team members: *“I had* *an incident where several patients were sick at once and it was only me that was available to look after them with all of the seniors scrubbed, I think it's dangerous"* (J2). Most recipients believed that the first point of contact for an initiator when seeking clinical support should be the surgical registrar, junior surgeons responses were slightly varied with some suggesting the FY1 or SHO as more appropriate initially. All SNs and CCOT members thought the surgical house officer was the appropriate first point of contact but also stated that they would escalate higher if they were unable to contact the house officer or decided a patient was critically unwell. The exact threshold for being 'critically unwell' was not clearly articulated, some participants mentioned abnormal vital signs, and others simply discussed being concerned about a patient.

3.4.2 Information required prior to reviewing a patient

Recipients were asked what key information they would require from an initiator prior to reviewing a deteriorating patient, initiators were asked what information they would provide to a senior colleague when requesting clinical support. The patient's vital signs were the most common answer followed by the history, examination and diagnosis, and the degree of clinical urgency. Other participants wanted to confirm that they were responsible for the patient's care prior to hearing clinical information to avoid confusion and time-wasting.

3.4.3 When to call for help

All groups of participants identified an initial patient assessment as being important prior to calling a senior colleague for help. Recipients considered information gathering by initiators necessary before calling to allow them to prioritise their workload. Some initiators did state a preference for commencing initial management for the patient prior to calling. *"If it's a simple thing like a chest infection I'd probably initiate the management and then check in with the registrar later on"* (J7). However, participants from all groups were keen to stress that in extreme circumstances it would be entirely appropriate to call straight away, before seeing the patient: *"If they can work out from the nursing call that there is a problem with active bleeding or severe respiratory distress they should call me and the outreach team directly before going to see the patient"* (S14). The CCOT members were keen to highlight their escalation skills and availability to initiators: *"We can fast-track escalation and speak directly to the ICU consultant, facilitating movement quite quickly if needed."* (CCOT1).

The above situations all represent subjective time points. Participants also identified several objective time points in answer to the question. The presence of abnormal vital signs or an obviously deteriorating patient on visual assessment were enough to trigger a call for senior support according to some participants: *"If their observations are deranged and haven't improved with small things like giving Paracetamol then that's when I would call for help"* (J3). The most common subjective time point that should have prompted a junior surgeon or nurse to call for help was if they were uncomfortable with the situation or felt they couldn't manage: *"The moment they have seen the patient and think it's beyond their level is when they should call"* (S6). Nursing staff appreciated the availability of the 'worried' criterion on the referral form: *"On some occasions you might know the patient is unwell but not know exactly what is going on, luckily there is a part on the referral form which says 'I am worried, just come and see them'"* (N1).

3.4.4 Factors influencing the decision to escalate care

Five themes emerged as factors influencing the decision to escalate care and formed the basis for the conceptual model; patient, individual, team, environmental and organisational factors (see **Table 3A**).

Patient: A patient who looked seriously unwell on visual assessment should trigger a call for help without further investigation according to the majority of participants. Several of them stated that they would supplement their visual assessment with an Early Warning Score and Glasgow Coma Scale (GCS), *"If a patient is acutely unwell with increasing MEW* (modified early warning) *scores they need something doing rapidly"* (J5).

Table 3A – Factors influencing the decision to call for help and the number of senior and junior surgeons identifying these factors

Theme	Senior	Junior	Total
Clinical – Patient factors			
Patient looks unwell on visual assessment	5	8	13
Abnormal vital signs or GCS	4	7	11
Individual – Factors relating to individuals			
Clinical experience	12	6	18
Confidence	9	4	13
Concerns about senior doctors acumen	4	8	12
Desire for independence	4	1	5
Team – Factors affecting the quality of work within the team			
Rapport with senior	9	9	18
Fear of negative response/criticism	9	9	18
Environmental – Technological and workforce factors			
Availability of senior	5	6	11
Time of day	3	2	5
Phone signal	1	2	3
Organisational – Protocols and scheduling factors			
Not knowing who or how to contact	3	3	6
Not familiar with escalation policy	3	2	5
Multiple demands/high workload	1	2	3

Individual: The most important individual factors influencing a junior surgeon/nurse's decision to call for help were their clinical experience and confidence. Interestingly the two did not always correlate in that the house officers (who are the least experienced) tended towards overconfidence. For example one surgeon described a patient with a severe post-operative chest infection that had been reviewed by a junior who had started antibiotics and nebulisers. However this junior *"didn't tell anyone because they actually thought there was nothing more that could be done. The patient ended up requiring* *assisted ventilation after further deterioration"*. This lack of insight was a significant barrier to escalation of care. However another reason that some juniors/nurses did not call for help was their concern regarding the clinical acumen of their senior colleagues: *"I have the experience of feeling that the person I'd be asking questions wouldn't know the answer"* (J2). Personal accountability and legal liability were other factors influencing the decision to escalate *"It sounds bad but I'm always trying to cover my own back, I don't want it to come back and bite me"* (N3).

Team: A fear of a negative response or criticism from a senior colleague when calling for help concerned all groups of participants: *"They're scared. If they have not met me before then they would be scared that I might be the most horrible man in the world"* (S6). Conversely, the most important team factor in deciding whether a nurse/ junior surgeon escalated care was the rapport with their senior colleague *"I have built rapport with certain consultants and am confident enough to phone them"* (J7). In addition, the trend for senior doctors to work on-call shifts off-site and the frequency with which junior doctors were asked to cover multiple specialties when on-call created some difficulties for staff wishing to escalate care promptly.

Environmental: The availability of a senior colleague was crucial in determining whether a nurse/junior would call for help. For example, one senior mentioned: *"I've walked past my house officer at 2am and they've wanted to run something by me but if we hadn't bumped into each other would they have actually called?"* (S16). Other factors included the availability of mobile phone signal and the time of day: *"If it's coming to the evening and the patient is quite unwell I'd try to* *organise a* (senior) *review faster. They could possibly get very unwell overnight"* (J9).

Organisational: Participants identified several organisational factors affecting the decision to escalate. The themes identified included familiarity with the escalation policy, and not being aware of whom to contact: *"On a number of occasions I've had difficulties contacting a senior because there is no fixed framework for doing so"* (J7). The current unstable nature of surgical teams due to policies such as the EWTD was felt to be a significant hurdle in this respect – summarised by one senior surgeon, *"Life was a lot simpler when I was a junior, and we had a very good team-working environment. Continuity of care, teamwork and clear direction are what is missing in this system"*(S8).

3.4.5 Communication tools and information transfer

Clinicians felt that the best communication modality to use when calling for help was the mobile phone. However, nurses tended to use bleeps despite the fact they were highlighted as suboptimal: *"Most of the time our bleeps are not answered, if it is answered it's usually two hours after we have bleeped"* (N4). Direct conversation was also considered useful, mostly by senior surgeons who appreciated juniors coming to the operating theatre to discuss patients. To optimise communication and information transfer, participants were asked to provide details of the information that they would provide or require when making or receiving a request for clinical support. Vital signs were the most common answer followed by the history, examination and diagnosis alongside the degree of clinical urgency: *"If there's a patient that is bleeding massively that* *needs to be tackled right now. It may be that I need to clear some space in theatres"* (S1).

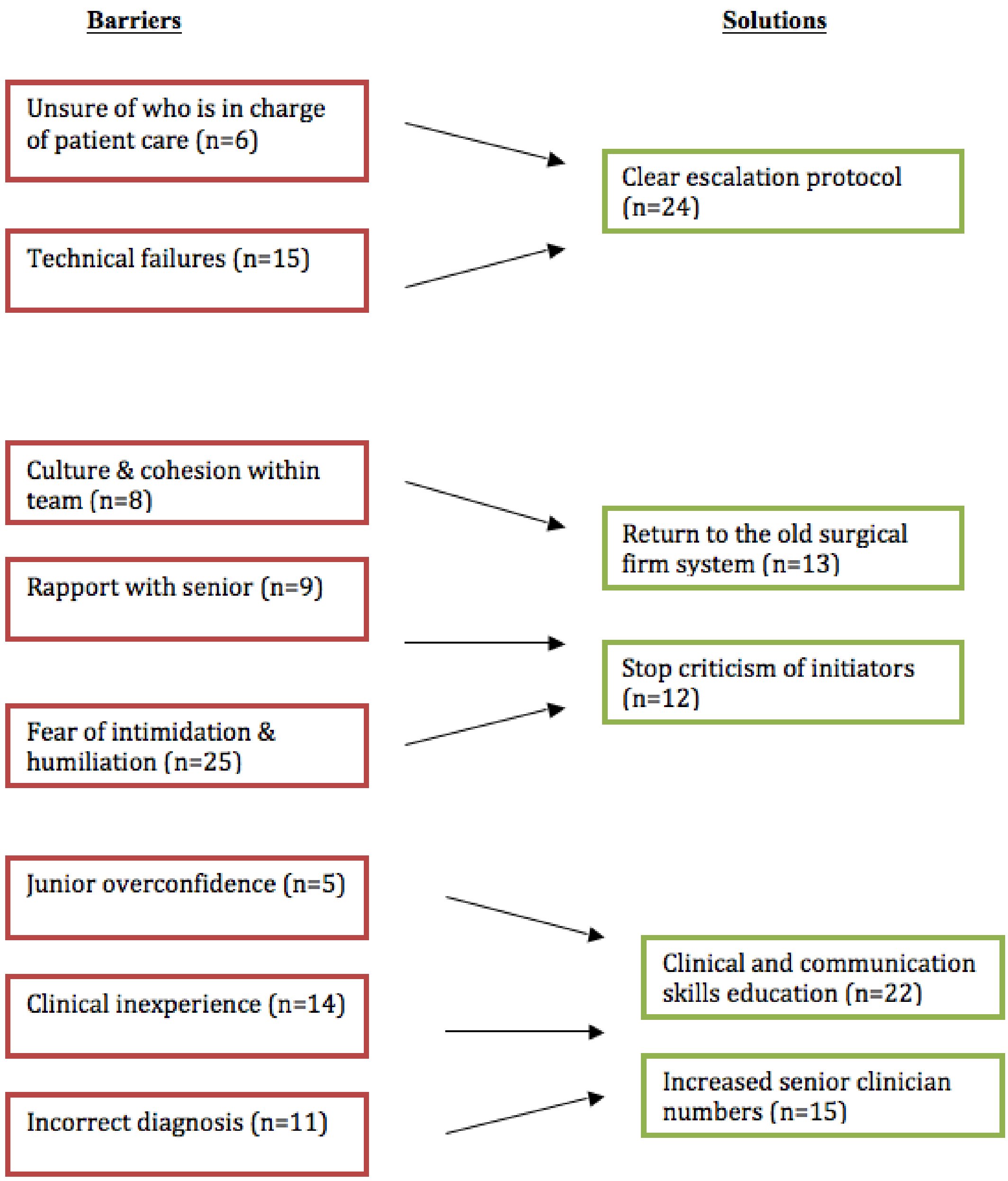
3.4.6 Barriers to escalation of care

Participants were asked what factors might prevent the initiation of the escalation of care process, even when clinically indicated. Two themes emerged - failure to recognize patient deterioration and failure to communicate concerns to a senior colleague. Regarding the former, the most common underlying factors were clinical inexperience and diagnostic inaccuracy. Regarding the latter, fear of a negative response was identified as a key reason why a junior surgeon/nurse would not communicate their concerns to a senior (see **Figure 3A**). Some participants felt that intimidation and humiliation also play a part in this: *"I couldn't get hold of anyone and decided the patient needed an HDU bed and the on-call ICU registrar refused to come…"* (J1). Technical failures (calls not answered or not made due to faulty equipment) were also raised as potential barriers to escalation. Other important themes were the culture and cohesion within surgical teams, patient ownership and not knowing the escalation policy.

Failure to recognise or respond to deterioration: Participants identified three factors that would contribute to initiators failing to recognise or respond to deterioration. The most common of these was clinical inexperience with incorrect diagnosis also considered a significant factor. Junior surgeons did not raise the issue of overconfidence, however, five senior clinicians felt this was an issue.

Failure to escalate to a senior colleague: Fear of a negative response was identified as a key reason why an initiator would not escalate care, in this case even when it was considered clinically indicated. Other important themes were the culture & cohesion within surgical teams, not knowing who is in charge of patient care and rapport with the senior. Several initiators stated that, despite the barriers, they would always escalate care if clinically appropriate as it is in the best interests of the patient.

Figure 3A Barriers to escalation of care and potential solutions



3.4.7 How to improve the escalation process

Participants made suggestions regarding how to improve escalation of care, these have been split into improvements relating to communication and feedback, and improvements regarding workforce management.

Communication, supervision and feedback: Participants felt that communication skills teaching and a clearer escalation protocol were the two best methods of improving the escalation process: *"If I found out that a junior had been struggling on their own without calling for somebody I would sit them down for a supportive chat to help them realise we don't want them working outside their comfort zone"* (S1). Other suggestions were to improve supervision by reassuring initiators that they wouldn't be criticised for incorrect escalation and that escalation was actually a part of the job and expected of them: *"Make it clear to the juniors that we expect them to escalate, even if it's just to tell us something has happened but they have it under control"* (S1).

When asked directly whether a hospital protocol for escalation would result in better patient care some participants answered in the affirmative with others expressing mixed feelings: *"It is clear to me that a protocol would be sensible, however, I suspect that half the time it would be ignored"* (IC4). When asked if they would support the use of new communication technology to distribute tasks and control workflow 26 participants expressed enthusiasm: *"I'm not a big fan of the hospital bleep, it wastes time running up and down the stairs to different wards trying to find a phone. An app that sends a detailed message would be really useful"* (J1). However, some participant's views were mixed: *"These things are helpful but there is a learning curve to overcome"* (IC2).

Workforce management: A return to the old surgical firm system of working was felt to be a good way of improving the escalation process by several participants in each group. Several participants also felt that increasing the number of senior clinicians available for support would be helpful.

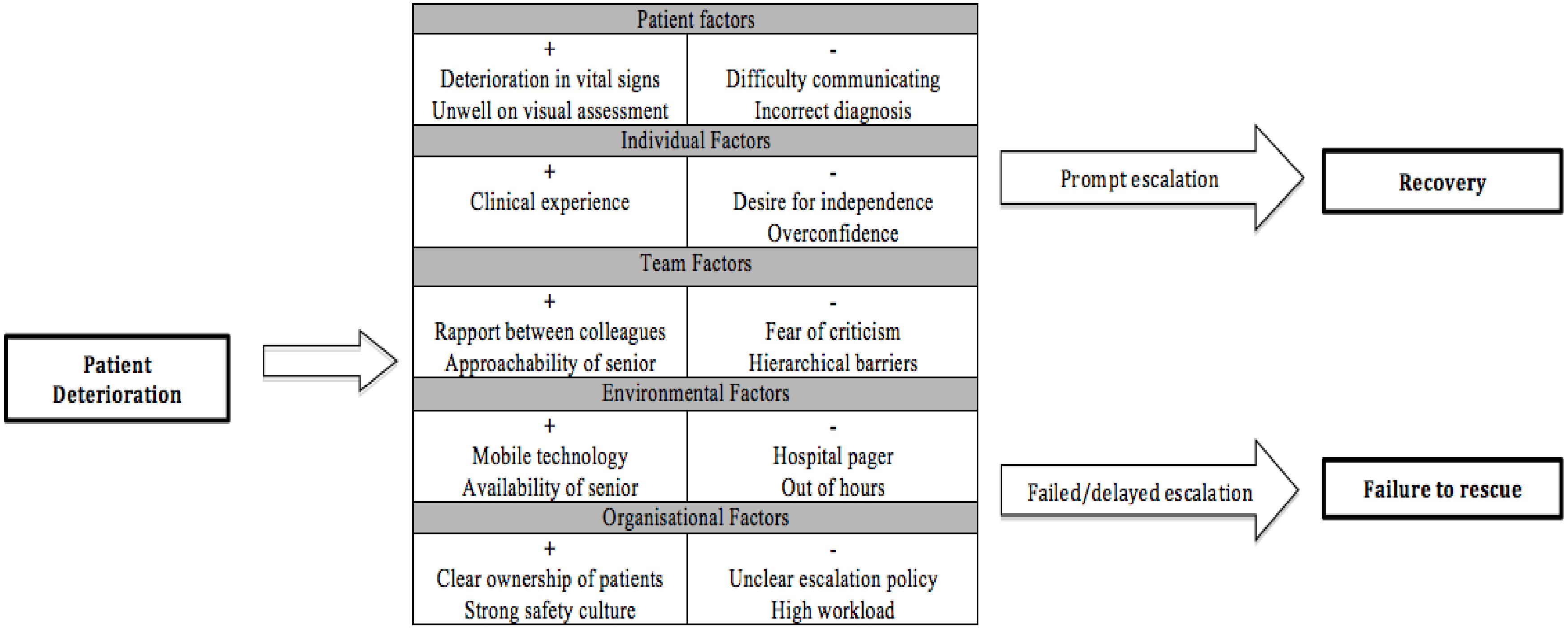
3.4.8 How to measure improvements

Questionnaires regarding morale and satisfaction were thought to be the best way of measuring improvement in the escalation process by 17 participants. Quantitative measures such as time to senior review or length of stay were also felt to be of potential value by five senior and five junior surgeons. The intensive care clinicians and outreach team members both felt that monitoring process measures such as ICU admission rates and patient outcomes such as mortality were the best way of evaluating improvements.

These results were all collated together to produce a conceptual framework for escalation of care in surgery (see **Figure 3B**). This framework shows the factors that may facilitate or impede escalation of care.

Figure 3B A conceptual framework of escalation of care

(Note: + represents facilitators and – represents barriers to escalation)



3.5 Discussion

This is the first study to qualitatively explore escalation of care in surgery. The escalation of care process can be facilitated or impeded by a variety of interprofessional factors. Preventing avoidable patient harm requires a team-based approach and a good safety culture. This semi-structured interview study aimed to identify, explore and understand facilitators and barriers to escalation of care in surgery so as to apply the information gained to develop a conceptual framework of escalation of care to guide interventions. The findings will be discussed in relation to these aims and their context within the wider literature will be considered. Following this the implications for the field of surgery will be discussed, taking the strengths and limitations of this study into account. Lastly, some conclusions will be presented.

3.5.1 Summary of findings and context within the literature

Facilitators and barriers to escalation of care in surgery: The factors that may facilitate or impede escalation of care were presented using the categories from Vincent's taxonomy to analyse risk in medicine.

Patient factors: Incorrect diagnosis and difficult communication were identified as significant barriers to escalation of care whilst abnormal vital signs and a visually unwell patient were likely to facilitate escalation of care.

Individual factors: Good clinical experience can facilitate escalation of care but juniors with overconfidence or a desire for independence may impede the process.

Team factors: Good rapport and approachability will facilitate escalation of care whilst criticism and hierarchy are significant barriers.

Environmental factors: Innovative mobile technology may facilitate escalation of care and could replace outdated pager technology. Staffing ratios may also impact on escalation of care, when seniors are readily available and approachable, escalation of care is facilitated. However, out of hours or at night, the process may be impeded by the lack of suitable staff.

Organisational factors: Seniors who take responsibility for their patients and encourage a strong safety culture can facilitate escalation of care. High clinician workloads and ambiguous escalation pathways may impede or prevent the process.

How to intervene in the escalation of care process: The two main themes that emerged regarding interventions to improve escalation of care were communication, supervision and feedback, and workforce management. A combined approach of communication skills teaching for juniors, clear escalation of care protocols and increased senior surgeon availability was felt to be the approach to improve escalation that held the most realistic potential. The participants felt that the best ways to measure the impact of an intervention would be a combination of survey results measuring satisfaction and safety, and the analysis of process and outcome measures.

One of the principal barriers to escalation of care, highlighted by participants, was hierarchy. A paradox was observed where seniors stated that they actively encourage escalation whilst juniors and nurses feared criticism, intimidation and humiliation. This finding is consistent with experiences of internal medicine clinicians requesting clinical support from seniors[114,115]. It is of serious concern given recent reports highlighting the difficulties faced by staff when raising the alarm about patient welfare[120]. Specifically, the recent Mid-Staffordshire Trust Inquiry into unacceptably high mortality rates highlighted how “some staff did express concern about the standard of care being provided to patients. The tragedy was that they were ignored and worse still others were discouraged from speaking out”. Previous studies have also highlighted significant hierarchical barriers that may contribute to this effect[98]. In contrast, a flattened hierarchy is a key feature of a high-reliability, highly resilient organisation where errors are trapped before they occur[42]. Efforts to improve escalation of care will, therefore, need to attempt to flatten hierarchical barriers. Towards this end, participants also highlighted the importance of rapport and effective team working in enabling escalation of care. Although a return to the traditional surgical firm could benefit both senior and junior clinicians, the likelihood of this happening is low due to the labour constraints placed upon the healthcare industry by the EWTD[121].

3.5.2 Implications

The findings identified two important issues that must be addressed to allow improvements in the surgical escalation process. Firstly, juniors and nurses must be furnished with a clear escalation protocol and secondly seniors must be made available to provide support when required. The former is simple but the latter may not be easily resolvable particularly due to training surgeons wanting to gain experience in theatre – often at the expense of ward-based care[122]. Educators and curriculum developers must address this in the design of future training programmes. Future research should also explore the use of technological innovations and human factors in facilitating the escalation of care process. The conceptual framework could be used as a model to link failure to escalate with a failure to rescue and patient outcomes. This will pave the way for real improvements in care quality and patient safety practices to be made.

3.5.3 Strengths and limitations

The strengths of this study include its approach to sampling. All stakeholders in the escalation of care process were included meaning that balanced findings without bias to any particular grade or specialty of clinician were reported. This multi-centre pan-stakeholder approach to exploring escalation across the surgical care pathway is the first of its kind; it lends credibility and generalisability to the findings. Whilst the study was aimed at the specialty of surgery, the interprofessional nature of recruitment means that it can be applied to other specialties. Other work exploring escalation of care has limited itself to a single specialty and not involved interprofessional staff[123]. The qualitative nature of this study allowed the themes to be explored in great depth with the procurement of rich, sensitive data a benefit that would not have been possible using quantitative methodology. Care taken to ensure qualitative rigour throughout lends further strength to this study.

Limitations include the subjective nature of participants' views alongside the focus on academic institutions within London. As such the views expressed may not reflect those in other geographical regions, non-metropolitan hospitals or other specialities, whilst the issues raised may not be prevalent in private institutions where the communication pathways are different. In addition, whilst escalation of care is a key component of failure to rescue, other organisational issues such as hospital infrastructure, human and, especially, financial resources may also play an important role and should be considered in further work.

3.5.4 Conclusions

This study confirms escalation of care as an important facet of patient safety. Current escalation processes are suboptimal which puts patients at risk of avoidable harm. Suggestions to improve escalation of care including communication skills training, escalation protocols and increased senior supervision are achievable. Future chapters build on the findings of chapters 2 and 3 to evaluate the effectiveness of interventions and the effect of these on safety culture and patient outcomes. However, before this, it is of the utmost importance to consider the role of the most central stakeholder in this process – the patient. This is explored in the next chapter.

4 Factors affecting patients' willingness to escalate care on surgical wards: a questionnaire study

4.1 Introduction

Surgical patients who suffer a post-operative complication experience worse overall outcomes than those who avoid a complication[37]. The speed with which a complication is recognised and acted upon has an important role to play in patient survival. This places a premium on the quality of communication between healthcare professional (HCP) and patients. Chapter 1 found that delays in escalation of care lead to poor patient outcomes whilst chapter 2 identified the factors that may impact on the ability of healthcare staff to escalate patient care safely. The recognition of a complication involves both HCPs and patients; the role of HCPs has been explored previously in literature and in this thesis. However, the role of the patient remains unknown[117].

The first indicators of patient deterioration that are acted upon by HCPs are commonly changes in the vital signs and early warning score, however, deterioration may be apparent to the patient prior to these changes[97]. Therefore, it is vital that the patient is willing and able to report symptoms to an HCP promptly, in order to to start the escalation of care process. This is especially important on the surgical ward when compared to high-dependency and intensive-care units as normal ward areas do not routinely have continuous or invasive monitoring systems for patients to aid in the speedy recognition of complications[124,125]. Empowering patients to be involved in all aspects of their care is a vital step in improving health care[126]. Patients are able to play an effective role in healthcare improvement[127]. This role has also been acknowledged as important by physicians[128]. The importance of the patient perspective when conducting research cannot be underestimated and this is an important approach to use. The willingness of patients to question healthcare staff on issues related to their care has been previously explored with researchers finding that patients are less willing to challenge healthcare staff than ask factual questions[46]. The willingness of patients to call for help if they feel an error has occurred or have other concerns (e.g. pain or bleeding) is not known, improving patient's willingness to call for help may help to reduce complications.

4.2 Aims

1. Investigate the factors affecting patient's willingness to call for help on surgical wards;
2. Establish how, and from whom, patients are willing to call for help;
3. Explore how to encourage patients to ask question of ward staff, and;
4. Identify barriers to patients calling for help.

4.3 Methods

4.3.1 Study design

A cross-sectional survey study was conducted. This study design was selected, as the perceptions of patients in the position to commence the escalation of care process were required. Using survey methodology allows researchers to collect data from a large number of participants in different locations. Whilst interview methodology may enable more depth to the data collection process; surveys allow a wider sample of participants, which was felt to be necessary for this study. Another method of collecting data from multiple participants is a focus group study but this is time-consuming and logistically difficult to conduct with large numbers of participants. It is important when using survey methodology to ensure the survey will capture all the desired data. To ensure this, the survey must be designed using a team-based approach rather than an individual approach[129]. Furthermore, the opinions of the target audience must be sought in advance of data collection. This allows researchers to tweak the survey to ensure the language is appropriate and that the questions make sense before it is disseminated to a large number of participants. As this study involved questioning patients, ethical approval was sought and received from the Berkshire B Research Ethics Committee.

4.3.2 Participants

Patients who had undergone surgery under general anaesthetic and required at least an overnight stay in hospital were invited to participate. Patients from three London hospitals (one teaching hospital, one district general hospital and one private hospital) were included using purposive sampling. These hospitals were invited to participate as they each represented one of the three different types of hospital within the UK. Had hospitals of the same type been included instead of different types, this would have limited the collected data. Patients were considered eligible if they were over 16 years of age, able to speak English, able and willing to give informed consent and either situated on a surgical ward. Patient demographics can be seen in the following results section.

4.3.3 Measures

The 'Factors affecting hospital patient's willingness to seek help' questionnaire was developed by generating a list of categories and questions from previous studies exploring the role of patients in healthcare, which were debated and confirmed by the research team[46,127]. Subsequently the survey was trialed with 15 patients to ensure face validity and that the language used was comprehensible. Multiple iterations were produced to ensure that the aims would be met using the questionnaire. The final questionnaire used in this study can be seen in **Table 4A**.

Table 4A Factors affecting hospital patients' willingness to seek help questionnaire

Please indicate your level of agreement with the following statements on a scale of 1-7

Questions	**Strongly disagree**			➔			**Strongly agree**
1. Methods of calling for help							
If I was feeling unwell in my hospital I would be most likely to:							
Call for help by pressing my buzzer	1	2	3	4	5	6	7
Call for help by calling over a nurse	1	2	3	4	5	6	7
Call for help by calling over a doctor	1	2	3	4	5	6	7
2. Prompts to action – Type of problem							
I would press my buzzer if:							
My wound started bleeding	1	2	3	4	5	6	7
I was in pain	1	2	3	4	5	6	7
I thought another patient was unwell	1	2	3	4	5	6	7
My observations had not been done recently	1	2	3	4	5	6	7
I knew I had received the wrong medication	1	2	3	4	5	6	7
My wound dressing came off	1	2	3	4	5	6	7
I felt sick	1	2	3	4	5	6	7
I would call over a nurse if:							
My wound started bleeding	1	2	3	4	5	6	7
I was in pain	1	2	3	4	5	6	7
I thought another patient was unwell	1	2	3	4	5	6	7
My observations had not been done recently	1	2	3	4	5	6	7
I knew I had received the wrong medication	1	2	3	4	5	6	7
My wound dressing came off	1	2	3	4	5	6	7
I felt sick	1	2	3	4	5	6	7
I would call over a doctor if:							
My wound started bleeding	1	2	3	4	5	6	7
I was in pain	1	2	3	4	5	6	7
I thought another patient was unwell	1	2	3	4	5	6	7
My observations had not been done recently	1	2	3	4	5	6	7
I knew I had received the wrong medication	1	2	3	4	5	6	7
My wound dressing came off	1	2	3	4	5	6	7
I felt sick	1	2	3	4	5	6	7
3. Prompts to action – Healthcare professional factors							
I would be more likely to seek help if:							
A nurse told me it was ok to ask questions	1	2	3	4	5	6	7
A doctor told me it was ok to ask questions	1	2	3	4	5	6	7
A fellow patient told me it was ok to ask questions	1	2	3	4	5	6	7
A relative told me it was ok to ask questions	1	2	3	4	5	6	7
Staff members wore badges saying it was ok to ask questions	1	2	3	4	5	6	7
4. Potential barriers to calling for help – Psychosocial factors							
If I called for help from a healthcare professional I would worry:							
That I am taking up too much time	1	2	3	4	5	6	7
That I would look stupid	1	2	3	4	5	6	7
That I would be perceived as a difficult patient	1	2	3	4	5	6	7
That my medical care would suffer as a result	1	2	3	4	5	6	7

The final questionnaire consisted of 33 items divided into six categories. Three items aimed to explore the methods used by patients to call for help, 21 items explored the likelihood of a patient calling for help depending on the cue, and these included both visual cues of deterioration (e.g. bleeding or a wound dressing falling off) and physical cues of deterioration (e.g. pain or vomiting). Five items investigated potential ways of encouraging patients to call for help and the final four items aimed to identify potential barriers to patients calling for help. Participants answered each item on a seven point Likert scale ranging from 'strongly-disagree' (1) to 'strongly-agree' (7).

4.3.4 Patient-demographic questionnaire

In addition, a socio-demographic questionnaire was also compiled for each participant to complete. Data on gender, age, ethnicity, employment status, surgical specialty and whether the patient was admitted electively or emergently were gathered (see **Appendix B**).

4.3.5 Statistical analyses

Data were analysed using IBM SPSS Statistics® (Version 21). The data in the main questionnaire were treated as continuous (as per previous studies of similar methodology)[127,128,130]. Means and standard deviations for each item in the questionnaire were computed before scale reliability analysis was performed using Cronbach's Alpha to ensure that the items grouped together in categories demonstrated internal consistency. The analysis of variance (ANOVA) for repeated measures test was used to compare the means for groups of items; post-hoc analysis was performed using the Bonferroni correction. The t-test was used to examine differences and associations between individual items and demographic data. Statistical significance was taken when $p<0.05$.

4.4 Results

4.4.1 Patient demographics

155 patients between 16 and 100 years of age completed the questionnaire, 84 were male. A total of 26 patients were approached and elected not to participate (83% response rate). **Table 4B** displays the patient demographics.

Table 4B Patient demographics

Demographic	Number of patients
Gender	
Male	83
Female	71
Not disclosed	1
Job status	
Employed	83
Unemployed	19
Retired	39
Student	10
Not disclosed	4
Ethnicity	
White	120
Asian/Asian British	14
Black/Black British	10
Other	3
Not disclosed	8
Age	
Mean	50.8
Standard deviation	19.7
Surgical specialty	
General	60
Urology	35
Orthopaedic	24
Colorectal	13
Breast	7
Ear, Nose and Throat	7
Plastic	6
Bariatric	3
Admission status	
Elective	79
Emergency	74
Not disclosed	2
Hospital type	
Teaching	55
District General	84
Private	16

4.4.2 Questionnaire results

Descriptive statistics for each questionnaire item can be seen in **Table 4C.**

Table 4C Descriptive statistics for each questionnaire item

Items	Mean	SD
1. Methods of seeking help		
If I was feeling unwell in my hospital I would be most willing to:		
Seek help by pressing my buzzer	6.50	1.05
Seek help by calling over a nurse	5.68	1.58
Seek help by calling over a doctor	4.33	2.22
2. Cues to action – Type of problem		
I would press my buzzer if:		
My wound started bleeding	6.65	0.78
I was in pain	6.30	1.09
I thought another patient was unwell	5.91	1.44
My observations had not been done recently	4.62	1.99
I knew I had received the wrong medication	6.26	1.32
My wound dressing came off	6.04	1.39
I felt sick	4.18	2.28
Total	5.72	1.75
I would call over a nurse if:		
My wound started bleeding	6.42	1.15
I was in pain	6.11	1.32
I thought another patient was unwell	5.80	1.61
My observations had not been done recently	4.80	1.96
I knew I had received the wrong medication	6.18	1.41
My wound dressing came off	5.91	1.51
I felt sick	5.98	1.36
Total	5.88	1.56
I would call over a doctor if:		
My wound started bleeding	4.80	2.28
I was in pain	4.67	2.15
I thought another patient was unwell	4.60	2.13
My observations had not been done recently	3.76	2.18
I knew I had received the wrong medication	4.93	2.17
My wound dressing came off	4.18	2.29
I felt sick	4.40	2.18
Total	4.50	2.22
3. Cues to action – Healthcare professional factors		
I would be more willing to seek help if:		
A nurse told me it was ok to ask questions	5.67	1.63
A doctor told me it was ok to ask questions	5.94	1.58
A fellow patient told me it was ok to ask questions	3.92	1.95
A relative told me it was ok to ask questions	4.22	2.05
Staff members wore badges saying it was ok to ask questions	4.64	2.17
Total	4.89	2.04
4. Potential barriers to seeking help – Psychosocial factors		
If I sought help from a healthcare professional I would worry:		
That I am taking up too much time	4.41	2.02
That I would look stupid	3.05	2.10
That I would be perceived as a difficult patient	3.68	2.18
That my medical care would suffer as a result	3.01	2.26
Total	3.54	2.21

The internal consistency of each group of items can be seen in **Table 4D.**

Table 4D Internal consistency of groups of items

Category	Number of items	Internal consistency (α)
Methods of seeking help	3	0.482
Cues to action - buzzer	7	0.690
Cues to action – nurse	7	0.858
Cues to action - doctor	7	0.951
Cues to action – HCP factors	5	0.860
Barriers to seeking help	4	0.791

N.B. HCP=Health-Care Professional

4.4.3 Methods of calling for help

Patients indicated they would be most willing to seek help by pressing a bedside buzzer, followed by alerting a nurse directly and that they would be least willing to seek help directly from a doctor ($F_{2,125}$=66.546, p<0.001). The scale consistency for methods of seeking help was moderate (α=0.482).

Cues to action – using the buzzer: There were significant differences in how willing a patient would be to call for help using the buzzer depending on the different cues to action ($F_{6, 130}$=60.792, p<0.001). Post-hoc analysis revealed that patients would be most willing to call for help using the buzzer if they were bleeding compared to all the other cues to action (all p<0.025). Other cues to action likely to result in the patient being willing to call for help using the buzzer were pain and if they thought they had received the wrong medication. Patients were least willing to call for help using a buzzer if they thought their vital signs had not been recently recorded or they felt sick (all p<0.001). The scale consistency for cues to action using the buzzer was acceptable (α=0.690).

Cues to action – calling over a nurse: There were significant differences in how willing a patient would be to call over a nurse for help depending on the different cues to action ($F_{6, 133}$=28.292, p<0.001). Patients would be most willing to call over a nurse for help if they were bleeding compared to all other cues to action (all $p<0.035$). Other strong cues to calling over a nurse were if the patient thought they had been given the wrong medication, thought another patient was unwell, were in pain, felt sick or their dressing fell off. Patients were least willing to call for help if they felt their vital signs had not been recently recorded ($p<0.001$). The scale consistency for cues to action - calling over a nurse was good ($\alpha=0.858$).

Cues to action – calling over a doctor: There were significant differences in how willing a patient would be to call over a doctor for help depending on the different cues to action ($F_{6, 134}=14.507$, $p<0.001$). Post-hoc analysis revealed that patients would be significantly less willing to call over a doctor for help if they felt their vital signs had not been recorded recently or their dressing fell off. There were no significant differences between the other cues to action. The scale consistency for cues to action - calling over a doctor was excellent ($\alpha=0.951$).

Comparison between all cues to action: Testing of all cues to action combined together revealed that there were significant differences between patient's willingness to call for help depending on the cue ($F_{6, 136}=47.156$, $p<0.001$). Post-hoc analysis revealed that patients were most willing to call for help due to bleeding, pain or if they thought they had been given the wrong medication. They were less willing to call for help if they thought another patient was unwell or their dressing fell off. They were least willing to call for help if they felt sick or thought their vital signs hadn't been recorded recently (see **Table 4E**).

Table 4E Patient's willingness to seek help per the cue to action

Cue to action	Mean	SD
Bleeding	5.96	1.74
Pain	5.71	1.73
Thought another patient was unwell	5.42	1.84
Vital signs had not been recorded recently	4.84	2.01
Given the wrong medication	5.80	1.78
Dressing fell off	5.40	2.00
Felt sick	4.87	2.13

4.4.4 Effects of patient demographics

Differences in cues to action in relation to patient demographics:

Male patients were more willing to call for help if they felt sick than their female counterparts (mean 4.58 vs. 3.74, t_{136}=2.177, p=0.031); there were no differences for other cues to action in relation to gender. Patients in the district general hospital were more willing to call for help due to bleeding than those in the teaching hospital (mean 6.75 vs. 6.39, $F_{2, 144}$=4.134, p=0.029). Patients in the private hospital and district general hospital were more willing to call for help if their dressing fell off than those in the teaching hospital (mean 6.40 vs 5.43 and mean 6.27 vs 5.43). There were also differences between how willing patients were to call for help when feeling sick between the different types of hospital ($F_{2, 136}$=3.237, p=0.042), however, post-hoc analysis results failed to reach statistical significance. There were no differences for other cues to action in relation to the hospital type. There were no statistically significant differences between all the cues to action and the admission status, job status, specialty or ethnicity of patients.

Differences in methods of calling for help in relation to patient demographics: There were no significant differences in methods of calling for help when patient demographics were taken into account.

4.4.5 Encouraging patients to call for help

There were significant differences between the healthcare professional factors that may encourage patients to call for help ($F_{4, 138}$=66.772, p<0.001). Post-hoc analysis revealed that patients were more willing to call for help if encouraged by a doctor rather than a nurse (p=0.002). They were also more willing to ask questions if encouraged by a healthcare professional, either verbally or by wearing a badge, rather than a relative or fellow patient (all p<0.01). The scale consistency for encouraging patients to call for help was good (α=0.860).

4.4.6 Potential barriers to patients calling for help

There were significant differences between the degrees to which patients worry about potential barriers to calling for help ($F_{4, 138}$=25.998, p<0.001). Post-hoc analysis revealed that patients are more likely to worry about taking up too much time when seeking help than being perceived as a difficult patient (all p<0.001). In addition, being perceived as difficult worried patients more than the potential for them to be thought of as stupid (p<0.002) or that their medical care might suffer as a result (p<0.002). The scale consistency for encouraging patients to call for help was good (α=0.791).

4.5 Discussion

Performing any type of surgery places patients at risk. They should therefore, be involved in all research to improve patient safety in surgery. This cross-sectional survey study is the first to explore the factors affecting patients' willingness to call for help, thereby initiating the escalation of care process, on surgical wards. This study aimed to also establish how, and from whom, patients are willing to call for help, explore how to encourage patients to call for help and identify barriers to them calling for help. The findings will be discussed in relation to these aims and in the context of the wider literature. Following this the implications for the field of surgery will be discussed, taking the strengths and limitations of the methodology used into account. Lastly, some conclusions will be updated.

4.5.1 Summary of findings and context within the literature

Methods of seeking help: Patients indicated that they would be most likely to seek help using the bedside buzzer but also indicated a willingness to engage directly with nurses and doctors if they were present at the right time.

Prompts to calling for help: Irrespective of the method used, physical signs of illness such as bleeding were most likely to prompt a patient to call for help. Pain and the provision of incorrect medication were also likely to prompt a call for help. Patients placed less importance on the frequency with which their vital signs were recorded.

Differences in prompts to calling for help in relation to patient demographics: Male patients appeared more willing to call for help if they felt sick but there were no other differences in relation to gender. This difference is not likely to be clinically significant. Patients in private hospitals (and to a degree, in district general hospitals) appeared more willing to call for help than those in academic institutions. This may be a reflection of the perceived higher workload of HCPs in academic institutions which tend to have higher volumes and rates of patient turnover[131].

Encouraging patients to call for help: Patients felt most encouraged to call for help when engaged with by healthcare professionals, especially doctors, compared to relatives or fellow patients.

Barriers to patients calling for help: Taking up the time of busy HCPs and being perceived as difficult were the most significant barriers to patients calling for help in this study. Patients did not worry that their medical care would suffer as a result of calling for help, which is encouraging. It is interesting to note that patients worry about being perceived as difficult if they adopt a questioning role, a finding supported by Frosch et al. who found that being categorised as difficult may reduce the patient's role in their own healthcare[132]. Previous research indicates that patients are willing to question HCPs about errors in their care, whilst other research found that the authoritarian role of physicians presents an obstacle to shared decision making[46, 132]. This study revealed that patients were less willing to call for help if they didn't think their vital signs were being measured frequently than for other prompts. Fortunately, there are strict protocols in place in UK hospitals, dictating the frequency with which vital signs are measured so large time gaps should be a rarity[28,43].

4.5.2 Implications

The main implication of this study is the identification of multiple factors that affect patients' willingness to call for help on surgical wards and that these factors are of varying importance to different patient groups. It is concerning that patients worry about taking up the time of healthcare staff and a greater effort is required from staff to appear visible and available to patients, ensuring they will escalate care early and ameliorate further deterioration. This study has provided the foundation for the development of interventions to ensure patients feel able to call for help and initiate the escalation of care process in a prompt fashion. Patient comfort rounds and other such interventions of this nature must be explored to quantify their impact on the escalation of care process[133].

4.5.3 Strengths and limitations

This study has certain limitations. The participants were all recruited from London hospitals so the results may not be generalisable to other geographic regions or non-urban communities. Furthermore, the predominance of Caucasian participants means the sample may not be representative of other patient ethnicities. The questionnaire was self-reported so the ecological validity of the findings needs to be assessed (i.e. how willing patients are to call for help in real-life situations). Lastly, the finding that patients would be more willing to call for help from a nurse than a doctor must be interpreted with caution; some participants commented that they would call for help from a doctor were one present on the ward but this is an infrequent occurrence.

The mobile nature of doctors compared to nurses means that that nurses are more available to patients wishing to call for help. A study exploring the actual experiences of patients calling for help would be an interesting comparison to the theoretical study outlined in this article. However, there is also a key strength of this study. The design of the survey allowed exploration of the impact of different methods of calling for help on the various prompts and potential barriers to calling for help. A more simple design was considered (that would have used categorical data) but this would not have allowed the depth of findings encountered in this study.

4.5.4 Conclusions

The findings from this study represent novel and valuable insights into the factors affecting patient's willingness to call for help on surgical wards. Taking these factors into account may allow HCPs to focus on patient groups who are less willing to call for help, and cues to calling for help that are not heeded regularly by patients, to avoid delays in treatment.

Future work will use the findings of the review in chapter 2, the qualitative study of healthcare professionals and escalation of care in chapter 3 and the findings from this study to inform interventions to improve the escalation of care process. However, before this occurs, the findings of these three chapters must be prioritised for action. This is explored in the next chapter of this thesis.

4.6 Phase 2

Understanding problems within the escalation of care process and identifying potential improvement strategies

Chapters 2, 3 and 4 have enabled an understanding of what escalation of care is, what impact delayed escalation of care has on patient outcome and the factors that may facilitate or impede escalation of care, from both the patient and the healthcare professional's viewpoint. Therefore, the next step is to identify areas for intervention within the escalation of care process. In chapter 5, the escalation of care process will be mapped out, risk assessed and stakeholders will be asked to prioritise areas for intervention. Following this, in chapter 6, a focus group study will be reported. This study further explores one of the principal findings from chapter 5, the potential for communication technology to improve escalation of care.

5 A systematic, prospective risk assessment of the escalation of care process in surgery to identify strategies for the avoidance of patient harm

5.1 Introduction

The escalation of care process is fraught with difficulty; the review in chapter 2 demonstrated that failures in escalation of care are ubiquitous with at least one in five patients experiencing escalation of care delays resulting in a delay of urgent treatment[86,134]. The effect of these delays can be catastrophic; patients experiencing delayed escalation have an increased risk of morbidity[65] and mortality[68,84]. Chapters 3 and 4 have reported valuable insights into the escalation of care process, from both the patient and healthcare professional perspective. However, further investigation of the escalation of care process is warranted if the momentum in patient safety and quality research is to be extended onto surgical wards.

Recent reports from the Joint Commission for Patient Safety in the USA and the Francis inquiry in the UK have identified a requirement for more proactive risk assessments of healthcare processes[120,135]. Healthcare Failure Mode Effects Analysis (HFMEA) is a systematic method of conducting a proactive risk assessment[136]. It allows for the most hazardous failures in a process to be identified and prioritised, so that interventions can be targeted at the most appropriate point. HFMEA incorporates a multi-stage approach which utilises the expertise of a multidisciplinary team to develop process flow-charts, hazard scores and decision trees, which define areas of potential failure where the patient is most susceptible to avoidable harm. Originally used by the US army, this research method has also been employed effectively by the aviation and motor industry for decades[44,137]. Within surgery, risk assessments using this approach have identified problems in hand washing and medication delivery[110]. However, no previous studies have conducted a proactive risk assessment of the escalation of care process in surgery. Not surprisingly therefore, interventions have not been developed with sound knowledge of the process and have had limited success in improving either the process of escalation, safety culture or patient outcomes[78,88].

5.2 Aims

1. To graphically describe the escalation of care process
2. To risk assess the process and identify hazardous failures within it
3. To understand the causes of hazardous failures within the process
4. To prioritise areas within the process amenable to intervention

5.3 Methods

5.3.1 Introduction to FMEA in healthcare

The HFMEA process enables prospective identification of the severity, detectability and frequency of potential risks to patient care[19]. The standard HFMEA process involves the following steps: define the process being explored, assemble the research team, graphically describe the process, conduct a risk assessment, discuss areas for intervention and feedback recommendations to decision-makers. HFMEA differs from root cause analysis (RCA) in the timing of data collection. HFMEA aims to prospectively identify failures within a process to allow prevention prior to their occurrence. In contrast, RCA involves retrospective analysis of events leading to an adverse outcome using casenote analysis and interview techniques. The benefit of using HFMEA rather than RCA methodology is similar to a comparison of a prospective versus retrospective clinical study. As such HFMEA is a powerful tool for patient safety due to its proactive nature allowing identification and prevention of failures before they occur.

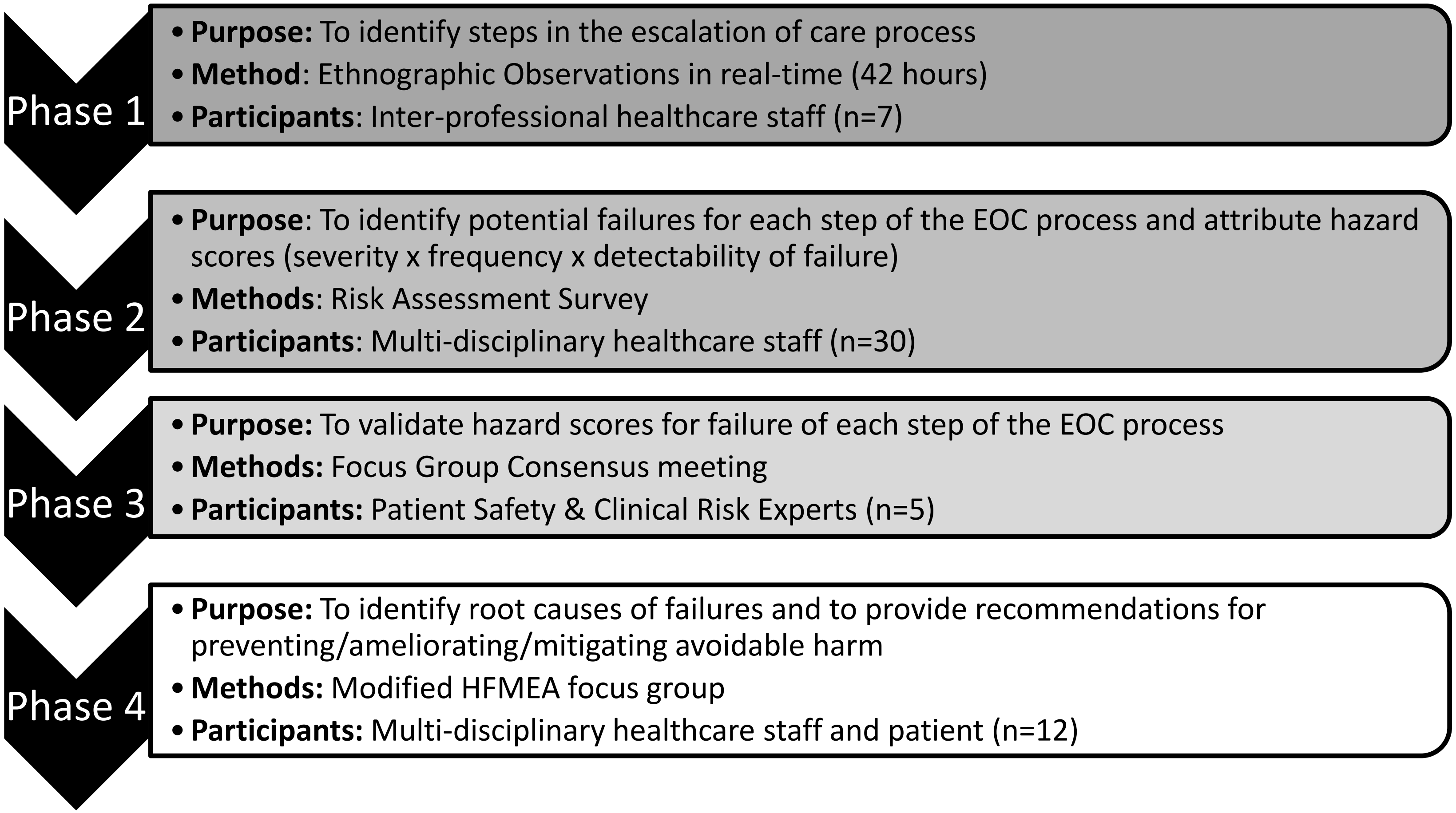
This study used the validated HFMEA technique modified by the Veterans Affairs National Center for Patient Safety[138] and was conducted in four phases. Phase 1: Ethnographic observation of escalation episodes on surgical wards. Phase 2: A risk assessment survey of the escalation of care process. Phase 3: Validation of hazard scores by patient safety and clinical risk experts through a consensus group meeting. Phase 4: Modified HFMEA to identify root causes of potentially hazardous failures and provide recommendations for intervention to prevent avoidable harm (see **Figure 5A**).

5.3.2 Setting

This study was carried out in four North-West London hospitals and included six surgery wards in both academic and district general settings. This region of London was chosen as three of these hospitals featured earlier in this thesis and wished to continue involvement in research exploring escalation of care. The remaining hospital was selected, as it was a different type of hospital to the other three (district general rather than academic/teaching). The study aimed to explore the escalation of care process in several different surgical specialties, therefore, six different surgical wards were selected to participate in the study.

The rationale behind selecting different types of hospitals and multiple surgical wards was to increase the generalisability of the study findings beyond academic institutions. The specialty of surgery was chosen due to the fact that complication rates are higher in surgical specialties compared to medical. This allowed the observational part of this study to yield rich data on the steps of the escalation of care processes, where errors may occur and an understanding of how to prevent avoidable errors. This study was registered as a quality improvement project after consultation with the research compliance office in North-West London.

Figure 5A Study design and steps of the modified HFMEA methodology



5.3.3 Phase 1: Ethnographic observations

Ethnographic observations were conducted to ensure comprehensive capture of all of the steps in the escalation of care process. Ethnographic observation allows researchers to witness events in-situ and in real-time with minimal interference. In this study the observers were external to the organisation where the study took place and, as such, were not known to staff members. Ward staff members were notified that observers would be conducting an evaluation of clinical communication on the wards and had agreed to the presence of observers prior to commencement of the study. Observational work also gives the researcher insight into how teams and organisations work; this is important for escalation of care as it is a collaborative rather than individual process[24].

Two researchers with a background in general surgery and patient safety observed and kept detailed ethnographic field notes on episodes of patient deterioration and escalation of care on general surgery wards and surgical high-dependency units for 42 hours. During this time, 28 escalation events were observed. Each stakeholder in the process (HCA, nurse, FY1, SHO, registrar and consultant surgeon) worked on a postoperative surgical ward and was observed for two separate 3.5-hour sessions, one by each observer (a total of 42 hours). As per the study protocol, all observations were conducted in 3.5-hour aliquots. If an event of interest was occurring at the 3.5-hour mark the observer remained until that event had been concluded. Each stakeholder was observed for one session during normal working hours (8am-5pm) and one session outside of normal working hours (5pm-8am).

While a single stakeholder was the primary focus of each observation session, the inter-professional nature of escalation of care meant that multiple stakeholders were encountered during each session (e.g. nurse contacting registrar regarding a deteriorating patient). The observers performed the primary 3.5 hour observation session together to ensure consistency of data capture in future sessions. These sessions took place between January and March 2013. No data was collected that could identify staff members and as such, no evaluation of individual staff members was conducted. All data was anonymised at the point of collection. From these observations a comprehensive flow diagram of the escalation of care process was produced with input from all investigators and the literature[6,25,26] (see **Table 5A**).

Table 5A Validated escalation of care process flow diagram

Hazard scoring system			
Score*	**Severity****	**Frequency**	**Detectability**
4	Death	1 per day	Remote
3	Disability	1 per week	Low
2	Increased stay	1 per month	Moderate
1	None of the above	1 per year	High

* The three scores were multiplied together to give a hazard score, (Maximum score =64).
** The severity was interpreted as the worst possible potential outcome from each failure mode.

Key:
Single point –This failure may cause total failure of the escalation process
Control **-** An effective control measure exists that adequately addresses the failure for this step
Bold text = hazardous, uncontrolled failures
Italic text = hazard score not exceeding threshold
<u>Underlined text = hazardous, controlled failures</u>

Start – an acutely deteriorating surgical patient is in a ward or HDU bed

Step number	**System step**	**Failure mode**	**S**	**F**	**D**	**Hazard score**	**Single point**	**Control**
1	*Patient feels unwell*	*Patient does not feel unwell*						
2	**Patient informs HCA**	**Patient does not inform HCA**					**x**	
3	*Visitor notices patient is unwell*	*Visitor does not notice that patient is unwell*						
4	*Visitor informs HCA*	*Visitor does not inform HCA*						
5	*HCA notices that the patient is unwell*	*HCA does not notice that the patient is unwell*						
6	*HCA attends patients*	*HCA does not attend patient*						
7	*HCA records vital signs correctly*	*HCA does not record vital signs correctly*						
8	*HCA informs nurse that patient is unwell*	*HCA does not inform nurse that patient is unwell*						
9	**Nurse notices that the patient is unwell**	**Nurse does not notice that the patient is unwell**					**x**	
10	**Nurse attends patient**	**Nurse does not attend patient**						
<u>11</u>	<u>Nurse assesses patient correctly</u>	<u>Nurse does not assess patient correctly</u>						<u>x</u>
12	**Nurse measures vital signs correctly**	**Nurse does not measure vital signs correctly**					**x**	
13	**Nurse documents vital signs correctly**	**Nurse does not document vital signs correctly**						
<u>14</u>	<u>Nurse adheres to escalation/MEWS protocol correctly</u>	<u>Nurse does not adhere to escalation/MEWS protocol correctly</u>					<u>x</u>	<u>x</u>
15	**Nurse informs senior nurse**	**Nurse does not inform senior nurse**						
16	**Senior nurse contacts doctor**	**Senior nurse does not contact doctor**						
<u>17</u>	<u>Doctor attends patient</u>	<u>Doctor does not attend patient</u>						<u>x</u>

18	**Doctor takes a history correctly**	**Doctor does not take a history correctly**						
19	**Doctor examines patient correctly**	**Doctor does not examine patient correctly**						
20	*Doctor checks vital signs chart correctly*	*Doctor does not check vital signs chart correctly*						
21	**Doctor checks drug chart correctly**	**Doctor does not check drug chart correctly**					**x**	
22	**Doctor checks fluid chart correctly**	**Doctor does not check fluid balance chart correctly**					**x**	
23	*Doctor checks blood sugar chart correctly*	*Doctor does not check blood sugar chart correctly*						*x*
24	**Doctor checks patient records correctly**	**Doctor does not check patient records correctly**					**x**	
25	*Doctor checks blood test results correctly*	*Doctor does not check blood test results correctly*						
26	*Doctor checks imaging results correctly*	*Doctor does not check imaging results correctly*						*x*
27	**Doctor starts correct treatment**	**Doctor does not start correct treatment**					**x**	
28	*Doctor orders correct tests*	*Doctor does not order correct tests*						
29	*Doctor reviews new results correctly*	*Doctor does not review new results correctly*						
30	**Doctor contacts senior doctor**	**Doctor does not contact senior doctor**					**x**	
21	*Senior doctor attends the patient*	*Senior doctor does not attend the patient*						
32	*Senior doctor assesses the patient correctly*	*Senior doctor does not assess the patient correctly*						
	REPEAT CYCLE OF ASSESSMENTS							
33	**Senior doctor arranges definitive transfer (e.g. ITU, theatres, interventional radiology)**	**Senior doctor does not arrange definitive transfer**					**x**	

5.3.4 Phase 2: Risk assessment survey

This phase was conducted to provide quantitative data on stakeholders' views of the level of risk associated with each step of the escalation process. Data were collected through a detailed risk assessment survey based upon the observations from phase 1 in two London hospitals (hospitals 1 and 3 in **Table 5B**). All stakeholder groups in the escalation process completed the survey (n=30). From the 1st hospital there were two consultant surgeons, seven surgical registrars, two surgical FY1s, three nurses and two HCAs from the postoperative surgery ward. From the 2nd hospital there were two consultant surgeons, four surgical registrars, three surgical FY1s and five nurses from the postoperative surgery ward. Participants used a four-point scale to rate the potential consequences of failure for each step in the escalation process according to the likelihood of occurrence, potential harm associated with failure to escalate and the detectability of a problem being identified prior to patient harm. These three ratings were multiplied together to calculate hazard scores for each process step (see top of **Table 5A**).

Table 5B Details of the hospitals participating in the HFMEA

Hospital	Type of hospital	Bed volume	Wards observed (n)	Surgical specialties on ward(s)	Patients on a typical ward (n)	Grades of surgeon in clinical team	Surgical HDU (number of beds)
Hospital 1	Academic	418	2	General Vascular	18	1xFY1 1xSHO 1x SpR	General (4) Vascular (6)
Hospital 2	Academic	500	1	General Urology	26	1xFY1 1xSHO 1xSpR	No
Hospital 3	Academic	430	1	Emergency General	28	2xFY1 1xSHO 1xSpR	Yes (4)
Hospital 4	District General	463	2	Vascular Urology General	32	1xFY1 1xSHO 1xSpR	Yes (5)

5.3.5 Phase 3: Hazard score validation

The hazard scores from the risk assessment were then validated by a group of patient safety and clinical risk experts. There were two consensus group sessions involving five participants each that occurred two weeks after the initial risk assessment to allow the surveys to be analysed in the intervening period. Participants were recruited from the Centre for Patient Safety and Service Quality at Imperial College. The participants in each group were a patient safety manager, clinical risk director, surgeon, physician and critical care nurse. A facilitator was also present but did not express any opinions; their role was to structure discussions and act as a timekeeper.

Each process step and hazard score was discussed within the group and consensus was reached before moving on to the next step. To allow prioritisation, a hazard score threshold of 50% was chosen based upon previous guidelines for HFMEA methodology in surgical research[20,25]. Process steps exceeding this threshold were classified as hazardous (patient at risk of avoidable harm) and carried forward to the modified HFMEA.

5.3.6 Phase 4: Modified HFMEA

Formal modified HFMEA was used to confirm the failures and hazard scores associated with each of the hazardous process steps. These failures and hazard scores were generated based upon the literature[20,21] and observations in phase 1, the risk assessment in phase 2 and expert opinion in phase 3 so as to provide a triangulated approach ensuring detection of all potential failures in the process. An inter-professional HFMEA team was assembled consisting of a patient, an HCA and two nurses from a post-operative surgery ward, two surgical FY1s, four surgical registrars and two consultant surgeons. The patient was recruited from the post-operative general surgical outpatient clinic having had major abdominal surgery three weeks previously. The team was supplemented by a patient safety researcher experienced in the HFMEA process acting as a facilitator and ensuring that participants were given equal opportunity to air their views.

After explanation of the HFMEA procedure, the team checked the process diagram to ensure completeness. Following this, the hazard score for each failure mode was reviewed and discussed using decision-tree analysis. Here each failure mode was assessed in terms of its potential detectability and whether there were pre-existing control measures in place, were it to occur. Hazardous failures, which lacked control measures and were not easily detectable, were prioritised for further action. To eliminate the potential for participants with leadership qualities to dominate, each participant individually, and privately, scored each failure prior to discussion. Final ratings were reached through additional consensus agreement; if consensus was not possible the failure was automatically included in further analysis. This ensured all potentially hazardous failures were reviewed to minimise selection bias.

The HFMEA team explored each potential cause of a process failure using the framework for incident investigation from the London protocol root cause analysis method[27]. Potential causes were categorised into organisational, environmental, patient, staff (individual), team and task related factors. Serial causes for each failure were suggested until a definitive or root cause within each relevant category of the London protocol could be identified (see **Figure 5B**)[116]. This meant that each failure could have more than one cause if the participants assigned causes to multiple categories within the protocol. Identification of the underlying causes of a failure allowed synthesis of recommendations aimed at preventing the failure in the future. Suggested interventions were then fed back to managers and clinical directors through a clinical governance meeting and report. Finally, each participant was asked to fill out a questionnaire describing their perceptions of the success of the research method and their knowledge of patient safety.

Figure 5B Systems analysis of clinical incidents: The London protocol

FACTOR TYPES	CONTRIBUTORY INFLUENCING FACTOR
Patient Factors	Condition (complexity & seriousness) Language and communication Personality and social factors
Task and Technology Factors	Task design and clarity of structure Availability and use of protocols Availability and accuracy of test results Decision-making aids
Individual (staff) Factors	Knowledge and skills Competence Physical and mental health
Team Factors	Verbal communication Written communication Supervision and seeking help Team structure (congruence, consistency, leadership, etc)
Work Environmental Factors	Staffing levels and skills mix Workload and shift patterns Design, availability and maintenance of equipment Administrative and managerial support Environment Physical
Organisational & Management Factors	Financial resources & constraints Organisational structure Policy, standards and goals Safety culture and priorities
Institutional Context Factors	Economic and regulatory context National health service executive Links with external organisations

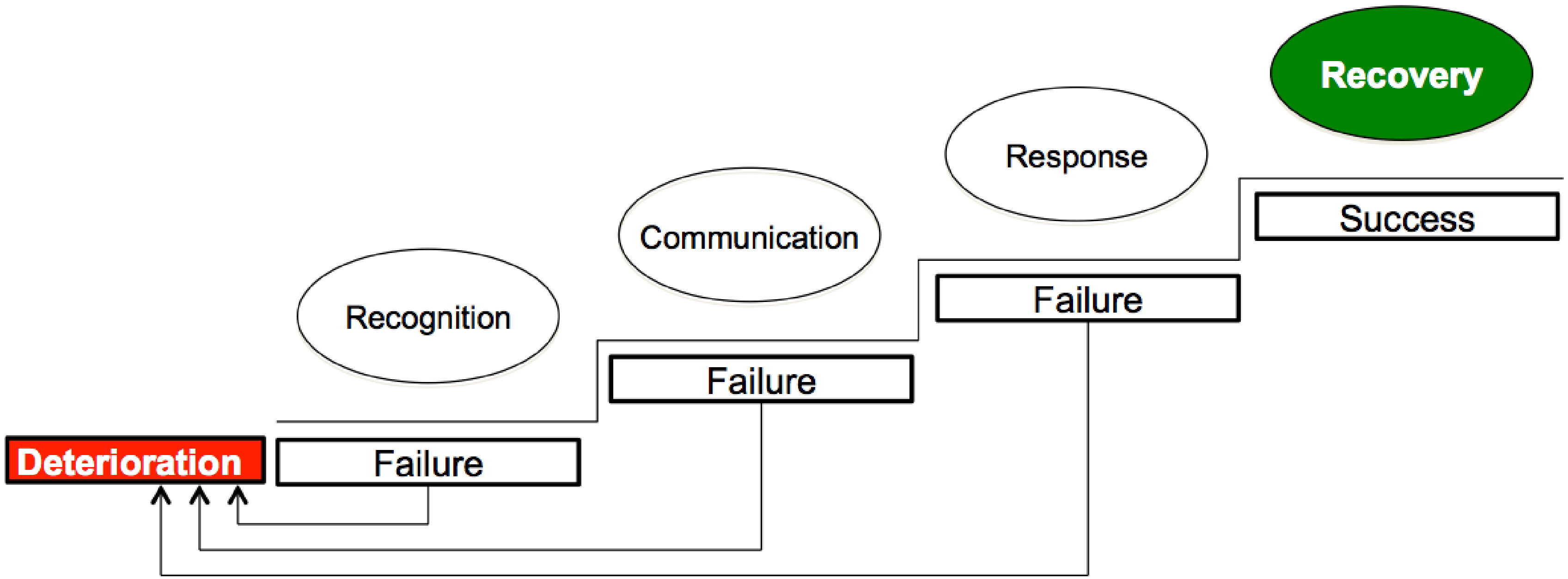
Reproduced from: Vincent C, Taylor-Adams S, Stanhope N. Framework for analysing risk and safety in clinical medicine. BMJ. 1998;316: 1154-1157.

5.4 Results

5.4.1 Phase 1: Ethnographic observations

Ethnographic observations of surgical patients and staff led to the identification of 33 core steps involved in a successful escalation of care process. Additional steps could have been added to this depending on whether a junior surgeon (FY1/SHO) escalated directly to a consultant surgeon or via their registrar (see **Table 5A**). As this eventuality would only involve a repeat cycle of assessments (registrar review followed by consultant review), these steps were combined and considered together. The observation phase of this study revealed escalation to be a stepwise process prone to failure until a patient received definitive management to enable recovery (see **Figure 5C**).

Figure 5C A step-diagram showing the pathway to successful escalation of care



5.4.2 Phases 2 and 3: Risk assessment survey and validation of hazard scores

Of the 33 process steps involved in escalation of care, the risk assessment participants identified a total of 17 hazardous failures that exceeded the hazard score threshold. The patient safety and clinical risk experts identified one additional hazardous failure via consensus agreement; this was the patient informing the HCA they feel unwell, rather than going straight to the nurse. These 18 steps were taken forward to discussion in the modified HFMEA.

5.4.3 Phase 4: Modified HFMEA

The steps with associated hazardous failures within the process were presented to the modified HFMEA team. The HFMEA team then repeated the hazard scoring, the lowest possible score was one and the highest possible score was 64. Ratings applied by the HFMEA team ranged from 27 to 48. The hazard score threshold was >26; therefore, all of the 18 process steps identified as hazardous in the risk assessment were confirmed by the HFMEA team. During the discussion, participants decided that three of these 18 hazardous steps had failures that were already adequately controlled with pre-existing protocols (common to all participating hospitals) so a total of 15 (45%) steps were carried forward to cause analysis and solution synthesis (see **Table 5C**). The three controlled failures were the nurse failing to assess the patient correctly, the nurse failing to adhere to the escalation protocol correctly and the doctor failing to attend the patient. The control measures identified by participants were the use of vital signs measurement (which participants identified as objective physiological evidence of deterioration), the requirement for nurse assistants and junior nurses to check all abnormal vital signs with the senior nurse for the ward and the directive which empowered nurses to contact senior registrars or consultants if more junior surgeons were not receptive to their request for assistance.

The causes and recommended solutions to uncontrolled, hazardous failures are described below. These are described according to the sequence of healthcare professional involvement when a patient becomes unwell and typically include nursing, junior surgeon and senior doctor stages.

Table 5C Details of steps taken forward to HFMEA

Process phase	Steps with hazardous failures	Average hazard score*	Steps included in HFMEA	Controlled steps	Steps analysed in HFMEA
Nursing	16	26.8	9	2	7
Junior surgeon	14	25.1	8	1	7
Senior surgeon	3	28	1	0	1
Total (mean)	33	(26.6)	18	3	15

* Threshold score for progression to modified HFMEA was $\geq$ 26.

5.4.4 Process steps involving nursing staff

Causes: There were seven steps with hazardous, uncontrolled failures to consider in the nursing stage of the escalation process (see **Table 5D**). These were the patient failing to inform the HCA they feel unwell, failure of the nurse to attend the patient, failure to notice the patient is deteriorating, failure to measure the vital signs correctly, failure to document the vital signs correctly, failure to inform the senior nurse that the patient is deteriorating and failure to inform the junior surgeon about the deterioration. Participants felt that clinical understaffing was the principal cause of all these failures. They explained that a greater (and therefore more visible) staff presence would allow patients to raise concerns about their wellbeing more easily. Interim causes of these failures included patient alarm bells not working, inexperience, use of agency staff, patients with dementia or communication difficulties and transcription errors when recording vital signs. An interim cause means a cause that contributed to a failure but was not felt to be the root cause. Regarding communication between the nurse and junior surgeon; the participants felt that both human and technological factors were contributory. Human factors included the nurses fearing criticism by junior surgeons, technological factors principally revolved around the limitations of the pager system.

Recommendations: The recommendations made by participants can be seen in full in **Table 5D**. The participants felt that more consideration needs to be given to the level of nursing cover that is considered safe. An adequate nurse: patient ratio should be provided that allows regular comfort rounds and patient checks. Furthermore, investment and training in the use of electronic vital sign recording and documentation systems could improve the detection of a deteriorating patient and should be explored. To remove hierarchical barriers both within and across disciplines, participants recommended development and implementation of a clear escalation protocol guided by early warning scores. Increased investment in, and use of, technology such as smartphones and tablet computers could also facilitate communication.

5.4.5 Process steps involving junior surgeons

Causes: There were 7 steps with hazardous, uncontrolled failures in the stage involving junior surgeons assessing and managing a deteriorating patient (see

Table 5D). These were failure to take an adequate history, failure to examine the patient thoroughly, failure to check the drug and fluid balance charts or case notes, failure to commence the correct initial treatment and failure to inform a senior doctor of patient deterioration. The causes of these failures included hierarchical and language barriers, senior staff being busy in the operating theatre and unable to answer a pager, understaffing, charts being poorly designed or unavailable on the ward, junior surgeon inexperience, illegible clinical notes and poor availability of equipment.

Recommendations: The recommendations made by participants can be seen in full in **Table 5D**. The participants felt that recruitment of permanent staff to decrease reliance on agency staff could help overcome the issue of unfamiliarity with hospital IT systems and clinical pathways. To combat language barriers, interpreter services could be made more available. To improve the accessibility and legibility of clinical notes, drug and fluid charts; the development and implementation of an electronic system with portable and desktop computers on wards was advocated. To prevent incomplete assessment and treatment due to inadequate equipment, a nurse "champion" for each ward could ensure provision and procurement of vital supplies and instruments for clinical use (examples given by participants included intravenous fluids, a tendon hammer and a tuning fork). A low threshold for non-surgical personnel to review surgical patients with a medical complication could help earlier implementation of urgent treatments.

To combat hierarchical barriers both within and across disciplines the senior doctors should be encouraged to be more proactive. This would mean that the responsibility for initiating contact would not be the sole responsibility of juniors and nurses – the senior could for example make routine calls to 'check-in' with their junior counterpart. Education of junior surgeons to remind them that prompt escalation of care is vital for patient safety coupled with assurance that there would not be criticism for doing so were highlighted as key strategies. To avoid escalation delays caused by the senior doctor being busy in theatre, the development of a software platform with integrated patient demographics, pathology, radiology and vital signs to allow prompt escalation in the presence of patient deterioration was recommended. It was postulated that a theatre assistant could then inform the senior of deterioration if they could not get to the phone themself.

5.4.6 Process steps involving senior surgeons

Causes: There was one step with hazardous, uncontrolled failures in the senior doctor phase of the process (see **Table 5D**) which was the senior doctor failing to arrange definitive management. Participants felt this could be due to the senior doctor failing to contact an appropriate colleague or failing to arrange appropriate patient transfer to the operating theatre or ICU. The root causes of these failures were felt to be fear when faced with contacting the consultant surgeon or intensivist on duty and the presence of logistical barriers. These barriers included a lack of intensive care beds and uncertainty regarding the appropriate level of care for each patient. The participants also felt that only having a single theatre available for emergent surgeries out of normal working hours was a major safety concern.

Recommendations: The recommendations made by participants can be seen in full in **Table 5D**. The participants felt that the issues regarding intensive care beds and theatre access were particularly challenging and would require significant organisational re-structuring; this was outside the participant's areas of expertise. Regarding levels of care, the recommendation was to produce a clinical guideline defining appropriate levels of care according to patient diagnosis, physiological parameters and predictive scoring systems (the Modified Glasgow Score for pancreatitis was an example given by participants).

5.4.7 Evaluation of the research method

The participants felt that the modified HFMEA process was easy to interpret (75%) and had increased their awareness of patient safety (83%). They expressed enthusiasm about participating in further sessions (75%) and would also recommend participation to a colleague (83%).

Table 5D Causes of failures in escalation of care and recommendations for improvement

Process phase and step with hazardous failures	Causes of Failure	Root cause	Recommendations
NURSING STEPS			
Patient fails to inform HCA they feel unwell	Patient decides not to inform HCA	Poor knowledge of patient personality	More regular patient rounds
	Patient cannot inform HCA	Bell not supplied or out of reach	Nominate ward 'champions'
Nurse fails to notice that patient is unwell	Decides patient is not unwell	Lack of specialty training	Investment and training in detection of deterioration for nurses
		Use of agency staff	Recruit more permanent staff
Nurse fails to attend to patient promptly	Fails to attend to patient promptly	High workload	Recruit more permanent staff
Nurse fails to measure vital signs correctly	Fails to measure vital signs correctly	Lack of appropriate technology	Invest in bedside electronic vital signs charts
Nurse fails to document vital signs correctly	Documents vital signs incorrectly on chart	Transcribing error	Invest in bedside electronic vital signs charts
Nurse fails to inform senior nurse that patient is unwell	Fails to inform junior surgeon	Unclear escalation protocol	Develop and publicize a clear escalation protocol
Nurse fails to contact junior surgeon successfully	Decides not to contact junior surgeon	Hierarchical barriers	Clear escalation protocol
		Lack of confidence	Teach handover skills (e.g. SBAR*) to nursing staff
		Previous trouble with pager system	Use of mobile telephones
		Extension engaged when returning page	Develop electronic patient platforms allowing transfer of patient information
	Pages doctor but no response	Unable to locate extension	Use of mobile telephones
		Busy with a patient	Use messaging services to send information
		Doctor receives multiple pages at once	Use messaging services to send information
	Contacts but junior surgeon will not attend	High workload	Recruit more permanent staff
		Poor judgment	Teach prioritisation skills

JUNIOR SURGEON STEPS			
Junior surgeon fails to take accurate history	Fails to complete history	Lack of specialty training	Investment and training in detection of deterioration for junior surgeons
		High workload	Recruit more permanent staff
Junior surgeon fails to complete thorough examination	Unable to communicate with patient	Agency staff unfamiliar with hospital	Recruit more permanent staff
		Language barriers	Mobile phones able to call interpreter from bedside
	Fails to complete examination	Patient positioning	Increase ward staff numbers and manual handling
		Equipment not available	Nominate ward equipment ‘champions’
Junior surgeon fails to review drug chart	Completes incorrect examination		
		High workload	Recruit more permanent staff
		Lack of specialty training	Encourage cross-discipline co-operation
	Fails to review chart	Chart not on ward	Electronic chart available across site
	Reviews chart incorrectly	Illegible chart	Computerized chart
Junior surgeon fails to review fluid chart			
	Reviews incorrect chart	Human error	Bedside software with electronic chart
	Fails to review chart	Chart not on ward	Electronic chart available across site
		Not completed accurately	Education and training for staff
Junior surgeon fails to review patient case notes	Unable to fully review case notes	Large files for long-term patients	Electronic notes system with weekly summaries
		Illegible	Computerized notes
Junior surgeon fails to initiate correct treatment	Selects incorrect treatment	Lack of specialty training	Support courses/teaching for junior medical staff
	Unable to commence correct treatment	Equipment not available	Nominate ward equipment ‘champions’
Junior surgeon fails to contact senior doctor successfully	Decides not to contact senior doctor	Hierarchical barriers	Clear escalation protocols
	Attempts contact but no response		
	Contacts but senior doctor will not attend	Busy with a patient	Use messaging services to send information
		Unable to locate extension	Use of mobile telephones
	Contacts senior but delayed response	Extension engaged when returning contact	Develop electronic patient platforms allowing transfer of patient information
		High workload	Recruit more permanent staff
		Senior off-site	Seniors from busy specialties to remain on-site when on-call

SENIOR DOCTOR STEPS

Senior doctor fails to arrange definitive management	Unable to transfer patient	No ICU beds	Set aside surgical ICU beds or a separate unit
		No theatre available	Increase theatre availability for emergency surgery
		Uncertainty regarding appropriate level of care for patient	Physiological parameter thresholds to decide level of care
	Fails to contact appropriate colleague	Fear of consultant surgeon or intensivist	Clear escalation protocol

5.5 Discussion

This study represents the first systematic risk assessment of the entire escalation of care process, which encompasses the recognition, communication and response to a deteriorating patient on a surgical ward. The aims of this study were to graphically describe, systematically risk assess and analyse the escalation of care process so as to identify areas of failure and avoidable patient harm, understand their causes and make recommendations to improve patient safety on the surgical ward. The findings will be discussed in relation to these aims and the wider literature. Following this, the implications for the field of surgery will be discussed, taking the strengths and limitations of this research methodology into account. Lastly, some conclusions will be presented.

5.5.1 Summary of findings and context within the literature

Description of the escalation of care process: Using ethnographic observational techniques, the escalation of care process was comprehensively mapped out using a flow diagram. The process consists of 33 steps, several of which may be repeated should multiple junior surgeons assess the patient before a senior surgeon does so.

Risk assessment and identification of failures: Using a stakeholder survey and hazard scoring, 18 steps within the process were deemed hazardous by participants and progressed forward to the modified HFMEA, three of these were felt to be adequately controlled so 15 of 33 hazardous steps were fully analysed.

Understanding of cause and recommendation synthesis for intervention: The London protocol for cause analysis was combined with decision trees to determine the causes of failure within each hazardous step of the process.

Causes that were common throughout the process included staffing levels, resource allocation, inadequate clinical training and experience, limited communication technology and hierarchical barriers. Principal recommendations for intervention within the escalation of care process included the development of education for nurses and junior surgeons, recruitment of more permanent staff, increased use of technology and implementation of safe escalation of care protocols.

This study exposes the significant vulnerabilities faced by patients on a surgical ward, at a point when high quality care is paramount to safety. It demonstrates that failures can occur at any step of the escalation of care pathway, highlighting poor resilience and reliability in the overall system. This is in contrast to other high-risk, safety critical industries such as aviation and the military where redundancy mechanisms are incorporated into the system to compensate for a potential failure at any one point, for example, through the use of back-up behaviors, dual-tasking and debriefing[139].

The concerns and recommendations described in this study are consistent with previous studies evaluating the safety of patient care. In particular, clinical understaffing was highlighted as a significant contributor to delays in recognising and responding to a deteriorating patient. This finding is supported by worldwide research reporting better patient outcomes in centers with higher nurse staffing levels[140,141]. Staffing levels are also a focus for the Agency for Healthcare Research and Quality and the Joint Commission[142]. They highlight that recruitment and retention of staff requires determined action from healthcare providers.

The identification of communication failures leading to failed escalation of care is consistent with other work highlighting the ubiquitous nature of problems in information transfer across the surgical pathway[143]. Human factors and technological failure were identified as the root causes of communication failures. Regarding human factors, this study described the importance of overcoming hierarchical barriers between junior and senior surgeons as crucial for ensuring successful escalation of care. A flattened hierarchy is a key property of a safe system[98]; recommendations were made for a clear escalation protocol to facilitate this. Others have reported that such escalation protocols can reduce ICU admission[58] and mortality[82] making them a cost-effective proposition, which could be readily implemented. However, if measureable improvements in patient safety are to be attained, the safety culture of the healthcare institution must also be improved[55,144].

Recommendations regarding staff education and training were described as integral to this campaign so as to build capacity and capability in promoting patient safety. Evidence-based train-the-trainers courses and faculty development programs could be used to provide effective training at a large-scale, institutional level[145,146]. The technology available to staff was also felt to be suboptimal. In particular, the view that the hospital pager is an outdated technology with significant flaws was also supported by the literature[147].

Many of the findings in this study are consistent with previous chapters in this thesis. The negative impact of hierarchy on escalation of care and the value of protocols were also identified in chapter 3. The use of a patient participant within this study echoes the method used in chapter 4 where patients were placed at the centre of the research. In addition, the link between escalation of care, failure to rescue and patient safety identified in the review in chapter 2 has been reinforced by the findings in this study.

5.5.2 Implications for the field of surgery

This study has wide-reaching implications if further deterioration following adverse events in post-operative patients is to be prevented. This study highlights the complexity of the escalation of care process and, for the first time, describes the antecedents of the escalation of care process, which, if suboptimal, can lead to a failure to rescue event. In doing so it draws attention to the numerous areas where patients on surgical wards are susceptible to avoidable harm. The design and implementation of tailored interventions, based upon the recommendations of this study, should serve as a basis for future research. This can ensure that the quality of care received by a post-operative patient on a ward is at the same level as the exacting standards seen in the operating theatre.

5.5.3 Strengths and limitations

The modified methodology used in this study enabled the prospective capture of all potential failures as opposed to a retrospective analysis following an adverse event, which could be limited to the factors surrounding that event in particular. The length and depth of the observation period also allowed researchers to form a comprehensive map of escalation of care in surgery. The validation of process steps and associated failure modes by clinical risk and safety specialists strengthened the final analysis. The inclusion of all stakeholders in the surgical care pathway meant that robust recommendations were provided to decision makers.

The limitations to this study are present in all HFMEA processes. The subjective nature of participant's views inevitably introduces a degree of bias; attempts were made to reduce this by ensuring group consensus at appropriate points throughout the process. In addition, the HFMEA process is built to consider process failures in isolation. If failures in the escalation process were to occur contemporaneously, the recommendations made in this study may fail to control them. This study was conducted in hospitals in the United Kingdom. Therefore, the findings may not be generalisable to other regions, countries or private health systems. However, the findings regarding a fear of criticism might be universally applied and are supported by earlier work in this thesis and in the wider literature.

5.5.4 Conclusions

This study has identified areas within the escalation of process that may be amenable to targeted intervention. Future work should concentrate on the development of well-designed interventions and analysis of their effect on surgical patients and healthcare professionals.

The two improvement strategies most frequently recommended by participants in this study were improvement of communication skills (through human factors training and simulation) and improvement of communication technology. These key strategies must be explored further and will be the focus of the forthcoming chapters of this thesis.

6 Requirements of a new communication technology for handover and escalation of care: A mixed-methods study

6.1 Introduction

The HFMEA conducted in chapter 5 of this thesis demonstrated the priority areas for intervention within the escalation of care process. In addition, previous work in this thesis from chapter 2, 3 and 4 has indicated that timely and high-quality information transfer is critical to the success of the process. Participants in the HFMEA in chapter 5 came to a consensus that one of the cornerstones of successful escalation of care is the ability to communicate effectively. They also demonstrated that the quality of communication is not just dependent on the communicators, it may also depend on the quality of the communication technology available to healthcare professionals. Poor communication has been specifically identified as a key cause of deteriorating patients receiving suboptimal care in the UK[69]. This is of grave concern as the National Reporting and Learning System found in 2005 that of 425 potentially preventable deaths in acute/general hospitals, 15% were as a result of poorly managed deteriorating patients, with 4% dying as a consequence of failings in the communication of escalation of care[148].

The majority of clinicians in UK hospitals use a pager device for two-way interprofessional communication, including when they need to escalate care. However, pagers were invented more than 50 years ago and have failed to evolve in the same progressive way that mobile phones and computers have done over the last two decades[149]. Multiple industries have jettisoned the pager in favour of more advanced technology but healthcare has failed to follow suit. Since 1990, the mobile phone has progressed from a brick-sized device able to make and receive phone calls to palm-sized devices with the ability to send and receive phone-calls, text messages, emails, photos, videos and run software applications. During this time, the pager device has remained essentially the same and now appears to be hindering the safety of hospital patients[150,151]. Boulos et al. argue that the pervasive presence in society of smartphones and mobile app technology holds a great deal of potential for their use in healthcare[152]. To this end, there has been an increase in the number of research articles in the area of mobile health (mHealth) and application development for smartphones.

Unfortunately however, previous attempts to replace the pager device with a more modern, capable communication device have, thus far, been unsuccessful[153]. Research has been carried out on the use of smartphones as communication devices in hospital[154]. However these studies have focused on the convergence of modalities within one device i.e. the ability to choose between direct call, text message or e-mail. These studies highlighted that different health professions have different communication requirements. To date no study has considered the potential for smartphones, and more specifically, apps to improve interprofessional communication during escalation of care.

6.2 Aims

1. Evaluate, through literature review, current methods of communication used in hospitals for escalation of care and handover
2. Explore stakeholders' perceptions of current communication technology and their opinions on the potential for Application Based Communication Systems (ABCS) to improve interprofessional communication
3. Develop a guide for development of ABCS

6.3 Methods

6.3.1 Phase 1: Literature review

An in-depth picture of communication technologies that have been employed for interprofessional communication in hospital was gained through a narrative literature review. This methodology was chosen to enable comprehensive capture of the published evidence surrounding current communication technologies used in healthcare settings and to enable the research team to gain knowledge of important themes for consideration in development of any future communication technology. Studies published on this topic prior to April 2013 were identified from the following databases; Embase, Ovid Medline, Health Management Information Consortium, PsycINFO and PubMed. In addition, a snowballing technique was used to locate further studies.

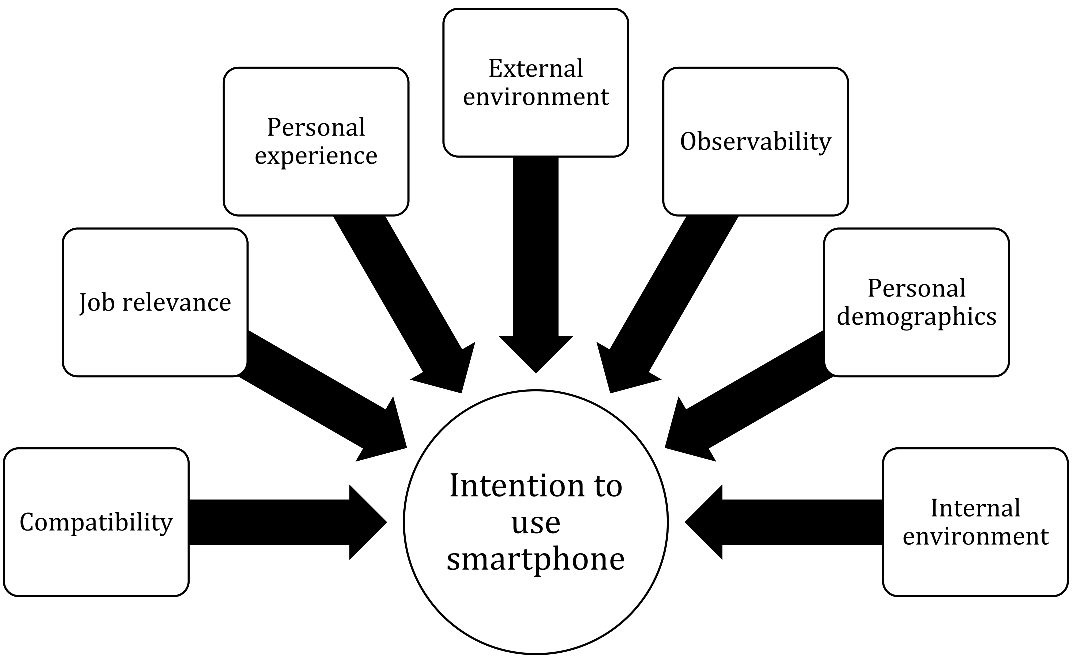
6.3.2 Phase 2: Qualitative exploration

Study design and setting: A qualitative approach was deemed appropriate due to the exploratory nature of our research question. The methodology chosen was a focus group study. This methodology was chosen to allow collection of descriptive data from population subgroups[119]. An understanding of both the issues surrounding current communication during escalation of care and handover along with end-user perspectives on ABCS was needed. Focus groups were felt to be more appropriate for this purpose as escalation of care and handover are interprofessional processes, meaning both individual and collaborative opinions were required. The anticipated interplay between different groups of participants was vital to ensure capture of potentially complex interactions that take place during interprofessional communication in the healthcare setting[155]. Qualitative interviews were also considered but using this method would have omitted the valuable interactions between potential end-users of new communication technology. The focus groups were carried out at a central London teaching hospital. The Joint Research Compliance Office for Imperial College waived formal ethical approval for the project prior to data collection.

Participants: Purposive sampling was used to recruit participants. Eligible participants included qualified doctors and nurses with more than one year of clinical experience on hospital wards and of using the hospital pager system and escalation protocols. Participants were recruited using posters placed in staff rooms around the hospital and emailed to ward managers for distribution. Researchers also recruited participants in person from their place of work. All participants gave written, informed consent in advance.

Focus groups: A focus group topic guide was developed based on the literature review with a focus on Putzer and Park's model for emerging mobile technologies (see **Figure 6A**)[156]. This model evaluates the impact of seven innovation factors on a physician's behavioral intention to use a smartphone and represents an excellent basis for the topic guide that was developed and employed in this study. The topic guide was modified and approved in collaborative sessions by the research team (see **Appendix C**). The focus groups explored current methods and technologies used for communication in escalation of care and handover and the receptiveness towards an ABCS to perform this task in the future. Specific features participants would like to see incorporated or avoided were explored in depth with the group to ensure that other participants felt the same or to uncover the reasons for disagreement. Two researchers moderated each focus group session, two researchers took comprehensive notes and one researcher was responsible for administrative tasks. The moderators generally allowed each session to be dictated by the participants but stepped in if participants with leadership qualities were dominating the conversation to ensure the views of everyone were collected. All researchers maintained the same roles throughout to ensure consistency between sessions.

Figure 6A Putzer and Park's model for emerging mobile technologies



Data analysis: The focus group sessions were audio recorded and transcribed verbatim. Transcripts were then checked for completeness and comprehension with the original recordings before being read and re-read to ensure adequate immersion in the data. Triangulation of the data was performed using the transcripts, original recordings and the detailed notes taken by the researchers. The transcripts were then analysed using systematic thematic analysis. Two researchers independently coded all focus group transcripts and points of contention were resolved by consultation with a third researcher.

To ensure methodological rigor, qualitative guidelines were adhered to throughout the data collection and analysis[119]. In addition a collaborative approach was used, involving experienced researchers throughout the process.

6.4 Results

6.4.1 Phase 1

A total of 28 reports were identified from the database searches, which evaluated various modes of communication technology used in the hospital setting (see **Table 6A**). Devices evaluated included pagers (numeric and alphanumeric); hands free communication devices (HFCDs), personal digital assistants (PDAs) and mobile phones (including smartphones). Literature describing each device type was collated to assess whether each technology facilitated or acted as a barrier to effective interprofessional communication and how they affected the communication pathway during escalation of care and handover. Findings were then synthesised across all devices to deduce the information system needs that must be met to facilitate IPC in the hospital setting (see **Table 6B**). Smartphone technology was found to best meet the identified information system needs.

Table 6A Characteristics and focus of reviewed studies

Author, year	Method	Subjects and setting	Alpha-numeric pager	HFCD	Mobile	Numeric pager	PDA	Smart phone
Ammenwerth[157], 2000	Mixed	31 Doctors & Nurses, Germany	–	–	–	–	✓	–
Aziz[150], 2005	Survey	9 Doctors, UK	–	–	–	–	✓	–
Ernst[158], 2013	Observation	9 Doctors, USA	–	✓	–	–	–	–
Haroon[159], 2010	Survey	60 Doctors, Ireland	–	–	✓	✓	–	–
Ighani[160], 2010	Survey	39 Doctors, USA	✓	–	–	–	–	–
Jacques[161], 2006	Survey	48 Doctors & Nurses, USA	✓	✓	–	–	–	–
Joseph[151], 2013	Survey	50 Doctors & Nurses, USA	–	–	–	–	–	✓
Katz-Sidlow[162], 2012	Survey	116 Doctors, USA	–	–	–	–	–	✓
Lapinsky[163], 2001	Focus group	26 Doctors, Canada	–	–	–	–	✓	–
Lo[164], 2012	Interview	31 Doctors & Nurses, USA	–	–	–	–	–	✓
Mejia[165], 2010	Focus group	5 Doctors, Mexico	–	–	–	–	✓	–
Mendonca[166], 2004	Mixed	2607 Doctors & Nurses, USA	–	–	–	–	✓	–
Menzies[167], 2012	Survey	850 Doctors, New Zealand	–	–	–	–	–	✓
Munoz[168], 2003	Mixed	28 Doctors & Nurses, Mexico	–	–	–	–	✓	–
Nguyen[169], 2006	Survey	48 Doctors & Nurses, USA	✓	–	–	✓	–	–
O'Connor[170], 2009	Survey	125 Doctors & Nurses, Canada	–	–	–	–	–	✓
Patel[171], 2006	Observation	14 Doctors, New Zealand	✓	–	–	–	–	–
Quan[153], 2013	Mixed	74 Doctors & Nurses, Canada	–	–	–	–	–	✓
Richards[172], 2011	Survey	53 Doctors & Nurses, UK	–	✓	–	–	–	–
Richardson[173], 2008	Mixed	23 Nurses, USA	–	✓	–	–	–	–
Smith[174], 2012	Descriptive	34 Doctors, Canada	–	–	–	–	–	✓
Solvoll[143], 2013	Mixed	11 Doctors, Norway	–	–	✓	✓	–	–
Thompson[175], 2005	Commentary	No subjects, USA	–	–	–	–	✓	–
Volpp[176], 2003	Commentary	No subjects, USA	–	–	–	✓	–	–
Wong[177], 2009	Mixed	50 Doctors & Nurses, Canada	✓	–	–	–	–	–
Wu[178], 2010	Survey	91 Doctors, Canada	–	–	–	–	–	✓
Wu[179], 2011	Mixed	34 Doctors, Canada	–	–	–	–	–	✓
Wu[180], 2013	Mixed	147 Doctors & Nurses, Canada	✓	–	–	✓	–	✓
Total			6	4	2	5	7	10

Table 6B Information system needs for interprofessional communication in hospital

No.	Information System Need	Description	No. of papers cited in	Reference Number
1	Enable Mobility	The sender or receiver are not required to be collocated or tied to specific locations	22	143,150,151,153,157-159,163,165,166,168-176,179-181
2	Communicate Context	Sufficient levels of detail can be communicated when transferring information	20	143,151,153,157,158,163-166,168-171,173-176,178-180
3	Enhance Teamwork	Increase in inter-professional collaboration/efficiency	20	143,150,151,153,157,164-167,169-171,173-176,178-181
4	Minimize Interruptions	Fewer interruptive alerts received	18	143,153,158,160,162,164,166,168-173,176,178-181
5	Minimize Response Time	Little time passes between sending a message and receiving the desired response	17	143,150,151,153,158,159,161,165,166,170,172-174,176,178-180
6	Minimize Disruptions	Less disturbance caused by interruptions	17	143,153,158,160,162,164,168-174,176,178,179,181
7	Improve Accessibility	Easier to contact individuals in times of need	17	143,150,153,157-159,163-166,170,172-174,176,178,179
8	Triage Issues	Able to assign levels of urgency to communication events	17	153,157,160,164-166,168-171,173,174,176,178-181
9	Identify Users	Individuals sending/receiving messages can be recognized separately by other users	12	153,158,164,165,168,169,172-174,176,178 179
10	User-Friendly	Simple to operate	12	143,150,151,157,163,168-170,172,173 177 180
11	Minimize Unnecessary Communication	Device discourages transfer of redundant information	11	143,153,170,171,173,174,176,178-181
12	Function reliably	Device performs desired functions robustly, minimal occurrence of malfunctions	11	150,153,157,159-161,163,170,172,173,175
13	Allow two-way communication	Device allows user to both send and receive information	11	143,153,157,166,171-174,178,179,181
14	Assign Ownership	Tasks and patients can be transferred with clarity and transparency	9	153,158,166,167,169,174 176,177 179
15	Protect patient data	Patient data securely stored/encrypted	9	159,161,165,166,172,173,175,180,181
16	Track communication	Evidence of all communications stored	7	153,157,164-166,168 174
17	Incorporate Patient Information	Access to complex patient data e.g. health records accessible within system	7	157,165,166,168,173-175

6.4.2 Phase 2: Focus groups

Three focus group sessions, lasting one hour each, were conducted during April 2013. These sessions were semi-structured by the topic guide. A total of 26 participants were recruited, including 11 nurses and 15 doctors. Doctors were recruited from house officer through to consultant level. Nurses were recruited from junior staff nurse through to senior staff nurse and ward manager level. Both homogeneous and heterogeneous sessions were conducted with each professional group. The homogeneous approach allowed participants to express views openly without hierarchical barriers influencing the discussion. The heterogeneous approach encouraged collaborative discussion between stakeholders with different requirements, to allow common ground or firm disagreements to be identified.

Six main themes were identified which detail user perceptions of the current pager system, attitudes towards smartphone technology and requirements of an ABCS for escalation of care and handover. These themes were common across all three focus groups and incorporate a full description of the data set. The six themes are described in detail below and accompanied by informative verbatim quotes from participants (N=nurse, D=doctor).

6.4.3 Theme 1: Clinician perspectives on current methods for communication during escalation of care

Pagers and mobile phones were identified as the main devices used by participants for interprofessional communication. Both nurses and doctors used the pager system although doctors sometimes used mobile phones as well, usually for communicating with other doctors in an ad-hoc fashion. In most cases they used their own personal mobile phones because they were dissatisfied with the devices provided by hospitals (usually pagers). Just one of the participants admitted to contacting their hospital's information governance department prior to using their phone to discuss patients. The majority of participants justified their use of mobile phones due to the issues surrounding the pager device.

Pager System: There was general consensus amongst participants that the pager is an outdated technology that is no longer fit for purpose. Doctors perceived the greatest weakness of the pager system to be the lack of information transmitted.

Doctors found responding to pagers time-consuming and that this could become potentially dangerous in urgent situations. They described how receiving numerous pages in succession could cause confusion and result in some pages being erased from the device to make room for new alerts. Pages were also received when doctors were off-duty, outside the hospital, meaning someone is waiting for them to call back rather than contacting the correct person.

Nurses identified the lack of feedback regarding page delivery as particularly problematic, leading to uncertainty about the next step to be taken.

N10: *''…you don't know why they haven't responded, is it because their bleep's not working? Is it because they're busy in theatre?"* This lack of feedback seemed to be a major barrier to good interprofessional communication.

Participants perceived a limited number of strengths to the pager system, with doctors expressing appreciation of the reliable reception pagers receive. Mobile phone reception and wireless Internet coverage were considered to be unreliable in some hospitals. Nurse participants expressed no positive views of the pager system.

Mobile phone (calling and texting functions only): Doctor participants deemed the direct contact made possible by mobile phones helpful when they were with patients, particularly for surgeons whilst operating.

D1 'You can very quickly say "I'm with somebody, is this urgent or not?''

Nurse participants also found it easier to get a response from doctors when calling them on mobile phones rather than pagers.

N6:"It's a better way of doing it than with pagers and just getting no response. I'll just pick up the phone and call them."

Text messaging was found to be useful, mainly for non-urgent situations. The issues of poor mobile reception in hospitals, data protection requirements and patient confidentiality were raised. Some doctors felt uncomfortable with the idea of sharing personal mobile numbers indiscriminately with all colleagues. The doctors were also concerned that the increased accessibility provided by mobile phones could cause regular interruptions during clinical tasks.

6.4.4 Theme 2: Factors affecting choice of communication method used

Different communication methods were deemed appropriate for different situations, with four factors found to influence the choice made:

1. Time of day – Nurses found communicating with doctors harder at night and stated that this is especially prevalent in surgery when several members of the team may be in theatre. The introduction of hospital at night teams with fewer members than when each specialty provided their own on-call team was also felt to be responsible for difficulties contacting clinicians at night.

2. Urgency – the participants thought pages and text messages were appropriate for less urgent issues whereas phone calls should be used for more urgent issues. Tension was observed between doctors and nurses when discussing what constitutes an urgent situation as nurses tended to adhere to the early warning score system whilst doctors tended to rely on both the early warning score and their previous knowledge of particular patients if they had been caring for them for some time.

3. Types of colleague – when doctor participants escalate within their own

team they use mobiles but when escalating to members of a different team they tend to use pagers. The doctors mentioned that they would find it easier to contact their direct superior if they had already exchanged contact details rather than using a pager.

4. Location – in general, doctors are more mobile and should use more versatile communication methods compared to nurses who work on one ward. Accordingly, doctors were keen to use a mobile device and nurses requested a stationary device to prevent loss (e.g. a desktop computer).

6.4.5 Theme 3: Attitudes towards smartphone technology in the workplace

Participants were generally receptive to the use of smartphones for interprofessional communication. One nurse pointed out that most people are used to using smartphones so the transition would not be difficult.

N11 "I think most people are used to using smartphones... it wouldn't be a huge leap."

Another nurse described how computerised systems quickly became part of daily practice, which was supported by one doctor's view that if smartphones were to become standard practice, clinicians would adapt quickly through necessity.

Some of the doctors expressed doubt regarding the added advantage of using a smartphone over a normal phone for communication. They felt the benefits of using a smartphone would be reliant on the reliability of wireless Internet coverage and integration of patient data and a group conversation function.

D4 ''If it's only for simple communication and doesn't have any patient information on it, then it's no more useful than having a bleep''

6.4.6 Theme 4: Factors affecting the successful adoption of an ABCS

Participants were asked to assess the 7 adoption factors identified by Putzer and Park's model. They felt the ABCS would be compatible with, and relevant to, their work. All 26 participants owned a smartphone, which may increase the likelihood of successful adoption of the ABCS. It was suggested that age could be a potential barrier to successful adoption.

D4*: ''Age is going to be the only barrier, but anyone under the age of 60 working inside a hospital pretty much has a smartphone''*

However, both doctors and nurses felt that resistance would be on a more individual basis as opposed to being widely pervasive within groups of healthcare professionals.

N3: *''I don't think any groups of staff [would be against using an app]. I think that there'd probably be individuals, you know... technophobes.''*

Good technical support and systems training were identified as crucial for the successful adoption of an ABCS.

6.4.7 Theme 5: Considerations for software design

Participants made a number of suggestions about design features they would include and avoid in an ABCS. The most commonly stated aspect valued by the participants was simplicity.

N3: *''Any complication on it is going to hinder people using it…. You make it difficult* *and they'll just bypass it and try and use the* [desk] *phone anyway."*

Both doctors and nurses believed the ABCS would increase efficiency by enabling immediate two-way and group communication. Overall, most doctors predicted a reduction in frustration and an increase in job satisfaction. The following features were repeatedly identified by participants as desirable features of an ABCS for the purpose of communicating during escalation of care and handover:

Ability to acknowledge messages: Almost all doctors and nurses suggested that a function informing the sender if a sent message had been received and acknowledged should be included.

N4: *"if you can see that the person has received that message at least you know they've had it and you're not going to keep trying to contact them"*

Pre-set responses were suggested if the doctor was unable to call back immediately. Nurses reported that this would reassure them and they would be less likely to send repeat messages. The doctors appreciated this potential for reduced messages whilst they were busy with other clinical tasks. One participant stated that a status could be incorporated into the software where a doctor could let others know they are in theatre or at a trauma call so won't be available for a period of time. A job list function was suggested for doctors, which could log tasks and indicate whether they had been completed or not.

Ability to triage messages: Triaging messages based on the clinical urgency of the situation was important for the participants. Several doctors suggested the ABCS should assign different ringtones/colors to messages of different urgencies.

D2: *"You'd have a basic text mail for a non-urgent call, and then a different color or a different bleep saying, "Urgent, please call. Patient deterioration.""*

The potential for system abuse was also raised as messages could be sent with a higher level of urgency than appropriate.

D4: *'' …they'll realize very quickly that they don't get things done immediately unless they're 'urgent', and then everything will become urgent.''*

The use of objective early warning scores (EWS) to determine urgency and collaborative educational sessions were suggested as a means of overcoming these issues.

Data input: The participants were mostly in favor of a system which would enable limited data input rather than unlimited free-text to save time at both ends of the conversation.

D2: *''There could just be three options … the desired response time, the urgency, and the job details, this would take seconds.''*

It was suggested this would improve efficiency by only having relevant information present. However some nurses were worried that this would limit the ability to have a discussion amongst colleagues.

Integration of patient information:

The doctors were particularly in favor of being able to access patient information through the ABCS including physiological parameters, pathology and radiology results.

D2: *''You literally click on the patient, that patient's reference name comes up, you've got a summary of them, and if you had a bloods access point on it, great''*

Group communication:

Many of the doctors considered the ability to have group conversations essential, possibly in a similar manner to communication apps currently in use in platforms such as WhatsApp (Inc., California).

D2: *''The app could have this background function that any communication between the team members and the nursing staff will register on their device.''*

However it was recognized that data protection issues would have to be addressed regarding confidential patient information. Several doctors were in favor of the ABCS automatically disconnecting once outside the hospital network range.

Monitoring of communication activity:

Several participants commented that the ABCS could serve as a useful record of communication events, and hence would provide an audit trail. Doctors noted that this would be useful for completing logbooks and portfolios. Nurses felt this would provide legal protection for them after patient safety events.

N9: *''I think for us, the nurses, it's going to be like good documentation, if something goes wrong then we are protected with a system like this''*

6.4.8 Theme 6: Considerations for system design and implementation

The infrastructure of the hospital was raised as an important consideration. The participants deemed convenient charging facilities and reliable wireless Internet necessary. Some doctors questioned whether the current hospital infrastructure would be able to support these features. Several doctors were in favor of hospital-supplied devices rather than using their own for ease of data protection whilst nurses were happy to share a communal wall-mounted device supplied by the hospital.

6.5 Discussion

This study represents the first exploration of current communications methods in use in hospitals and the features that should be avoided and included in any future technology created for interprofessional communication in the healthcare setting. The aims of this study were to evaluate current communication technologies in use in hospitals, explore stakeholder perceptions of current and future communication technology and produce a guide for the development of future communication technology for use during escalation of care and handover. The findings will be discussed in relation to these aims and the wider literature. Following this, the implications for the field of surgery will be discussed, taking the strengths and limitations of this research methodology into account. Lastly, some conclusions will be presented.

6.5.1 Summary of findings and context within the literature

Current communication technology used in hospitals: From the 28 articles that were explored in the literature review, the opinions and perceptions of more than 4,500 doctors and nurses from four different continents were collated and reported. From these, 17 information systems requirements for successful communication technology in healthcare were generated. Any potential developers of new communication technologies for use in the healthcare industry should consider these systems requirements. System needs such as the allowance of mobility and detailed context, enhancement of teamwork, accessibility and triage, and minimisation of interruptions and response times (among others) were cited repeatedly in the published literature, providing high-level evidence for these system needs.

Stakeholder perceptions of current and future communication technology: Six main themes were generated from the qualitative focus groups. These detail user perceptions of current communication technology and why different devices may be selected for use, attitudes towards smartphone technology, the factors that may affect adoption of smartphone and app-based technology, some considerations for future software design and wider considerations for system design and implementation. The participants felt that pagers are not fit for purpose and should be replaced by devices with greater functionality (such as smartphones). They identified the importance of securing end-user buy-in prior to implementation of a new communication innovation, especially for people less familiar with advanced technology. The inclusion of feedback loops and patient information were found to be important software features to include in a new communication technology, whilst investment in hospital infrastructure would be required to ensure they are receptive to advanced innovation.

Guide for the development of future communication technology for use during escalation of care and handover: Drawing on the findings from the literature review and focus groups, nine recommendations to enable successful development and adoption of an ABCS for use in hospitals have been developed (see **Table 6C**). In developing the recommendations every effort has been made to concurrently address the needs of all potential end-users and existing hospital policies regarding confidentiality. In addition, the recommendations were reviewed in accordance with the information system needs that emerged from the literature search to improve the robust nature of this evidence base.

Table 6C Development recommendations

No.	Recommendation	Link to study findings	Evidence base
1	Communication should be triaged based on level of urgency	1. Use of EWS in communication 2. Conflicting opinions of urgency between doctors and nurses	1. EWS produces an objective score of patient physiology[182] 2. Divergent interpretations of urgency[164]
2	Enable feedback to establish a closed communication loop	1. Nurse frustration with lack of delivery confirmation 2. Lengthy process of answering a page	1. Lack of feedback is a challenge to work practice[183] 2. Difficulty improving pager response time[184]
3	Establish structured data input	1. Produce clearer communication 2. Use of SBAR tool	1. Avoid interruptions and distraction[179] 2. SBAR correlated with reduced unexpected deaths[185]
4	Establish a team conversation function	1. Allows open style between doctors 2. Multiple participants in a conversation	1. Improved continuity of care[186] 2. MDTs can confer improvements in outcomes to patients[22]
5	Incorporate an electronic audit trail	1. Address nurses' concerns about responsibility 2. Collection of cases for logbooks	1. Responsibility is a key goal for effective handover[187] 2. Logbooks are a fundamental part of surgical training[188]
6	Ensure robust security systems are in place	1. Confidentiality may be a barrier to implementation	1. Raised in several previous pieces of research[165]
7	Provide individual smartphones to doctors and shared devices to nurses	1. Doctors want to use hospital mobile devices 2. Nurses wish to use shared ward devices	1. The choice of device depends on the clinical role of staff and degree of mobility required[189]
8	Provide staff training	1. Avoid rigidity 2. Allow judgment of urgency	1. Rigid adherence to guidelines can lead to harm[190] 2. Effective triage can improve patient care[191]
9	Invest in a flexible operating system allowing future alterations	1. Incorporate new features	1. Increased compatibility[192]

6.5.2 Additional considerations: These additional considerations arise from ongoing discussions with colleagues and experts in the areas of healthcare innovation and communication. For the success of such a system, individual hospitals would need to carefully consider their infrastructure. Adequate network coverage, technical support and charging facilities would need to be in place. The recommendations that have been provided cannot serve as a final step-by-step guide to designing technology; feedback must continually be sought from stakeholders throughout the implementation process to ensure the technology meets stakeholder requirements and serves its function well.

The problem of integrating new communication technology into healthcare is increased by extra barriers provided by safety and confidentiality concerns. This is a global issue for healthcare with no 'quick-fix' available. There are a number of companies in the early stages of technology development looking to overcome this problem. In the UK, The Learning Clinic has developed a system called VitalPac which uses algorithms to calculate patient risk and alert staff to unstable patients whilst DocCom has developed an app allowing limited team communication and medical alerting[43,193]. RelayHealth from the USA is also developing several communication solutions aiming to improve the efficiency of clinical care[194]. However, these systems do not currently meet the recommendations of this study or the level of functionality required to replace communication technology in use in hospitals at the present time.

This research aimed to develop requirements for an ABCS to improve escalation of care and handover between healthcare professionals. Participants stated a desire for development of this system and this study serves as an informative resource to aid practical implementation of such a system into the hospital environment. A considerable challenge to the success of this system would be ensuring adoption; numerous studies have demonstrated the complex challenge presented by introducing new IT to healthcare settings[195-197]. The potential for this system to improve communication and ultimately patient care would very much depend on stakeholder 'buy-in'. Previous research has indicated that barriers to adoption of new health information technology (HIT) are often more behavioral than technical in nature[198]. This study has expressly addressed this challenge by centralising stakeholders' views. This approach is consistent with the approach to software development that the National Health Service has endorsed for future projects and has been successful in other sectors[199].

6.5.3 Implications

The findings from this study have several important implications for the field of surgery. Firstly, the current landscape of communication technology in hospitals worldwide has been reported and many of the devices in use are suboptimal. Considerable efforts from healthcare administrators will be required to bring about innovation. Secondly, the potential for smartphones and ABCS to improve the efficiency and safety of communication during escalation of care has been evidenced through high-level synthesis of published literature and detailed interprofessional qualitative methods. Lastly, the importance of patient confidentiality and information governance in the healthcare industry has been reinforced to clinicians, patients and administrators. Innovation of communication technology needs to, and will, happen eventually. However, it is critical that security is not compromised to ensure patients are reassured regarding the security of their personal details.

6.5.4 Strengths and limitations

The findings of this study are strengthened by the recruitment of participants of varying experience levels from multiple hospitals. The hospitals involved serve demographically diverse populations in London whilst the variation in type of institution (teaching and district general) also provided generalisability to the findings. However, the findings may not generalise to healthcare settings outside the UK or in more remote settings[200].

As a qualitative study the subjective opinions of the participants must be taken into account, although the use of an interprofessional focus group approach rather than individual interview techniques also has advantages[119]. This study did not consider the views of patients; managerial staff and IT support staff. These will need to be taken into account prior to implementation of any new technology [201].

6.5.5 Conclusions

Clinicians find the current methods of communication for escalation of care and handover, namely the pager system, to have significant shortcomings. They view smartphone and app technology as a potential opportunity to better meet their communication needs. In light of previous failed healthcare information technology projects (such as the drive to create a paperless NHS), it has been deemed advisable to engage end-users in the design process to increase the likelihood of successful adoption. Doctors and nurses of different experience levels have been found to have varying requirements of communication devices in hospital and their different roles in the communication pathway require further scrutiny. This study provides a thorough, evidence-based guide for how to combine the different requirements of doctors and nurses in an ABCS for escalation of care and handover.

Before such a system can be developed or implemented however, the receptiveness of healthcare professionals to, and practicalities of, new communication technology must be investigated in the clinical environment. This will be the focus of the next chapter in this thesis.

6.5.6 Phase 3

Development and implementation of interventions to address the problems with escalation of care

Chapters 2, 3 and 4 detailed the preliminary investigations conducted into the escalation of care process and uncovered valuable insights into why the process may be delayed or performed poorly, and the implications of this to the surgical patient. Chapter 5 then provided a detailed risk assessment of escalation of care in surgery and prioritised several important areas as amenable to, and in need of, intervention. The two principal priority areas for intervention in the escalation of care process are:

1. Development and implementation of innovative communication technology in the mHealth arena.
2. Development and implementation of escalation of care protocols based on human factors and a flattened hierarchy.

These priority areas will both be dealt with in the final section of this thesis. Chapter 6 will build on the findings from chapter 5 regarding the use of suboptimal communication technology and chapter 7 will further explore priority one through implementation of a communication technology intervention in a surgical team.

Chapter 8 will then describe the development and validation of a metric to measure the quality of information transfer, a vital tool to allow assessment of core communication skills during escalation of care. This is important to measure the impact of any subsequent interventions. Finally, chapter 9 will pursue priority two through the implementation of a human factors intervention bundle in a UK surgical department.

7 An exploration of the role of instant messaging services in surgical teams

7.1 Introduction

Patient care has been revolutionized by the information age; the last two decades have seen diagnostics and treatments transformed by widespread technological progress[202]. Chapters 5 and 6 illustrated the pitfalls of current communication technology in use in UK hospitals and advocated the use of smartphones for interprofessional communication.

Smartphones are built on mobile operating systems and have more advanced connectivity and computing power compared to traditional mobile phones. WhatsApp (Inc. California) is an increasingly popular mobile messaging application (app) available over all smartphone platforms. With its widespread uptake WhatsApp represents a potentially disruptive innovation in healthcare communication offering numerous potential benefits to surgeons.

However, many hospitals still use outdated pager systems as the foundation for interprofessional clinical communication between physicians, nurses and other healthcare professionals. This is despite the problems identified in chapters 3 and 5, and discussed in chapter 6, which include long waiting-times for the return of a page, lack of feedback loops, frequent interruptions and an inability to identify the location or identity of the caller[147,169,179]. From a patient safety perspective, this is of significant concern given the fact that poor communication often lies at the heart of an adverse event[203].

Although previous studies have evaluated communication in acute settings[35,204], the focus has been on direct or face-to-face communication. Communication using electronic devices has been explored in general internal medicine [205] and the use of social media has been explored in psychiatry [206] with investigators finding that the proliferation of new electronic devices and use of social media can lead to difficulties with boundaries and information governance. No study available to date has evaluated the use of mobile electronic communication in surgical teams; despite the fact that many physicians are now jettisoning their hospital pagers and using their personal mobile phones to facilitate professional communication[207].

7.2 Aims

1. Identify the interprofessional communication pathways used through WhatsApp
2. Evaluate the response times to communication for different communication types, domains and clinician grades.
3. Explore participant's perceptions of how increased supervision of junior team members provided by WhatsApp affects team culture and the escalation of care pathway

7.3 Methods

7.3.1 Study design

This study used a mixed-methods approach to investigation. A combination of quantitative script analysis was combined with qualitative semi-structured interviews. The quantitative analysis of communication was deemed necessary to ensure that valid data reporting the frequency and direction of communication with the team could be collected. The qualitative interviews were included to ensure that the quantitative results were expanded upon using in depth analysis of the perceptions of the study participants. The combination of quantitative and qualitative research methods is used to supplement objective quantitative data with descriptive detail provided by qualitative methods. This approach has been used successfully to gain knowledge of the perceptions of potential end users of an innovation or intervention and was therefore chosen as the study design for this chapter[208,209].

7.3.2 Participants and setting

An acute surgical team responsible for all emergency admissions in a London teaching hospital was invited to participate in the study. All team members agreed to participate so no sampling was required. The nature of the team's emergency workload involves rapid assessment, management and discharge of all acute surgical patients. The team consisted of one consultant, one registrar rotating on a six monthly basis and two FY1 doctors, rotating on a weekly basis between surgical teams. The total number of core participants therefore totalled forty people over the course of the study. Additionally medical students and SHOs of varying experience joined the team sporadically when patient loads were high or to seek educational and training opportunities. The setting was selected as it has wide-ranging wireless Internet coverage (a key theme in chapter 6), enabling excellent reception for WhatsApp messaging at all times.

7.3.3 Details of app

WhatsApp is an app, used by over 500 million people worldwide, that allows smartphone users to send text messages and other types of media (such as videos, voice messages and photographs) to their contacts. It also facilitates the creation of groups, this allows multiple users to participate in and monitor the conversation. WhatsApp avoids charging for each message by utilising cellular data plans and wireless Internet networks; a subscription is currently £0.69. For the purposes of this study, participants used the secure wireless network rather than their mobile data plan when using WhatsApp to ensure security and confidentiality were maintained.

7.3.4 Study procedure WhatsApp was downloaded onto all team members' smartphones for the last week of September 2012 to allow participants to familiarise themselves with the workings of the software, clinical communication during this week took place using both the hospital pager system and WhatsApp messaging service. By the end of the pilot week all participants chose to use WhatsApp for their clinical communication rather than the pager system despite being given the option of opting out at any time. To prevent disruption to the medical emergency calling system all doctors who previously carried pagers continued to do so allowing medical emergency team calls to continue without any change. Capture of data commenced during the first week of October and ran through to the first week of March. Data was captured for 19 consecutive weeks excluding occasions when the consultant was on annual leave. The data captured includes all clinical communication events on WhatsApp between the hours of 8am-8pm during the normal working week (Monday-Friday). Clinical communication taking place at night or over the weekend is not included in this study. Therefore each script contains the team communication that took place over five consecutive working days.

Clinicians continued to be notified of cardio-respiratory arrest and peri-arrest scenarios via the pager device, all other matters were communicated on WhatsApp. At the end of the data capture period scripts were produced for each eligible week between October 2012 and March 2013. The consultant participant carefully anonymised each script prior to passing them to the research team.

7.3.5 Project approval

This project was confirmed as a service evaluation; formal ethical approval was not required. Participants used their own smartphones over the hospital secure wireless network and gave informed consent prior to participation. Approval was secured from the hospital Information Governance department on the basis of three conditions being met:

1. No storage of WhatsApp data on participant devices beyond the end of the working week was allowed. The team consultant downloaded and kept a hard copy in a secure location for record keeping purposes.
2. Patient identifiable data was omitted from team communication on WhatsApp, the patient's initials, location and a brief clinical description

allowed team members to identify the subject of communication without breaking confidentiality.

3. Professional behaviour had to be exercised in all communication on WhatsApp. To facilitate this all participants were offered a weekly induction briefing from the consultant detailing the above conditions along with practice guidelines. These guidelines reminded participants of the importance of contemporaneous documentation of clinical decisions communicated via WhatsApp in the clinical notes.

7.3.6 Data analysis

Each of the nineteen scripts was carefully checked for consistency and completeness including the date and time of messages to make sure data had not been omitted. Scripts were read and reread by the research team to ensure adequate immersion in the data. Four researchers with a background in surgery and patient safety developed a coding framework for script analysis prior to detailed scrutiny. The scripts were finally subjected to analysis by one researcher to extract data regarding the identity of the initiator and receiver of each communication event. Communication events were analysed using the chi-squared test for frequency data. The data was then separated further into communication episodes, which involve a series of events that all deal with the same initial event.

Data analysed for communication episodes included the response time for each participant grade, the type of communication and the clinical domain involved (e.g. operating theatre, ward etc.). Analysis of continuous data was performed using the Kruksal-Wallis test and the Mann-Whitney test on SPSS

Statistics (Version 20), statistical significance was taken when $p<0.05$. In addition, standardised qualitative methodology was used to identify emergent themes regarding the nature of these communication events. Two coders used a coding framework to categorise these communications, noting in particular where potential patient safety events had occurred. Such episodes are reported with supporting quotes. Participant's reflections of using WhatsApp were captured using semi-structured interviews, conducted at the study centre, which were analysed using standard qualitative techniques.

7.3.7 Assurance of methodological rigour

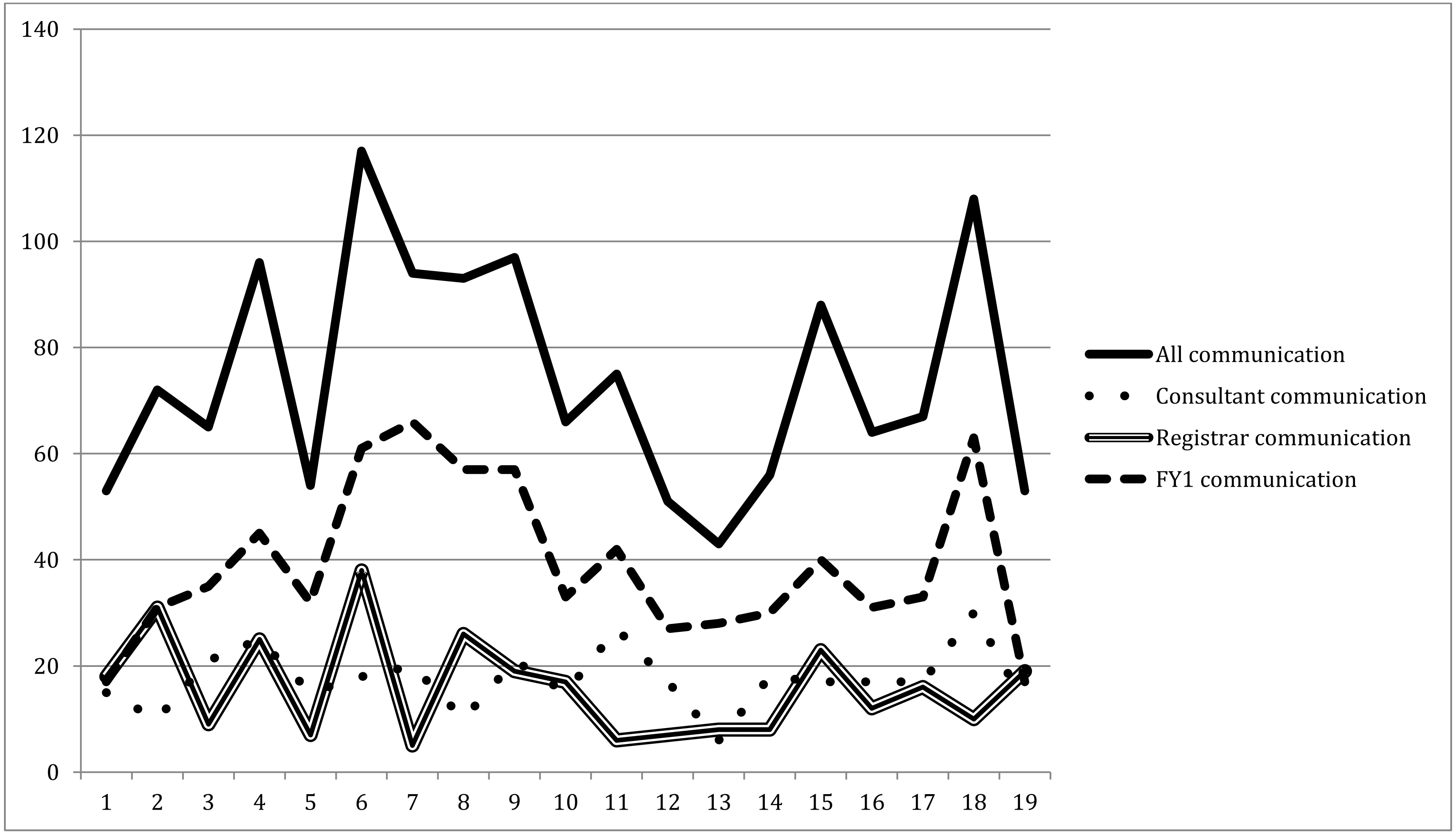
Quality guidelines for qualitative research were strictly adhered to throughout this study [119]. Data analysis protocols were formulated via a collaborative approach between all researchers and were used consistently for all data synthesis. Independent coding of two scripts by separate researchers (10% of the total number) was performed prior to triangulation to assess the reliability of data analysis.

7.4 Results

A total of 1140 hours of clinical communication pertaining to 636 patients over 95 days was recorded. This yielded 1,495 communication events (a median of 65.5 communication events per week, see **Figure 7A**). Of the communication events 359 came from the consultant (mean 17 per week), 318 from the registrar (mean 16 per week), 784 from the FY1 (mean 39 per week) and 34 from other team members. Messages from FY1s were longer, on average, than those from the registrar or consultant (18 words compared to 11 & 9 respectively).

Communication events were then grouped into communication episodes where events consisting of discussion regarding the same issue or patient that followed each other chronologically were combined to form one episode. A total of 658 communication episodes were produced from 1,495 events (a mean of 35 episodes per week). The initial communication event in each episode then had two codes assigned to it, one to designate the communication type and one to designate the clinical domain. There were four possible communication types: administrative question, clinical question, informative comment or instructive comment. There were seven possible clinical domains: administration, discharge, education, investigations, prescribing, theatre or ward care.

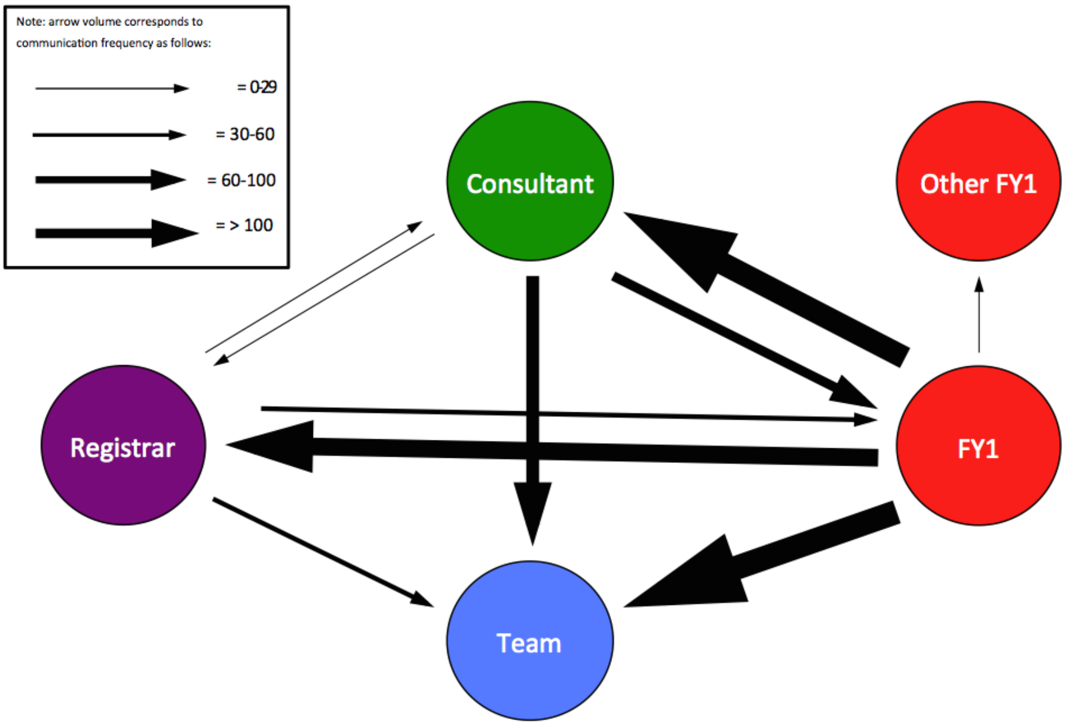
Figure 7A Frequency of communications per week



7.4.1 Initiators and recipients of communication

The FY1s initiated the most communication episodes (413, 64.9%) followed by the consultant (151, 23.7%), then the registrar (72, 11.3%) with the remaining episodes initiated by other team members. For episodes where the intended receiver was not specified or was not a core team member the receiver was classified as 'team'. There were also episodes where the initiator specified the team and a designated receiver; hence the reason for a greater number of received episodes than initiated. The team received the most communication episodes (269, 38.7%) followed by the consultant (196, 28.2%), the registrar (132, 19.0%) and the FY1s (98, 14.0%) received the least (see **Figure 7B**).

Figure 7B Frequency and direction of communication events



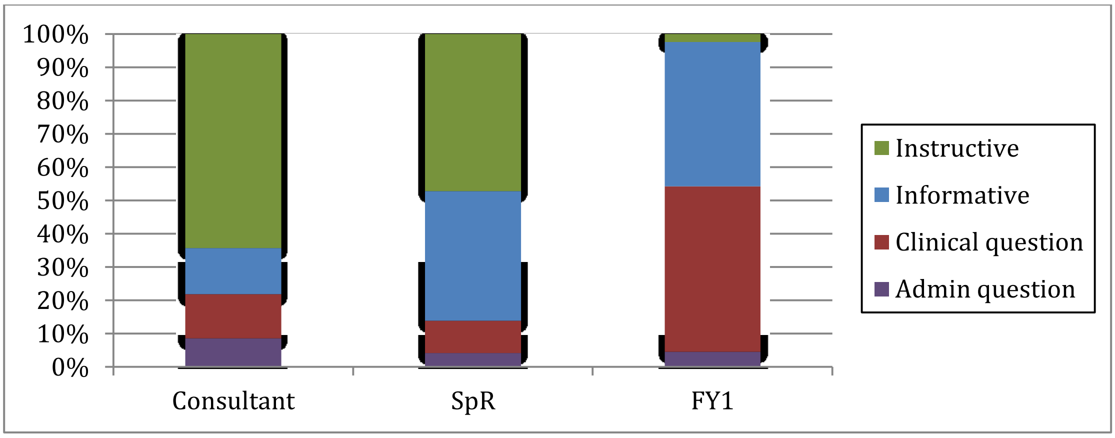
7.4.2 Initiators and recipients by communication type

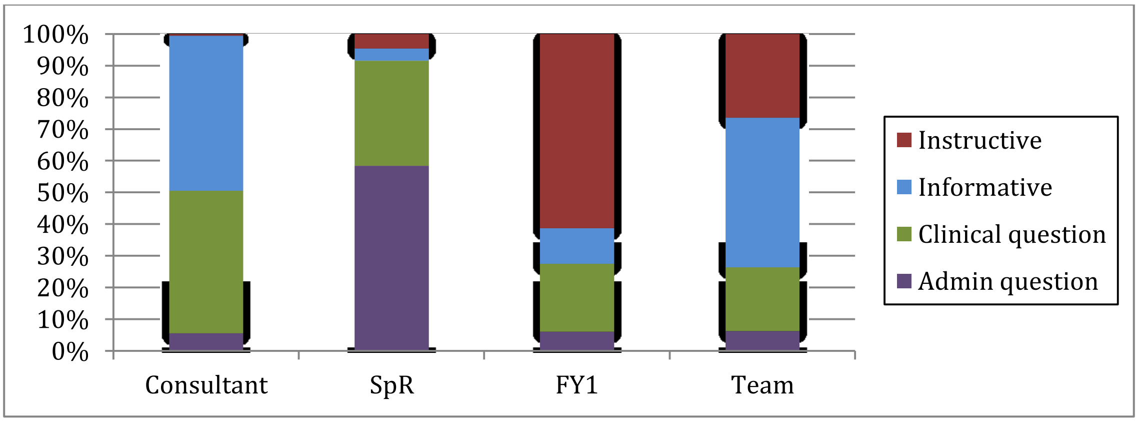
Administrative questions were most frequently initiated by FY1s and received by the consultant (n=60, p=0.02). The FY1s were most likely to initiate a clinical question than the consultant or registrar whom received a large number of this type of communication (n=417, p<0.001). Informative comments were most commonly initiated by the FY1s and most commonly received by the consultant (n=387, p<0.001). Accordingly the consultant initiated more instructive comments than other participants with the FY1s receiving the majority (n=207, p<0.001). It was not possible to directly compare the amount of initiated and received communications by the 'team'. The 'team' received more informative comments than any other communication type (n=269, p<0.001). The above results are summarised in **Table 7A** and **Figure 7C.**

Table 7A Initiators and receivers by communication type

	Grade	Frequency initiated	Frequency received	Total	X^2	*p*-value
Admin question	Cons	13	11	60	7.75	0.02
	SpR	3	8			
	FY1	19	6			
Clinical question	Cons	20	88	417	248	<0.001
	SpR	7	76			
	FY1	205	21			
Informative	Cons	21	96	378	192	<0.001
	SpR	28	43			
	FY1	179	11			
Instructive	Cons	97	1	207	143	<0.001
	SpR	34	5			
	FY1	10	60			

Figure 7C Initiators (top) and recipients (bottom) by communication type (N.B recipients graph contains 'team')





An example of instructive communication can be seen in **Figure 7D.** Often, several different types of communication were combined in a single communication episode (see **Figure 7E**).

Figure 7D A WhatsApp screenshot showing instructive communication (attending=consultant)

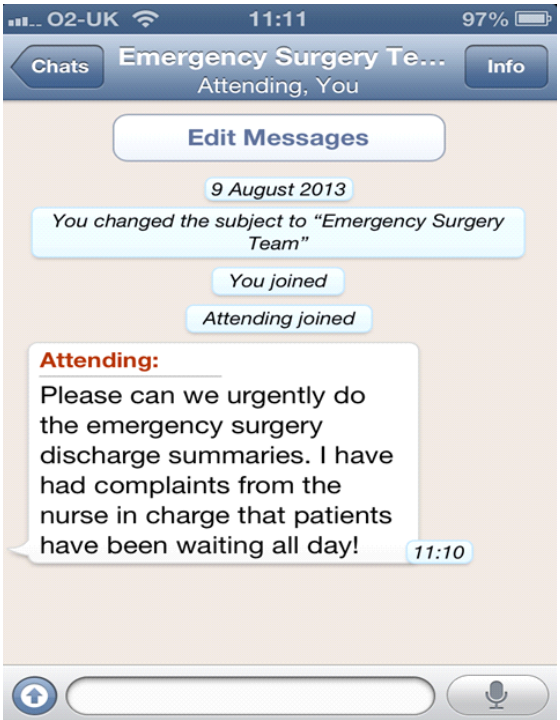
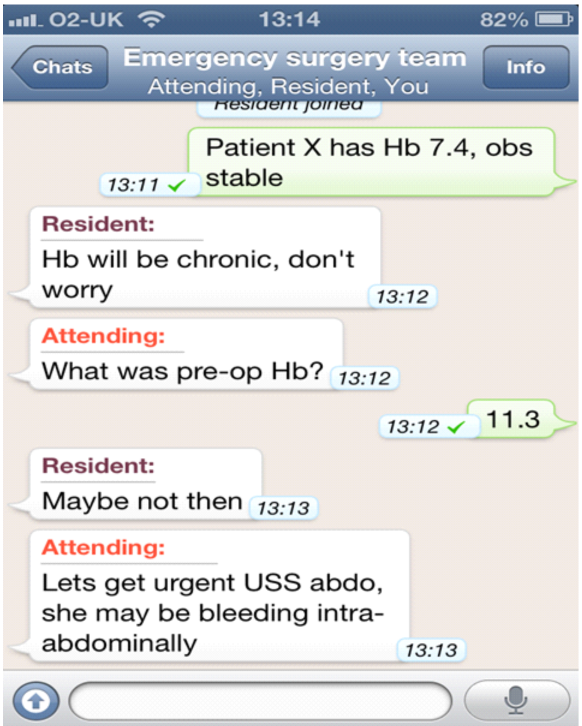


Figure 7E A WhatsApp screenshot from the FY1 handset showing different types of communication and a potential patient safety event (resident=registrar)



7.4.3 Initiators and recipients by clinical domain

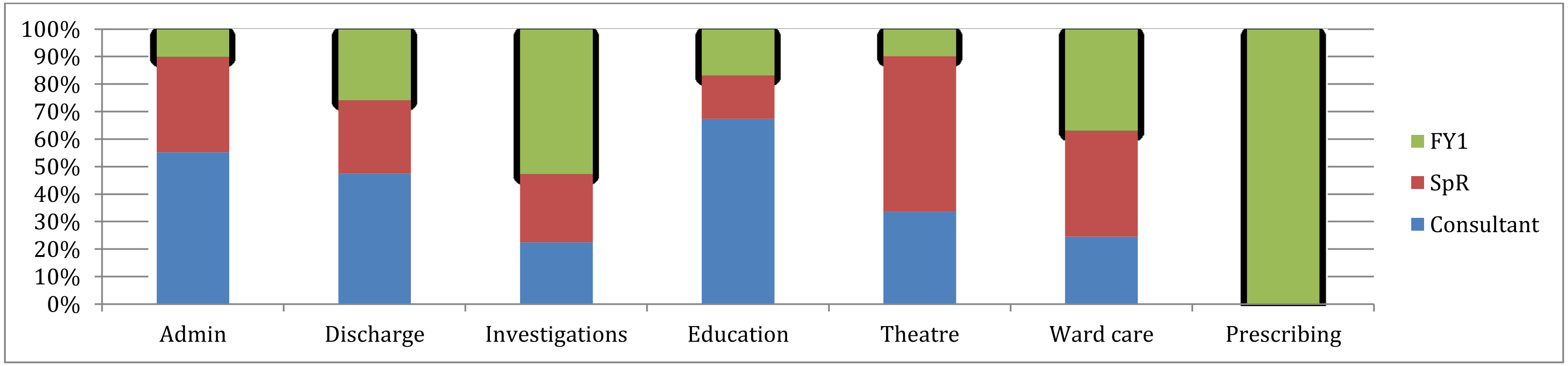
Administrative comments were initiated more frequently by consultants than other participants and received more frequently by FY1s but there was no significant difference (n=58, p=0.11). The FY1s and consultant initiated communications about patient discharge with greater frequency than the registrar (n=188, p=0.003). Communication episodes regarding patient investigations were initiated by the FY1s in large numbers and most commonly received by the consultant (n=310, p<0.001). There were small numbers of communications regarding education so these were compared using Fisher's exact test rather than chi-squared, there were no significant differences (n=27, p=0.49). There were also no significant differences between the number of initiated and received communications regarding the operating theatre (n=66, p=0.27). FY1s initiated communications regarding ward care significantly more often than other participants (n=357, p<0.001). It was not possible to compare the number of initiated and received communications regarding prescribing. These results are summarised in **Table 7B** and **Figure 7F**.

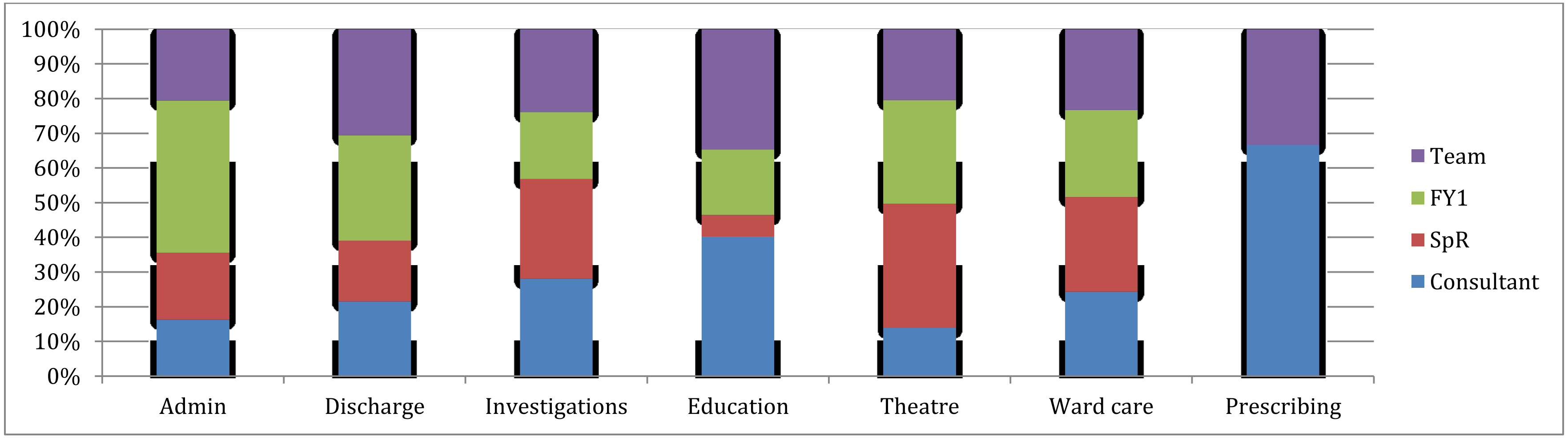
Table 7B Comparison of communication by clinical domain

N.B Cons=Consultant, SpR=Specialty Registrar, X^2 is the Chi-Squared value.

	Grade	Frequency initiated	Frequency received	Total	X^2	p
Admin	Cons	20	6	58	4.42	0.11
	SpR	6	6			
	FY1	10	10			
Discharge	Cons	45	25	188	11.33	0.003
	SpR	12	17			
	FY1	67	22			
Investigations	Cons	23	56	310	118	<0.001
	SpR	12	48			
	FY1	147	24			
Education	Cons	9	8	27	Fisher's test	0.49
	SpR	1	1			
	FY1	6	2			
Theatre	Cons	15	6	66	2.6	0.27
	SpR	12	13			
	FY1	12	8			
Ward care	Cons	39	50	357	69	<0.001
	SpR	29	47			
	FY1	160	32			

Figure 7F Initiators (top) and recipients (bottom) of communication by clinical domain





7.4.4 Response times to communication

The response time (in minutes) to each communication event was recorded along with the grade of participant, the communication type and clinical domain. In instances where the response was to multiple queries the data was excluded from analysis. Data was also excluded where the response time was greater than 90 minutes as participants felt these instances were very likely to be due to technical difficulties including phones being turned off in teaching or long difficult operations where communication could not be responded to.

Response time to communication by grade: The consultant responded to 193 communication events in a median time of 7 minutes, the registrar responded to 174 communication events in a median time of 2 minutes and the FY1s responded to 177 communication events in a median time of 3 minutes. A Kruskal-Wallis test revealed a significant difference between these response times ($H(2)=41.3$, $p<0.001$) with Mann-Whitney tests revealing significant differences between the overall response times of consultant compared to registrar ($p<0.001$), consultant compared to FY1 ($p<0.001$) and registrar compared to FY1 ($p=0.007$). These results are summarised in **Table 7C**.

Response time by communication types: There were 43 administrative questions responded to in a median time of one minute. Clinical questions were responded to 193 times with a median response time of five minutes. Informative comments represented 181 responses with a median response time of three minutes. Lastly, 110 instructive comments were responded to in a median time of 2.5 minutes. There was a significant difference between these response times ($H(3)=13.05$, $p=0.005$, administrative questions v clinical questions, $p=0.006$, clinical questions v instructive comments, $p=0.003$ and informative comments v instructive comments, p=0.019. All other comparisons revealed no statistically significant differences between communication types. These results are summarised in **Table 7C**.

Response time by clinical domain: There were 64 communications discussing administration answered in a median time of two minutes. Responses to communications regarding patient investigations (149), the operating theatre (32) and ward care (171) were answered in a median time of three minutes. The 75 responses regarding patient discharge and 12 responses regarding education were answered in a median time of four minutes. Responses to 24 prescribing questions took a median time of six minutes. A Kruskal-Wallis test for response time by clinical domain revealed no significant difference (H(6)=3.5, p=0.739). These results are summarised in **Table 7C.**

Table 7C Response times to communication by grade, communication type and clinical domain

		Events (n)	Median	Min	Max	Range
Grade of responder	Consultant	193	7	1	88	87
	SpR	174	2	1	73	72
	FY1	177	3	1	84	83
Communication type	Admin question	43	1	1	64	63
	Clinical question	193	5	1	75	74
	Informative	181	3	1	88	87
	Instructive	110	2.5	1	46	45
Clinical area	Admin	64	2	1	64	63
	Discharge	75	4	1	70	69
	Education	12	4	1	35	34
	Investigations	149	3	1	84	83
	Prescribing	24	6	1	43	42
	Theatre	32	3	1	88	87
	Ward care	171	3	1	75	74

Comparing response times by grade and communication type: There was no significant difference between the response times for administrative questions ($H(2)=1.5$, $p=0.468$) or instructive comments ($H(2)=0.075$, $p=0.963$) when each grade of participant was compared. When response times for clinical questions were compared by each grade there was a significant difference ($H(2)=28.9$, $p=<0.001$, consultant v registrar, $p<0.001$, consultant v FY1, $p=0.024$ and registrar v FY1, $p=0.006$). There was also a significant difference between response times by each grade for informative comments ($H(2)=14.4$, $p <0.001$, consultant v registrar, $p<0.001$).

Comparing response times by grade and clinical domain: There were no significant differences between the response times by each grade for communications regarding education (consultant v FY1 only as there were no registrar responses, p=0.142), investigations (H(2)=4.2, p=0.123) and prescribing (H(2)=0.629, p=0.730). There were significant differences when the response times by each grade of participant were compared for communications regarding administration (H(2)=8.8, p=0.012, consultant v registrar, p=0.005 and registrar v FY1 p=0.03), patient discharge (H(2)=11.3, p=0.003, consultant v registrar, p=0.003 and consultant v FY1, p=0.008), prescribing (H(2)=8.9, p=0.012, consultant v FY1, p<0.001) and ward care (H(2)=29.2, p<0.001, consultant v registrar, p<0.001 and consultant v FY1, p<0.001).

7.4.5 Participant's perceptions of how use of WhatsApp affected the culture within the team and the escalation of care pathway

WhatsApp was used to facilitate communication between members of the emergency general surgery team as well as improving the speed with which care could be escalated and urgent decisions could be made and communicated: *"EH in HDU, I'm worried she's got pulmonary oedema so I've stopped fluids, put her on Oxygen, doing a chest x-ray and giving 20mg intravenous Furosemide"* (FY1) *"Good. Let's get urgent medical registrar review as well please"* (consultant). This example illustrates how the FY1 can escalate care rapidly to a senior clinician. In this instance the consultant felt they had implemented the correct initial management and recommended liaison with a specialty team who are experienced in dealing with cardiorespiratory failure.

Another example shows how the whole team could have input into an escalation of care episode. In this situation, the registrar initially felt they could deal with the clinical problem, however, the consultant saw the need to intervene: *“Patient MD (reversal jejunostomy) has Hb 7.4, WCC 26.1, CRP 68, obs stable, will go see soon”* (FY1) *“Hb will be chronic so don’t worry”* (registrar) *“What was pre-op Hb?”* (consultant) *“11.3”* (FY1) *“Maybe not then”* (registrar) *“Lets get urgent USS abdo and transfuse a couple of units, she may be bleeding intraluminally”* (consultant).

There were also instances where potential patient safety events were avoided through use of WhatsApp: *Shall I restart Aspirin and Clopidogrel for subarachnoid haemorrhage patient?”* (FY1) *“No, don’t restart. Please check with Cardiology”* (consultant).

7.4.6 Examples of participant’s reflections on WhatsApp for communication: Participants were asked to reflect on how the use of WhatsApp has affected their work during the course of the study. Both junior and senior participants felt that the ability to send a quick message rather than make a phone call was helpful and efficient: *“I like being able to send a message about basic questions that require a simple answer”* (FY1). Junior participants also appreciated the increased level of support they felt WhatsApp gave them *“The fact I can just send a quick update about patient care to the registrar or consultant is very reassuring”* (FY1). The consultant was grateful for the increased level of supervision WhatsApp gave him: *“The fact that I can constantly monitor what my team is doing for my patients allows me to step in when needed but leave them to it at other times. This reassures me and my juniors whilst giving them a sense of* *independence as non-response to an informative comment provides feedback to the sender that I am in support of what they are doing."*

The registrar felt that WhatsApp helped to remove communication barriers between junior and senior colleagues by flattening the traditional hierarchy: *"I feel that this system has encouraged the juniors to keep us updated, even about things they think are minor. They may not take the trouble to bleep us with informative updates to avoid disturbing us in theatre but are very happy to send a WhatsApp message."* The registrar also felt that WhatsApp made coordination of the team easier: *"Being able to update several people at once about where a ward round is starting or when a theatre case is being sent for is a real time-saver."* All of the participants felt positive about using WhatsApp for clinical communication during the study period and as a result the acute general surgery team decided to continue using this method of communication in the future.

7.5 Discussion

This study investigated the use of WhatsApp in surgical teams, through a combination of quantitative and qualitative methodology. This is the first study of its kind that investigates how such a communication system operates within a clinical team and quantifies both the direction and type of communication between doctors. Facilitating supervision, communication and escalation of care using improved communication methodology can be achieved through simple innovations. The prevention of avoidable patient harm may also be augmented by innovative communication technology but core clinical skills and human factors also require improvement and this will require a team-based approach and a good safety culture.

This mixed-methods study aimed to identify the interprofessional communication pathways used through WhatsApp; evaluate the response times to communication for different communication types, domains and clinician grades; and explore participant's perceptions of how increased supervision of junior team members provided by WhatsApp affected the team culture and escalation of care pathway. The findings will be discussed in relation to these aims and their context within the wider literature will be considered. Following this the implications for the field of surgery will be discussed, taking the strengths and limitations of this study into account. Lastly, some conclusions will be presented.

7.5.1 Summary of findings and context within the literature

Identification of interprofessional communication pathways using WhatsApp: The main protagonists of communication within the team were the

FY1s. They initiated the most communication episodes, and, though they received fewer communications from other team members they were still the most heavily involved members of the team. The reasons for this are two-fold. Firstly, there were two FY1s within the team and only one registrar and consultant so it is not surprising that the volume of communication arising from the FY1s is greater than that of other participants. Secondly, the FY1s initiated a large volume of clinical questions, which gives a good insight into their role within the team. It is also worth noting that the team was the most frequent recipient of communication episodes. When the team received communication this means that the episode was initiated with communication that was not specifically addressed to any particular team member or began with a generic greeting such as “hi” or “guys”. The large volume of communication received by the team reflects the participant’s confidence in the communication system and the fact that all participants could see all communication events, unlike when a pager is used and the communication is limited to a two-way conversation by default.

Regarding the type of communication events, clinical questions were the most frequent, followed by informative, instructive and administrative comments. The FY1s were most likely to initiate communication with clinical questions and informative or administrative comments. The team received the most informative comments. However, reflecting the interprofessional nature of communication analysed within this study, frequently, there were several types of communication utilised in each episode.

Regarding the clinical domain of communication, the heaviest frequency of episodes concerned ward care and patient investigations.

Response times to communication: For all communication types, the consultant tended to be slower to respond than both the registrar and FY1s. This may be a reflection of higher workload. This is important from the patient perspective as the consultant is responsible for the team and must be contacted when definitive decisions about patient care need to be made[210]. Regarding communication type, clinical questions were responded to more slowly than other types of communication and this may be due to their relative complexity compared to other communication types. A simple administrative question or instructive comment may only require a short, quick response but a clinical question often requires a doctor to review a patient or at least check a test result, therefore the reply takes longer. Regarding the clinical domain of communication, there were no significant differences.

Supervision and escalation of care: The greatest potential benefit from using systems such as WhatsApp is the increased involvement and supervision from the consultant surgeon. The consultant is in a position to constantly oversee what is happening within the team. This allows them to step in whenever an escalation of care episode occurs, especially if the patient deterioration is not recognised by more junior team members of if the patient is about to be treated inappropriately. Previous chapters in this thesis have discussed the harm patients are susceptible to when escalation of care is not initiated promptly, especially if the incorrect diagnosis has been made or the initial treatment is not correct.

This study provides a unique insight into the importance of supervision of junior clinicians. It is interesting to consider the role of the registrar within the team. There were instances in the study where they gave advice, which was quickly corrected by the consultant. Whilst the maintenance of high-quality patient care underpins the role of any medical professional, a degree of autonomy and independence is also required, to allow clinicians to develop their skills.

As this work is taken forward care must be taken to ensure that the autonomy of developing decision-makers in the team (such as the registrar) is preserved to avoid prolonging their learning experience. It is also noteworthy that this study also discovered several instances where drug errors were prevented through use of WhatsApp. Whilst drug errors are not strictly a part of the escalation of care process, they are an important cause of medical error, and if left undetected, may lead to deterioration and the requirement for escalation of care for a patient further down the line. A good example of this is seen in the results where a swift reply from the consultant advising the FY1 to seek specialist advice prevented a potentially lethal error. Whilst this thesis principally focuses on escalation of care, some of the interventions and teachings within it will spill over into other areas of medicine.

There is a paucity of literature that examines healthcare worker's response times to communication, this is an important subject and deserves greater focus. Research on medical emergency teams has revealed that ineffective communication methods can lead to treatment delays and failed escalation of care[85,97]. Worse still, studies have highlighted that patients are subject to significant harm due to poor communication[211,212]. Human factors such as hierarchical barriers and inadequate information transfer techniques contribute to these failures[213]. In this study the threat to patient safety presented by these factors was successfully overcome through the use of WhatsApp and determination of the participants to improve team communication. A flattened hierarchy is a key component of safe surgical care and this mantra was reinforced by the findings in this study.

The fact that almost all health professionals in the USA and UK now carry mobile phones (and increasingly smartphone devices) has disrupted the way many clinical teams are communicating[214]. WhatsApp represents a successful technological innovation that effectively replaced the pager over a short time period and continues to be used well after the period of this trial ended. The findings of this study are in agreement with research showing that handheld computers improve efficiency, clinical decision-making and documentation practice[215]. These positive aspects may have an effect on the quality and safety of healthcare delivery.

7.5.2 Implications

This study has shown how increased supervision of junior team members may facilitate escalation of care and improve safety for patients. However, human factors and non-technical skills must also be taken into account. Future research could seek to determine how well communication tools such as SBAR and innovations such as WhatsApp work together. Successful interventions in this area should aim to include strategies for improvements in both the content (e.g. SBAR) and mode (WhatsApp) of communication.

7.5.3 Strengths and limitations

Efforts to make changes in healthcare are often ambitious and employ a whole-system goal[216]; the use of a more modest initial target in this study may have

contributed to its success. Computer-based innovations supporting decision-making have been successful in improving the safety of medication prescribing. The barriers overcome by these systems, of which WhatsApp is an example, may be a platform for further successful innovation in the healthcare communication sector[217]. Further development of healthcare communication technology will need to include the integration of direct access to patient information[218].
This study involved an entire population rather than a sample, eliminating the potential for participant bias. Consecutive weeks of data collection mean that selection bias was also not an issue. There was no observer bias or measurement bias as the ability to record; date and time stamp clinical communications removed any interpretation error. Detailed qualitative analysis of team perceptions allowed in-depth exploration of participant's receptiveness to WhatsApp. The statistical analysis presented in this study allows the crucial role of hierarchy within the team to be explored in detail, something that has not previously been researched in surgical teams outside of the operating theatre.

The use of a single-centre and exploration of communication in emergency surgery only may limit the application of the findings to other hospitals and specialties. There was an absence of out of hours communication in this study and further work is required to evaluate the use of WhatsApp and other communication tools between different healthcare staff (e.g. nurses). There was no comparison of any communication outside the WhatsApp platform, nor an assessment of the quality of communication; these areas were outside the scope of this study. Furthermore, the communication pathways may be different in private healthcare institutions, limiting the generalisability of the findings to academic centres. Consideration of wireless network coverage and hospital dead-zones (areas without wireless service) will be needed as this system is expanded into other clinical domains and institutions.

7.5.4 Conclusions

The findings of this study provide a novel and detailed examination of the communication pathways between members of a surgical team involved in escalation of care. It meets the current need for evaluation of communication methods in healthcare[219]. The WhatsApp platform was deemed to be user-friendly and was extensively used to facilitate communication, and escalation of care within a team where junior physicians rotate on a weekly basis. In addition, significant benefits were realised through a system in which senior physicians had a constant overview of activities undertaken within their team without active interference, allowing their juniors to develop a degree of clinical independence at minimal risk to patient safety.

WhatsApp was perceived to be a simple and efficient innovation for communicating within a surgical team. It helped flatten the traditional hierarchy between team members thereby overcoming the human factor barriers to effective escalation of care. This study illustrates the potential for simple technological innovation to improve patient safety. In doing so it lays the groundwork for both technology development and implementation.

8 Measuring information transfer during escalation of care: Development and validation of the QUality of Information Transfer tool

---

8.1 Introduction

The escalation of care process has been shown to be amenable to intervention in the areas of communication technology and escalation protocols based on human factors and flattened hierarchies. The former was dealt with in chapter 7 whilst the latter will be discussed and investigated in the remaining chapters. Chapter 7 demonstrated how innovation of technology could facilitate interprofessional communication and improve the safety of clinical supervision and escalation of care. However, there was no quantitative evidence showing that escalation of care had improved, just the perceptions of participants.

With the ultimate aim of this thesis, and future work in this area, being the implementation of interventions to improve escalation of care, it is critical to ensure that any improvement can be objectively measured. This is the penultimate step in this thesis. The beginning chapters dealt with exploring escalation of care, the middle chapters involved the development of ideas for successful intervention in the escalation of care process. This chapter links the development of interventions to their implementation and analysis. Before any improvement in escalation of care secondary to an intervention can be demonstrated, validated metrics to measure the core skills required to conduct the process successfully must be available. As a metric for this purpose is not currently available, one must be developed.

The two core skills required by the initiator of escalation of care are:

1. Recognition of patient deterioration through patient assessment, and;
2. Effective transfer of critical information to a senior colleague.

Regarding recognition of deterioration, metrics have already been developed that can objectively measure the quality of a patient assessment. The Surgical Ward care Assessment Tool (SWAT) was developed on a high-fidelity simulated ward in London and includes scales for both patient assessment and management[33]. In addition the Global Assessment Toolkit developed, content-validated and reliability-assessed by Hull et al. is a psychometric toolkit which includes a tool to measure the quality of patient assessment skills in surgery and is appropriate for use in deteriorating patients[220]. In addition, metrics have been developed to measure the quality of postoperative handover (transfer of a patient from the theatre complex to the ward or intensive care unit). However, these assess face-to-face communication rather than telephone referrals, which are more commonly used to refer patients to senior colleagues during escalation of care[40].

Although there has been an exponential rise in the number of metrics to assess non-technical skills (e.g. Observational Teamwork Assessment for Surgery[103], Anaesthetists' Non-Technical Skills[221] and NOn-TECHnical Skills[222]) in the past decade, these have largely concentrated on the operative environment, often neglecting the high risk and inherently stressful nature of the surgical ward. In contrast, communication guides, such as the Situation-

Background-Assessment-Recommendation (SBAR) tool have been developed. However, the SBAR tool was produced to help nurses and junior surgeons structure their communication rather than to measure the quality of information transfer. Therefore, perhaps unsurprisingly, reports suggest that SBAR has not improved critical information transfer during the referral process[223].

It is noteworthy that, whilst tools exist to measure patient assessment skills in the setting of patient deterioration, there are no available metrics to measure the quality of information transfer during escalation of care for surgical patients. If the information transfer is not of high-enough quality, a senior clinician may not actually come to the ward to assess the patient. This crystallises the crucial role that information transfer may play in escalation of care and failure to rescue. An evidence-based, validated, reliable and feasible metric for objectively measuring the quality of information transfer needs to be developed before information transfer during escalation of care referrals can be improved.

8.2 Aims

1. To develop the QUality of Information Transfer (QUIT) tool;
2. To generate evidence for the reliability and validity of the QUIT tool in the simulated environment, and;
3. To assess the feasibility of using the QUIT tool in the clinical environment.

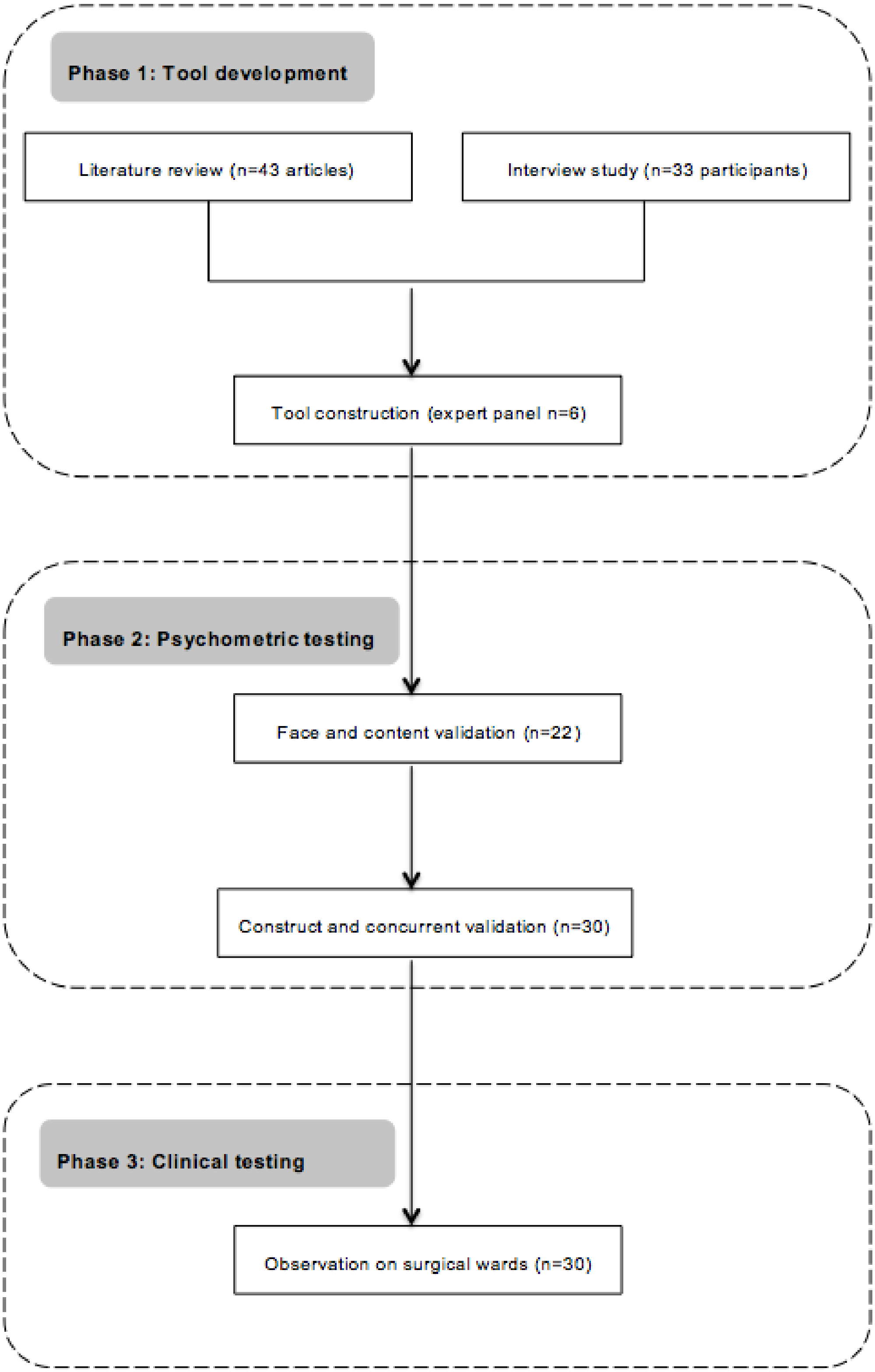
8.3 Methods

This study comprised three phases. Phase 1 involved development of the QUIT tool through a literature review and semi-structured interviews with stakeholders to identify best evidence for core skills required for effective information transfer. Phase 2 aimed to assess the face, content, construct and concurrent validity and the reliability of the QUIT tool using psychometric methodology. Phase 3 used direct observation to provide evidence for the feasibility of the tool in the clinical environment (see **Figure 8A**).

8.3.1 Phase 1

Literature review: A comprehensive review of the literature was conducted to identify the necessary components of successful information transfer for escalation of care. The Ovid Medline database was searched using the following keywords and their combinations (medical subject headings are indicated in parentheses): ‘escalation of care’, ‘referral’ (MeSH), ‘communication’ (MeSH), ‘quality assessment’, ‘patient handover’ (MeSH) and ‘surgery’ (MeSH). These terms were then combined with the term ‘information transfer’ using the Boolean conjunction ‘AND’. The reference lists of selected articles were hand-searched to identify additional relevant studies. The components of effective information transfer were synthesised from selected articles by two independent researchers. Any conflicts were resolved through consultation with a third researcher and then the research team. Reports were not excluded based on specialty or methodology to allow comprehensive capture of evidence for the QUIT tool.

Figure 8A Study procedure



Semi-structured interviews: Senior surgeons (consultant and year-5 registrars and above) and junior surgeons (FY1 or FY2 level) from general surgical specialties were recruited purposively for interview in three London hospitals. The rationale behind this was that data could be collected both from a top-down and bottom-up perspective, allowing a holistic picture of escalation of care information transfer practices in UK hospitals. Surgical ward nurses were also interviewed to ensure a multiprofessional approach to development of the tool. Participants were interviewed individually in order to gain a detailed understanding of their experiences of the communication phase of the escalation of care process. Interviews were semi-structured by a topic guide developed by the research team[117]. The following key questions were asked of each participant:

1. In which clinical situations should junior surgeons and nurses escalate care?
2. What information should be transferred to a senior surgeon to allow them to make an informed decision about a deteriorating patient?

Each interview was conducted with informed consent, audio-recorded and transcribed verbatim. To ensure methodological rigour each transcript was member-checked and re-read by researchers to ensure immersion in the data. Grounded theory methodology was then used to identify emergent themes by two independent researchers before triangulation of the dataset to ensure complete data capture[117,224].

Drafting of the QUIT tool: Finally, the research team evaluated the results of the literature review and interviews to construct the tool. The research team had backgrounds in surgery (n=2), patient safety (n=2), and validation methodology/psychometrics (n=2). All potential components of information transfer during escalation of care that were derived from the literature review and semi-structured interviews were reviewed by the team and key components to be included in the draft of the tool were selected through group consensus.

A five-point Likert scale (1=strongly disagree, 5=strongly agree) was employed for each of the items included in the tool, which were placed into one of seven core categories for information transfer during escalation of care. The alternative to using a Likert scale would have been to use simple yes/no ratings. However, the tool needed to be as sensitive to variations in individual performance as possible so the Likert scale was selected. The initial draft was then piloted with clinicians, nurses and researchers to ensure that the language used was understandable. Based on this small pilot, several iterations were produced within a plan-do-study-act cycle, to ensure it was ready for validation[225].

8.3.2 Phase 2

Face and content validity: A group of 22 clinicians and nurses was asked to complete a questionnaire to assess face and content validity. A five-point Likert scale was used to assess the level of agreement and the content validity index (CVI) was calculated by computing the proportion of ratings of four or higher. The CVI value gives an indication of the relevance of an item to the overall research question being pursued. If a category or item achieved a CVI value of $\geq$ 0.8, it was considered to be highly relevant[226]. Items with a CVI of >0.6 but <0.8 were considered to be acceptable with the caveat that they be discussed by the research team prior to a decision being made on inclusion or exclusion from the tool[227].

Construct validity: Construct validity denotes the ability of the QUIT tool to measure differences in the quality of information transfer during escalation of care. To assess the construct validity of the QUIT tool 15 senior (consultants and year-5 registrars and above) and 15 junior surgeons (FY1 or FY2) were recruited from four London hospitals using purposive sampling techniques and their performance in terms of information transfer was compared.

Participants followed the study protocol shown in **Figure 8B**. Each participant was asked to assess a deteriorating actor-patient in a previously validated high-fidelity ward simulator[33], once they had completed an assessment of the patient they made a referral to a senior colleague over the telephone. Each scenario ended with a debriefing for the participants to further their own training and skills.

The scenario used in this study was developed using the American College of Surgeons (ACS) surgical skills curriculum for residents developed at Tufts University (module 6: postoperative pulmonary embolism). The reason for using this material was that it had already been validated for use in a curriculum for surgical trainees and, as such, did not require validation itself within this study. Furthermore, the material provided by the ACS is comprehensive and allows the researcher to ensure that the simulation is set up in exactly the same way each time it is conducted. An actor playing the role of a ward nurse, patient casenotes, vital signs charts and investigation results were made available for each participant. The participant stem described a deteriorating post-operative patient with respiratory distress (see **Figure 8C**). Each referral was audio and video-recorded with informed consent to allow for independent rating by trained researchers (see **Figure 8D**). Construct validity was demonstrated for each item if a Mann-Whitney test comparing senior and junior scores was found to show a significant difference. Inter-rater reliability was calculated using the intra-class correlation co-efficient (values ≥ 0.7 indicate good reliability) and internal consistency of the tool items and categories was assessed using Cronbach's alpha.

Figure 8B Simulated scenario protocol

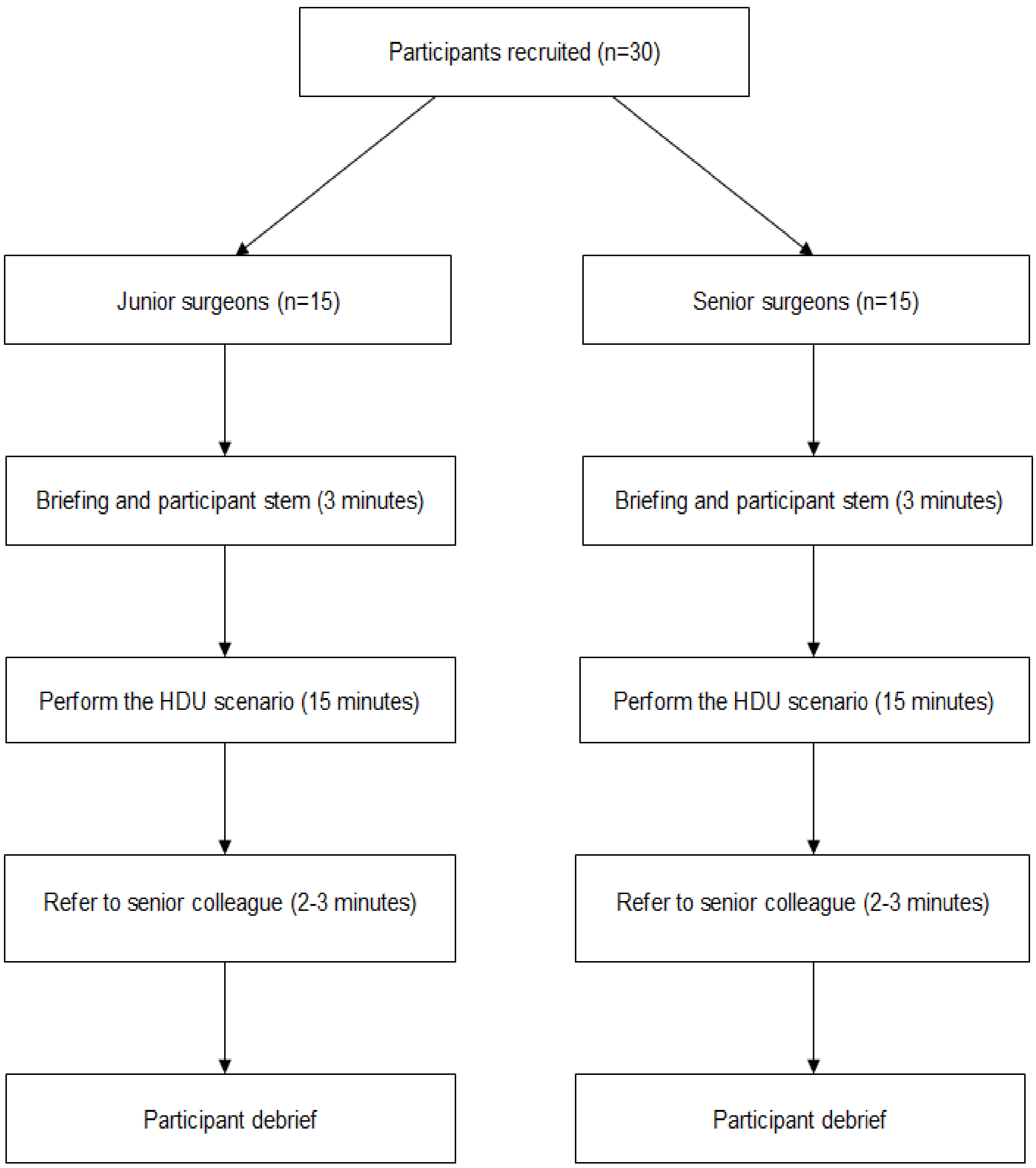
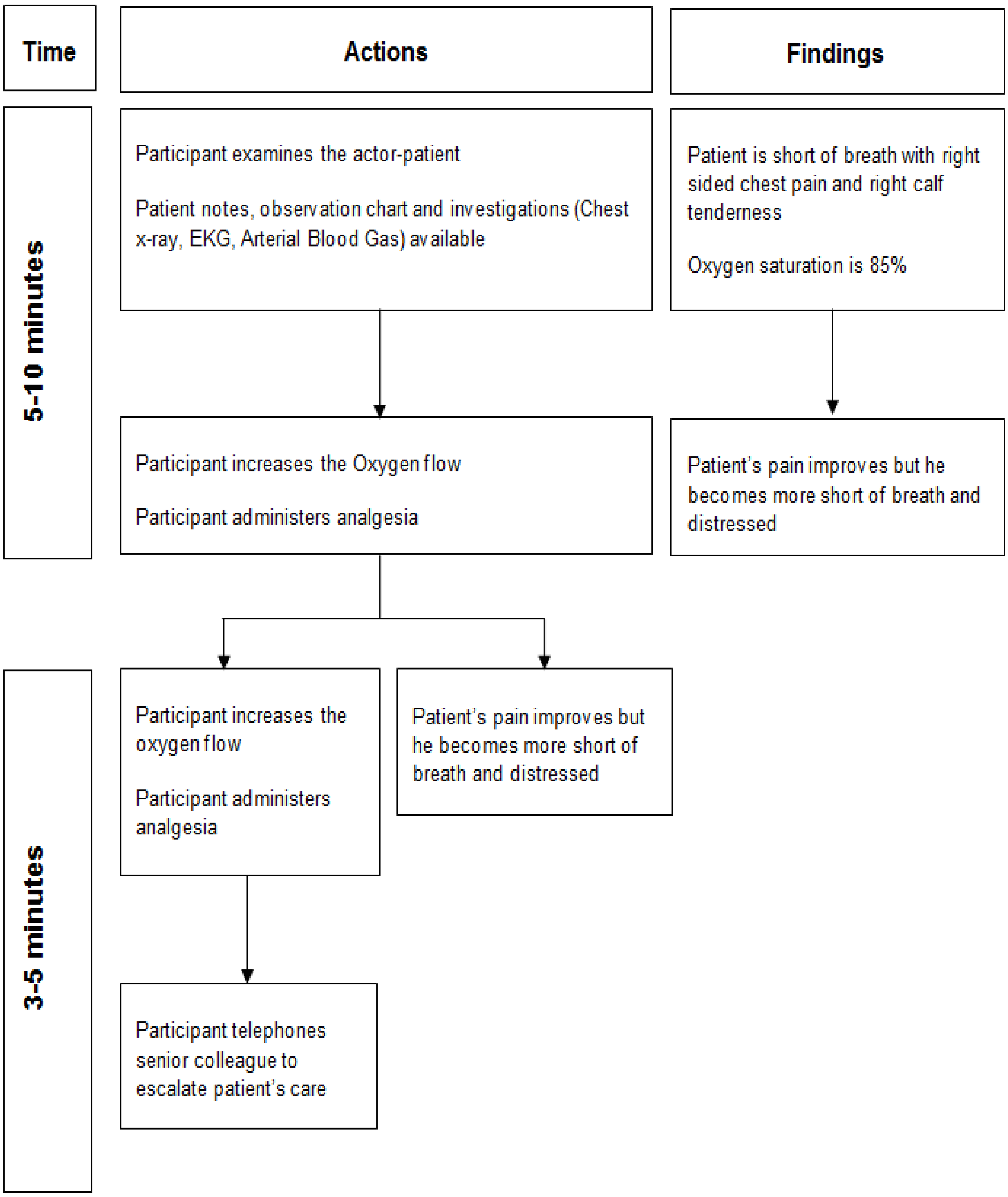


Figure 8C Simulated patient scenario flow diagram



Concurrent validity: Concurrent validity was demonstrated by comparing the scoring by two independent researchers for all participants using the QUIT tool and the SBAR communication tool adapted by Cunningham et al.[223] to assess the telephone referral skills of surgical interns (FY1s) in Australia. The point biserial correlation[228] was used to compare the dichotomous scores from the SBAR tool with the ordinal data from the QUIT tool. A correlation value (r) of $\geq$ 0.5 is considered a moderate positive relationship and a value of $\geq$ 0.7 is considered a strong positive correlation.

Reliability: Two independent researchers conducted scoring of all participants' referrals twice each, at least one month apart. These original scores ('test') and subsequent ('re-test') scores were compared using the Wilcoxon test to assess for the reliability of the QUIT tool. To be considered reliable the test and re-test scores would have a strongly positive correlation and not be significantly different. For all analyses in this study significance was taken at a level of $p<0.05$.

Figure 8D Simulation ward set-up

8.3.3 Phase 3

Clinical testing: In order to provide feasibility evidence for the QUIT tool in the clinical environment, real-time escalation scenarios were observed directly. It is very important to conduct feasibility analysis of a tool that is tailored for use in the clinical environment. The generation of evidence for validity does not allow the researcher to establish that the tool is practically useable (and useful) in the clinical environment. In-situ testing of the tool was deemed necessary to ensure that it could be used to measure the quality of information transfer during escalation of care contemporaneously, on the surgical ward.

Two independent researchers conducted observation sessions on surgical wards in two London hospitals with appropriate approvals secured beforehand. The researchers observed and scored 15 referrals each using the QUIT tool, aiming to score the information transfer during escalation of care in real-time, rather than retrospectively. Both nurses and junior surgeons were observed escalating care to ensure data collection was interprofessional. Data were analysed using SPSS Statistics (version 21) to compare scores for the nurses and doctors. The median, range and p-value (calculated using the Mann-Whitney test) were reported.

8.4 Results

8.4.1 Phase 1: Tool development

Literature review: A total of 43 articles reported components of effective information transfer in healthcare and were selected for inclusion from a total of 456 citations. Forty-one original research articles and two literature reviews were included. Of these there were three that employed qualitative methodology and 23 articles from the field of surgery. Other clinical specialties included paediatrics, internal medicine, general practice and emergency medicine. Full results of the literature review are displayed in **Table 8A**.

Semi-structured interviews: A total of 33 interprofessional healthcare staff including 16 senior surgeons, 11 junior surgeons and six surgical ward nurses were recruited for interview. The interviewees provided rich qualitative data regarding their perceptions of important components of information transfer, specific to surgery.

The different components of information transfer from the literature review and interviews were recorded on a database and through identification of frequent themes; seven key categories for information transfer were developed, which contained a total of 24 different items. These themes form the structure for the QUIT tool. Details of the data used to formulate the QUIT tool can be found below along with verbatim quotations from the interviews.

Table 8A Literature review articles and identified categories

			Category						
First Author (ref)	**Methodology**	**Subjects and Setting**	**Communicator Identities**	**Patient Identity**	**Clinical Details**	**Problem**	**Plan**	**Information Presentation**	**Overall Quality**
Adhiyaman et al.[229]	Observation study	200 discharged patients, UK			√				
Agarwal et al.[230]	Prospective observation study	Paediatric clinical team, USA		√		√			
Anwari.[231]	Survey study	276 patients, PACU, Saudi Arabia						√	√
Archbold et al.[232]	Survey study	GP surgeries, UK						√	
Bertrand et al.[233]	Retrospective case series	30 patient notes, France		√	√	√			
Catchpole et al.[234]	Interview study	F1 teams and 10 clinical staff, UK				√		√	
Clark et al.[235]	Prospective intervention study	General surgery registrars and Faculty, USA			√	√			
Craig et al.[236]	Prospective intervention study	Paediatric clinical team, UK				√	√	√	
Fair.[237]	Retrospective case series	Discharged patients, UK		√	√	√			
Foster et al.[238]	Audit	244 patient discharge notes, 4 GP surgeries, Scotland		√					
Greenberg et al.[239]	Retrospective case series	60 surgical malpractice claims, USA		√		√	√	√	
Horwitz et al.[240]	Prospective intervention study	Emergency department staff, USA							√
Joy et al.[241]	Prospective intervention study	79 paediatric patients, cardiac ICU, USA				√			
Karakaya et al.[242]	Prospective intervention study	48 paediatric patients, cardiac centre, Belgium			√		√		
Kendrick et al.[243]	Prospective observation study	110 discharged patients, UK				√			
Kripalani et al.[244]	Literature review	No subjects, USA				√	√		√
Lissauer et al.[245]	Retrospective case series	133 neonates, UK						√	
Mageean.[246]	Retrospective case series	Patient notes, General Practice surgery, UK			√	√			
Manser et al.[247]	Literature review	No subjects, Switzerland	√	√	√	√	√	√	√
Manser et al.[248]	Prospective intervention study	126 patients, UK hospital	√			√	√	√	√
Marks et al.[249]	Randomized controlled trial	60 paediatric patients, Australia						√	√
Nagpal et al.[250]	Prospective intervention study	50 staff, 100 patients, UK and Switzerland		√	√	√			

Nagpal et al.[203]	Interview study	18 staff, UK		√	√	√		√	
Nagpal et al.[251]	Prospective observation study	20 patients, UK		√	√	√			
Nagpal et al.[212]	Survey study	50 surgical staff, UK		√	√	√	√	√	
Pantilat et al.[252]	Survey study	1,030 Primary Care Physicians, USA		√					
Penney[253]	Prospective observation study	104 discharged patients, UK			√				
Petrovic et al.[254]	Prospective intervention study	238 staff, 60 patients, CSICU, USA	√						
Pickering et al.[255]	Prospective intervention study	Senior and junior ICU staff, Ireland	√			√	√		√
Rao et al.[256]	Prospective intervention study	150 patients, USA							√
Rudiger-Sturchler et al.[257]	Prospective intervention study	Emergency department staff, Switzerland						√	
Salerno et al.[258]	Prospective intervention study	34 FY1s, Medical ward, USA						√	
Sandler et al.[259]	Randomized controlled study	289 discharged patients, UK	√						
Scott et al.[260]	Prospective intervention study	Paramedics and Trauma physicians, USA		√	√				
Sevdalis et al.[35]	Observation study	Theatre staff, UK	√						
Smith et al.[261]	Observation study	17 anaesthetists 15 nurses, UK	√				√		√
Symons et al.[262]	Observation study	Medical handover team, UK	√	√	√	√	√	√	√
Telem et al.[263]	Prospective intervention study	45 surgical registars, USA	√						
Tulloch et al.[264]	Retrospective case series	546 discharge reports, UK		√	√	√			
van Walraven et al.[265]	Randomized controlled study	293 patients, Canada						√	√
Wayne et al.[266]	Prospective intervention study	Surgical registrars, USA		√		√	√	√	
Webster et al.[267]	Randomized controlled study	36 participants, USA						√	
Zavalkoff et al.[268]	Prospective intervention study	33 staff, Paediatric ICU, USA		√	√	√			

N.B PACU=Post-Anesthesia Care Unit, GP=General Practitioner, F1=Formula 1, ICU=Intensive Care Unit, CSICU=Cardiac Surgical ICU

Category 1: Communicator identities – The importance of establishing the identities of those participating in the information transfer was emphasised by nine articles, which stated that the clinical specialty and grade should also be included. Disclosing identity early was found to create rapport and reduce tension between colleagues[35,248,269].

Category 2: Patient identity – The name of the patient, including a unique identifier such as their date of birth, was identified by 16 articles. Other important details were the location of the patient, their hospital number and the name of their responsible consultant[239,264,270].

Category 3: Clinical details – The patient's relevant past history (including recent surgical procedures), current treatments and working diagnosis were identified by 16 articles. The surgical history was frequently identified as crucial[40,212]. The current treatment was particularly important for the interview participants with a junior surgeon stating: *"I make sure I initiate the first steps of the emergency management pathway prior to calling."*

Category 4: Problem – The current problem with the patient was identified by 22 articles. The patient's vital signs and recent investigation reports were frequently mentioned[40,236,271]. The inclusion of salient points only[236] whilst including sufficient detail[234,272] was identified as a difficult balancing act for junior surgeons.

Category 5: Plan – 11 articles identified the importance of concluding the information transfer with a clear plan for the patient's management. Questions or ambiguities over patient care were to be avoided[212,244,273]. One of the senior surgeons exclaimed, *"they* [junior surgeons or nurses] *must have all the information that is required* [for me] *to make a considered decision".*

Category 6: Information presentation – There were 17 articles that identified the necessity for good communicators to have strong non-technical skills. The clarity[232,258] and structure[265,274] of communication and avoidance of interruptions[275] were frequently mentioned. One of the nurses explained that the way information is packaged can impact on the success of the referral: *"On some occasions you might think the patient looks really unwell, the way you communicate can determine whether someone comes to see them quickly."*

Category 7: Overall quality – The importance of providing a score that rated the overall quality of the information transfer was raised by 11 articles. Receiver satisfaction[249,256] and areas for improvement[231] were highlighted as effective methods of packaging a global rating score. **Table 8B** shows the components of information transfer during escalation of care that were common themes identified from the interview transcripts.

8.4.2 Drafting of the QUIT tool

The research team combined the findings extracted from the literature review and interviews into a version of the QUIT tool that was ready for simulation testing.

Table 8B Components identified from interview transcripts

Item	Quote supporting component (S=senior surgeon, J=junior surgeon, N=surgical ward nurse)
Reason for the call	"If the patient looks acutely unwell and I don't really know what's going on then I would call for help urgently" (J)
Vital signs	"I'd want to know what the vital signs are...I'm busy in theatre and I've really got to know that this is a dire emergency" (S)
Initial diagnosis and management	"I would want to be sure that they have initiated first steps of the diagnostic or management pathway" (S)
Examination and investigation findings	"They must see the patient. They must have all of the information that is required to make a considered decision" (S)
Clinical problem and history	"A quick history with important background information and a summary of the current problem is very useful" (S)
Degree of urgency	"On some occasions you might think 'this patient looks really unwell, but I don't know the diagnosis. Please come to see them quickly" (N)

8.4.3 Phase 2: Psychometric testing

Face and content validity: Face and content validity were demonstrated to be high for the QUIT tool with all 24 items achieving a median score of $\geq$ 4 for both questions in the questionnaire. Furthermore, 21 of 24 items achieved a CVI of > 0.8. Items that did not achieve a CVI > 0.8 were 'clearly communicates responsible consultant (attending)', 'used available documentation to structure handover' and 'establishes rapport and mutual respect'. These items all had a CVI value between 0.6 and 0.8. These results indicate good evidence for the face and content validity for the QUIT tool (see **Table 8C**).

Table 8C Content validity of the QUIT tool

Categories and items	This item is relevant to information transfer for surgical patients.		Communication of this item will enhance escalation of care and/or patient safety.	
	Median (range)	CVI	Median (range)	CVI
Communicator Identities				
Clearly communicates initiator identity (include grade and specialty)	5.0 (3-5)	0.95	5.0 (3-5)	0.91
Clearly confirms receiver identity (include grade and specialty)	5.0 (4-5)	1.00	5.0 (1-5)	0.91
Establishes rapport and mutual respect	4.0 (2-5)	0.64	4.0 (2-5)	0.73
Patient Identity				
Clearly communicates patient name	5.0 (4-5)	1.00	5.0 (4-5)	1.00
Clearly communicates patient location	5.0 (3-5)	0.95	5.0 (3-5)	0.91
Clearly communicates responsible consultant	4.5 (2-5)	0.77	5.0 (1-5)	0.77
Clearly communicates age/DOB	5.0 (3-5)	0.95	5.0 (3-5)	0.95
Clinical Details				
Clearly articulates working diagnosis	5.0 (3-5)	0.95	5.0 (4-5)	1.00
Clearly communicates relevant history (including recent operations)	5.0 (4-5)	1.00	5.0 (4-5)	1.00
Outlines current treatment to date	5.0 (4-5)	1.00	5.0 (4-5)	1.00
Problem				
Clearly describes current problem with patient	5.0 (5-5)	1.00	5.0 (5-5)	1.00
Communicates relevant vital signs and fluid balance	5.0 (4-5)	1.00	5.0 (4-5)	1.00
Describes patient assessment and examination findings	5.0 (4-5)	1.00	5.0 (4-5)	1.00
Outlines relevant investigation results to date	5.0 (3-5)	0.95	5.0 (3-5)	0.95
Effectively prioritises clinical issues	5.0 (3-5)	0.95	5.0 (3-5)	0.95
Clearly communicates degree of urgency	5.4 (4-5)	1.00	5.0 (4-5)	1.00
Plan				
Clearly defines the reason for the call (e.g. advice, patient review, transfer)	5.0 (3-5)	0.95	5.0 (4-5)	1.00
Questions/ ambiguities about patient care definitively resolved	4.0 (3-5)	0.82	4.0 (2-5)	0.82
Agrees plan for on-going care for patient	5.0 (3-5)	0.91	5.0 (3-5)	0.95
Information Presentation				
Clear, understandable language used throughout	5.0 (4-5)	1.00	5.0 (4-5)	1.00
Information presented in a structured and logical order	5.0 (4-5)	1.00	5.0 (4-5)	1.00
Used available documentation to structure handover	4.0 (1-5)	0.73	4.0 (1-5)	0.68
All relevant information selected and communicated	4.0 (3-5)	0.86	5.0 (3-5)	0.95
Completes information transfer without digressing	4.-0 (3-5)	0.91	4.0 (3-5)	0.86

Construct validity: The QUIT tool was demonstrated to be construct-valid. For all of the seven categories, senior surgeons were found to perform significantly better than their junior counterparts ($p<0.05$). In addition senior surgeons were scored significantly higher than junior surgeons for 18 out of the 24 items in the tool ($p<0.05$). These findings were supported by the significantly higher median overall scores achieved by senior compared to junior surgeons (senior 98 vs. junior 78, $p<0.001$). These results can be seen in **Table 8D**. The reliability of the scores given by the independent raters was excellent. Both the inter-rater reliability and inter-rater agreement were shown to be high. All seven categories were rated with an intra-class correlation coefficient of > 0.7 and achieved high levels of internal consistency as demonstrated by the Cronbach's alpha statistic in **Table 8E**.

Concurrent validity: The scenario for each participant was scored using both the QUIT and the SBAR tools. The total score for all 30 participants was compared using each tool and the point biserial correlation between the two assessment tool scores was found to be moderately, almost strongly, positive ($r=0.694$, $p<0.001$) indicating good concurrent validity.

Reliability: The QUIT tool was found to be reliable when the scores from independent raters were compared at the time of the study and when they were scored again more than one month later. All seven categories and the overall score showed similar median values and were not found to be statistically significantly different ($p>0.05$). The overall scores achieved in the test compared to re-test comparison had a strongly positive correlation indicating a high degree of reliability (ICC=0.965, 95% CI 0.927-0.983, $p<0.001$).

Table 8D Construct validity of the QUIT tool

Component	Novices	Experts	Mann-Whitney U test
	Median (range)	Median (range)	p value
Communicator Identities	12 (11-15)	14 (12-15)	0.003
Clearly communicates initiator identity (include grade and specialty)	3 (3-5)	5 (3-5)	0.264
Clearly confirms receiver identity (include grade and specialty)	5 (5-5)	5 (5-5)	1.000
Establishes rapport and mutual respect	4 (2-5)	5 (4-5)	<0.001
Patient Identity	10 (4-15)	12 (4-16)	0.030
Clearly communicates patient name	3 (1-5)	4 (1-5)	0.740
Clearly communicates patient location	1 (1-5)	5 (1-5)	0.012
Clearly communicates responsible consultant	1 (1-5)	1 (1-5)	0.150
Clearly communicates age/DOB	3 (1-5)	5 (1-5)	0.150
Clinical Details	11 (8-12)	13 (11-14)	<0.001
Clearly articulates working diagnosis	4 (3-5)	5 (4-5)	<0.001
Clearly communicates relevant history (including recent operation and date)	3 (2-4)	4 (3-5)	0.001
Outlines current treatment to date	3 (2-4)	4 (3-5)	0.002
Problem	19 (15-23)	24 (18-28)	<0.001
Clearly describes current problem with patient	4 (2-4)	4 (3-5)	0.007
Communicates relevant vital signs and fluid balance	3 (1-4)	4 (2-4)	0.002
Describes patient assessment and examination findings	3 (2-4)	4 (3-5)	0.004
Outlines relevant investigation results to date	3 (2-4)	4 (3-5)	0.010
Effectively prioritises clinical issues	4 (2-5)	4 (4-5)	0.003
Clearly communicates degree of urgency	3 (2-4)	4 (2-4)	0.008
Plan	11 (8-13)	14 (12-15)	<0.001
Clearly defines the reason for the call (e.g. advice, patient review, transfer)	4 (2-5)	4 (3-5)	0.009
Questions/ ambiguities about patient care definitively resolved	3 (2-4)	5 (3-5)	0.001
Agrees plan for on-going care for patient	4 (3-5)	4 (4-5)	0.026
Information Presentation	17 (11-21)	20 (16-23)	0.001
Clear, understandable language used throughout	4 (2-5)	5 (4-5)	0.005
Information presented in a structured and logical order	2 (1-4)	4 (3-5)	<0.001
Used available documentation to structure handover	3 (2-4)	4 (3-4)	0.002
All relevant information selected and communicated	3 (2-4)	4 (3-4)	0.056
Completes information transfer without digressing	4 (2-5)	5 (4-5)	<0.001
Overall quality of information transfer	3 (1-4)	4 (2-5)	<0.001
Total score	78 (68-89)	98 (82-110)	<0.001

Table 8E Inter-rater reliability for the QUIT tool

Category	Intra-class correlation	95% CI	p-value	Cronbach's Alpha
Communicator identity	ICC = 0.925	0.728-0.931	<0.001	0.923
Patient identity	ICC = 0.998	0.997-0.999	<0.001	0.998
Clinical details	ICC = 0.792	0.564-0.901	<0.001	0.790
Problem	ICC = 0.790	0.662-0.870	<0.001	0.791
Plan	ICC = 0.902	0.793-0.953	<0.001	0.899
Information presentation	ICC = 0.891	0.809-0.938	<0.001	0.890
Global rating	ICC = 0.902	0.605-0.976	=0.001	n/a
Overall score	ICC = 0.932	0.745-0.983	<0.001	n/a

8.4.4 Phase 3: Testing in the clinical environment

Observation of 30 escalation scenarios was conducted. For 15 of these, two independent researchers observed a nurse escalating care to a junior surgeon (FY1 or FY2); the other 15 scenarios involved a FY1 or FY2 surgeon escalating care to their registrar. The researchers were able to score each telephone referral contemporaneously and completely. They felt that the QUIT tool was feasible to use in the clinical environment in real-time.

Data analysis revealed that the surgeons had statistically significantly greater information transfer skills compared to their nursing colleagues for five of the seven categories (including the total score). Nurses outperformed junior surgeons in the communicator identities category, there was no difference in the information presentation category (see **Table 8F**).

Table 8F Scores for clinical referrals

Category	Median (range) for nurse initiator	Median (range) for doctor initiator	p-value
Communicator identities	13 (9-15)	12 (10-14)	**0.023**
Patient identity	12 (4-16)	17 (10-20)	**<0.001**
Clinical details	10 (3-13)	12 (8-15)	**0.002**
Problem	16 (12-22)	21 (16-29)	**0.001**
Plan	10 (6-12)	12 (6-15)	**0.037**
Information presentation	16 (10-22)	18 (11-24)	0.305
Global score	3 (2-4)	4 (2-5)	0.061
Total score	78 (57-87)	91 (68-110)	**0.002**

8.5 Discussion

This study has led to the development, validation and feasibility analysis of a metric to measure the quality of information transfer during escalation of care. In doing so it has provided valuable evidence for the importance of high-quality information transfer in the setting of patient deterioration and has important implications for junior surgeon and nurse training.

The aims of this study were to develop and generate evidence for the reliability and validity of the QUIT tool in the simulated environment and to assess the feasibility of using the QUIT tool, real-time, in the clinical environment. The findings will be discussed in relation to these aims and in the context of the wider literature. Following this, the implications for the field of surgery and beyond will be discussed, taking the strengths and limitations of this research methodology into account. Lastly, some conclusions will be presented.

8.5.1 Summary of findings and context within the literature

Development of the QUIT tool: This study utilised a comprehensive literature review and qualitative, semi-structure interviews to generate best evidence for the categories and items contained within the QUIT tool. A collaborative approach was used which involved regular consultation with an expert research team to ensure that all the critical components of information transfer during escalation of care were included, whilst also ensuring the tool was as short as possible to enable real-time use. These two methodologies allowed capture of evidence from the widest number of potential stakeholders.

The literature review was very broad and did not limit articles to those in the surgical field, as communication and information transfer are core skills of all healthcare professionals. Limiting the search may have omitted some important articles from other specialties, which provided valuable evidence for the QUIT tool. The inclusion of interviews has also allowed the opinion of multiprofessional clinicians whom participate daily in escalation of care to be included in the development phase of the tool. The final draft of the QUIT tool included seven categories and 24 items.

Validation and reliability testing of the QUIT tool: Multiple types of validation were evidenced for the QUIT tool. Face validity, content validity and construct validity were all demonstrated in a robust fashion. Whilst a few individual items did not reach the desired CVI level or significance value, all categories and more than 75% of the items did. Furthermore, none of the items were demonstrated to be irrelevant to information transfer during escalation of care or to have displayed no construct validity whatsoever so all items will be retained in the tool going forward to further research.

Three of the items in the QUIT tool failed to reach the threshold for acceptable content validity. One of these items (uses available documentation to structure handover) was identified multiple times in the literature review and interviews and did achieve reasonable content validity ($\geq$0.7 overall) and construct validity ($p<0.001$) so was retained in the tool. Communicating the responsible consultant (attending) was also identified multiple times in phase 1 of this study and does seem important. This item achieved reasonable content validity (>0.7 overall) but was not found to be construct-valid. It may also, not be relevant to an on-call registrar who simply needs to know if the patient is under their specialty or not initially. The identification of the responsible senior clinician may come later, when resuscitation has been started. However, for the purposes of this study it was retained in the tool. The establishment of rapport and mutual respect item did not achieve high content validity (overall <0.7) but was construct-valid ($p<0.001$) and is important to ensure a flattened hierarchy so this item was retained.

The concurrent validity of the tool was assessed using a comparison to the SBAR tool. The correlation was found to be moderately, almost strongly, positive ($r=0.694$) and highly significant ($p<0.001$) and was just on the border between moderate (0.5-0.7) and high (>0.7). This result provided good evidence for concurrent validity between the SBAR and QUIT tools, but also shows us that there are differences between the two assessment tools. The reliability testing of the tool when scores more than 1-month apart were compared was also high, indicating that the tool can perform on a consistent basis in the simulated environment. Further analysis of the results in the simulated environment revealed that junior surgeons routinely failed to mention where the patient was located or describe their vital signs, examination and investigation findings as well as the senior surgeons did. The implication is that the senior cannot gain an accurate picture of the patient's clinical condition from their junior colleague and may fail to realize the seriousness of the patient's deterioration and not prioritise that patient appropriately. This may result in treatment delay and preventable harm[68,71,73].

Feasibility evidence for the QUIT tool: Clinical escalation scenarios were observed to provide feasibility evidence for the QUIT tool. Two independent researchers found they were able to contemporaneously rate telephone referrals, both by nurses and junior surgeons. It was demonstrated that junior surgeons perform better than nurses in the majority of tool categories but further analysis will be required to confirm this.

Context of these findings in the wider literature: Several standardized handover tools have been developed but the principal focus of these has been the transfer of a patient from the operating theatre to the ICU and they have not been thoroughly validated[230,242,255,276]. Additionally, these tools do not aim to measure or improve communication for a deteriorating patient where time is critical if failure to rescue is to be prevented. The QUIT tool incorporates both the key information that needs to be transferred by a junior surgeon to a senior surgeon during escalation of care and the way in which this information should be presented to ensure the senior surgeon can effectively prioritise. This sets the QUIT tool apart from other communication tools such as the SBAR tool, which simply acts to structure communication during escalation of care, rather than objectively measure its quality.

Previous studies have demonstrated the ubiquitous nature of threats to patient safety that are present on surgical wards[110] and the contribution of communication failures in these adverse events[113,272]. Clinical inexperience and hierarchical barriers have been shown to affect the confidence of junior staff and impede escalation of care[84,89,117]. Potential solutions to these issues have included the development of escalation of care protocols[277]. The development of these protocols can be augmented through the development of training regimes for surgeons to teach them valuable escalation and information transfer skills. The QUIT tool provides a valuable method of measuring the quality of information transfer during escalation of care, which will allow the efficacy of training programmes and protocols in this area to be accurately assessed.

8.5.2 Implications

The primary function of the QUIT tool is to serve as a metric to evaluate the quality of information transfer during escalation of care. As such, the QUIT tool is an important part of any clinical educator's toolkit. The pervasiveness of simulation training in surgical curricula means that trainees are spending increased time working on their non-technical skills, one of the most critical of which is communication skills (i.e. information transfer)[210]. The importance of communication skills in facilitation of both the interprofessional and the doctor-patient relationship is reinforced by the addition of communication skills modules to surgical and medical training programmes[278,279]. The QUIT tool can be used to assess the efficacy of communication skills training, which is important as training surgeons and nurses are using time away from the wards and direct patient care to participate in training. Although the QUIT tool is not intended to be a rigid protocol, the categories and items within it can also be used to teach training surgeons and nurses to standardise and structure information transfer during escalation of care, thus acting as a training tool as well as a tool for evaluation. The QUIT tool may improve training for surgeons and quality and safety for patients on the surgical ward and can also be adapted to specialties other than surgery, increasing its applicability to healthcare in general.

8.5.3 Strengths and limitations

To our knowledge, the QUIT tool is the first to accurately assess information transfer during escalation of care in surgery. The inclusion of data to support the use of the QUIT tool in the clinical environment adds strength to the findings of this study. Demonstrating the validity of any assessment tool is necessary, however, showing that the tool can be translated from the simulated to the clinical environment is also important if the aim is to improve the skills of healthcare professions in their own working environment. Phase 1 of this study involved the use of literature review and semi-structured interviews to establish best evidence in the topic area, adding strength to the development phase of the QUIT tool. Researchers seeking to develop and validate assessment tools in surgery have used this mixed-methods approach previously[220,280,281]. The data collected in phase 2 demonstrated that the QUIT tool has both high validity and reliability when utilised by junior and senior surgeons. Multiple facets of validity assessment were used in this study and the most current validity framework was utilised, adding to the robust nature of the results obtained[282].

This study has certain limitations, which future research should seek to address. Firstly, the QUIT tool should be tested across other sites in different geographic areas and outside of the UK to determine if the excellent results obtained in this study can be replicated. Furthermore, it should be realised that, despite this tool being ready for use, it remains a work in progress, the results in this study have provided good evidence for the validity, reliability and feasibility for the tool but further refinement may be required to adapt the tool for alternative settings and specialties. In addition, it should be recognised that the results presented in phase 3 aimed to provide evidence for the feasibility of the tool in the clinical environment, not its validity. The results should be interpreted with caution as differences in the culture and customs of the nursing and medical professions may have contributed to the differences observed in the results. Lastly, future research should aim to include analysis of whether the QUIT tool has an impact on error rates and avoidable adverse events; as per the study by Starmer et al. exploring the I-PASS handover program[283].

8.5.4 Conclusions

In conclusion, this study has described a reliable, valid and feasible tool to assess information transfer during escalation of care on surgical wards. It can be used to assess key non-technical skills of training surgeons and nurses and also serve as a training aide to increase the structure of information transfer during escalation of care. As one of the vital components of safe surgical care, improving the escalation of care process is a priority. The QUIT tool may lead to fewer delays in treatment and improved patient outcomes if widely adopted and implemented correctly.

The next chapter in this thesis will describe a human factors intervention bundle aiming to improve escalation of care and safety culture in a UK surgical department. Unfortunately, due to logistical considerations the intervention study presented in chapter 9 of this thesis had to be started prior to the development and validation of the QUIT tool to allow sufficient time for adequate pre and post-intervention periods. Therefore, the QUIT tool does not appear in the next chapter. However, the clear implications of the QUIT tool that have been outlined mean it will certainly be utilised in future research based on the findings in this thesis.

9 A prospective study exploring the impact of a human factors intervention bundle on supervision, escalation of care and safety culture in a UK surgical department

---

9.1 Introduction

Previous chapters in this thesis and articles from the published literature have shown that multiple factors can impact on the quality of escalation of care and safety culture in surgery. The most important strategies to improve escalation of care in surgery were identified in chapters 2-5 as improvement of communication skills through human factors training and escalation protocols, and the improvement of communication technology. Chapters 6 and 7 explored the potential of improved communication technology in escalation of care. However, the sheer abundance of barriers to implementation of new communication technology allied with the complexity of development of these innovations mean that an intervention would take several years to develop. A more timely approach to improving escalation of care may be to use human factors to prevent the previously identified human errors frequently present within the process.

A key strategy to improve escalation of care is to target the level of supervision provided to junior surgeons. The quality of supervision is dependent on many factors, one of which is the EWTD. The EWTD reduces the continuity of patient care and can also introduce unfamiliarity in clinical teams, which highlights the importance of supervision and escalation of care. Chapter 3 demonstrated that senior surgeons must provide adequate supervision to their juniors, ensuring escalation of care is not delayed and that avoidable patient harm can be prevented. Chapter 5 recommended implementation of escalation of care protocols, which include strategies to improve the speed with which patient deterioration is recognised and acted upon. These protocols can aim to facilitate the escalation of care process and ensure senior clinicians and experienced resuscitation staff arrive to a deteriorating patient promptly[66]. When used for this purpose, junior surgeons and nurses are empowered to act decisively as the hierarchy within and external to the team is flattened. However, these protocols must rely on human activation, and as such, are prone to human error[41]. Therefore, prior to the introduction of a new protocol or pathway for patient care, the staff that will be using it must be appropriately educated and trained.

The combination of an intervention to improve patient care and human factors education to ensure it is implemented appropriately has been proven effective in previous research exploring surgery and ward-based care[39,45]. The role of supervision on the surgical ward and its association with care processes and outcomes have not yet been explored. The above approach to development and implementation of an intervention may be the best way to bring about an improvement in safety culture in surgical care.

9.2 Aims

1. Develop and implement a human factors intervention bundle in a UK surgical department.
2. Describe the impact of the intervention on supervision, escalation of care and safety culture within the department.
3. Explore the impact of the intervention on process and outcome measures.

9.3 Methods

9.3.1 Setting

This study took place in a 500-bed academic hospital in London; the hospital is part of an NHS trust serving a population of approximately 500,000 people. The hospital is a tertiary referral center for general and gastrointestinal surgery and has four surgical wards with 18 beds each and a four-bed high dependency unit for general surgery patients in need of more intensive monitoring than normal ward patients.

9.3.2 Pre-intervention landscape

The junior surgeons working within the department had previously raised concerns about the level of supervision they were given and a lack of support they experienced when attempting to escalate care for deteriorating ward patients to their senior colleagues. These concerns are described in detail in chapter 3[117]. The concerns raised by junior surgeons were taken seriously and a team of researchers was requested by the institution to study the inner workings of the department, improve the supervision of junior surgeons and escalation of care in surgery and, ultimately, improve the safety culture.

9.3.3 Development of the intervention bundle

In order to effectively develop the intervention, several focus group sessions were held. Any clinical staff member involved in the care of surgical patients was invited to contribute. A total of 24 staff members attended two focus group sessions, staff included ward and theatre recovery nurses, FY1s, SHOs, registrars and consultant surgeons, anaesthetists and administrators. After the first session the research team developed a draft version of the intervention bundle. This draft was presented to staff on the wards for informal discussion and feedback. It underwent multiple iterations before a final draft was taken to the second focus group. By the end of the second session, consensus had been achieved with all attendees and the intervention bundle was finalised (see **Figure 9A**).

9.3.4 The intervention bundle

This consisted of four separate components, which were originally conceived in previous chapters of this thesis. The first of these was the introduction of twice-daily consultant on-call ward rounds. Previously, there had only been one consultant on-call ward per day. This took place in the morning and involved a review of each surgical patient admitted to the hospital in the preceding 24 hours. This round was kept in place but a further evening round was added to ensure that patients admitted after the morning round were seen by a senior surgeon and had a formal management plan in place overnight. Increasing the presence of senior clinicians and promoting clear ownership of patients were identified as important strategies to improving escalation of care in chapters 3, 4 and 5 of this thesis.

The second component was the designation of a 'ward registrar of the week' (WRW). Prior to the intervention the FY1s and SHOs were responsible for the majority of ward-based surgical patient care, if they encountered a patient requiring more senior input the juniors had to go to the outpatient clinic or operating theatre and request help, which was not always forthcoming. The introduction of the WRW gave ward-based junior surgeons direct access to an experienced clinician during normal working hours. The WRW was removed from any clinic or theatre commitments to ensure they were available to help care for ward-based patients at short notice. The introduction of the WRW was in response to findings from chapter 3 of this thesis stating that senior clinicians must be available and approachable to juniors wishing to escalate care. In addition, chapter 4 identified that patients may be more willing to escalate their own care if doctors were more frequently present and visible on the surgical ward.

The third component of the intervention was a new escalation of care protocol for deteriorating ward patients. Previously, the FY1s and SHOs had not known who to call for help and this had led to unacceptable delays for at-risk patients. The new escalation protocol decreed that the WRW was responsible for urgently reviewing any ward-patient the juniors had concerns about during normal hours (8am-5pm), if they were not available then the consultant on-call was the next person to contact. Similarly, out of hours and at night (5pm-8am), the registrar on-call was made responsible for urgently reviewing deteriorating patients. If they were unavailable (in the theatre or with another patient) and could not attend within 30 minutes the juniors were instructed to contact the consultant on-call to review the patient, thus ensuring a rapid, senior surgical opinion. This component was based on the findings of chapter 5 which identified the importance of formal escalation of care protocols to patient safety.

The final component of the intervention bundle was a credit-card sized team contact card, which listed the preferred contact number of each doctor working in the surgical department, along with an alternative contact number if needed. Previously, the pager system was being used when doctors were in the hospital whilst mobile phones were used for doctors out of hospital, this component was supposed to streamline the communication process and prevent any delays in contact of senior surgeons when required. This component was formulated based upon the findings from chapter 2 which identified that failure to rescue was lower in hospitals with increased uptake of technology. Furthermore, chapter 3 found that junior surgeons were not aware of who or how to call the correct person when they wished to escalate care so the knowledge of which communication paradigm to use (e.g. bleep, mobile or landline) should ensure that delays are kept to a minimum.

The hypotheses underlying the intervention bundle was that an improvement of supervision of junior surgeons would facilitate escalation of care for deteriorating surgical ward patients and improve safety culture and outcomes within a UK surgical department.

9.3.5 Study design

This was a pre-post intervention study. This study design was chosen because the aim was to establish the impact of the intervention on junior surgeon supervision, escalation of care and safety culture in a UK surgical department. The pre-post intervention design is a very useful research methodology when an intervention is being introduced in a wide and diverse arena. The pre-intervention period provides baseline data, which the post-intervention data can subsequently be compared with to yield the selected study outcomes. The randomised controlled trial (RCT) is a more rigorous methodology that is less prone to confounders than a pre-post intervention study. However, it is not logistically feasible or appropriate to conduct an RCT for a wide-ranging intervention such as the bundle used in this study[284]. It would not have been ethical to randomise patients to be treated without the use of the intervention bundle. Furthermore it would not have been possible to blind participants and patients as to whether they were in the control or intervention arm of the study. RCTs are more commonly used to evaluate medication or treatment interventions rather than multi-faceted interventions bundles such as the one employed in this study[285].

One further possibility would have been to perform a cluster-RCT with another institution acting as the control arm[286]. However, this was not feasible for this study due to the large number of potential confounders that could not be adjusted or controlled for. The study protocol that was followed can be seen in **Figure 9A**.

9.3.6 Study periods

The pre-intervention period was from 1st August – 30th November 2012 (four months), the post-intervention period was from 1st December 2012 – 31st March 2013 (four months). The intervention bundle was introduced across the whole department at the same time. An additional data collection window opened six months after closure of the post-intervention period for two months to allow investigators to assess whether any impact of the intervention bundle identified in the post-intervention period was retained. Four months was chosen as an appropriate pre-post period length as any shorter and the intervention bundle may not have had time to bed-down into the institution and become standard practice. If a longer period was selected, the length of the study (which included the six-month retention study) would have been so prolonged the results would not be available in this thesis. For instance, if the periods had been doubled to 8 months each, and the retention window and development time for the intervention included, the study would have taken almost 3 years to complete.

9.3.7 Participants

All surgical staff members working for the department of general surgery at the study hospital were eligible for recruitment into the study; both junior and senior surgeons were recruited. A senior surgeon was defined as a year-5 or above registrar, or a consultant, a junior surgeon was defined as an FY1 or FY2 surgeon. The year-5 cut-off to define a senior surgeon was decided in accordance with previous research exploring the surgical ward and is consistent with the experience level at which a surgical registrar ay be expected to act with a reasonable degree of autonomy[33].

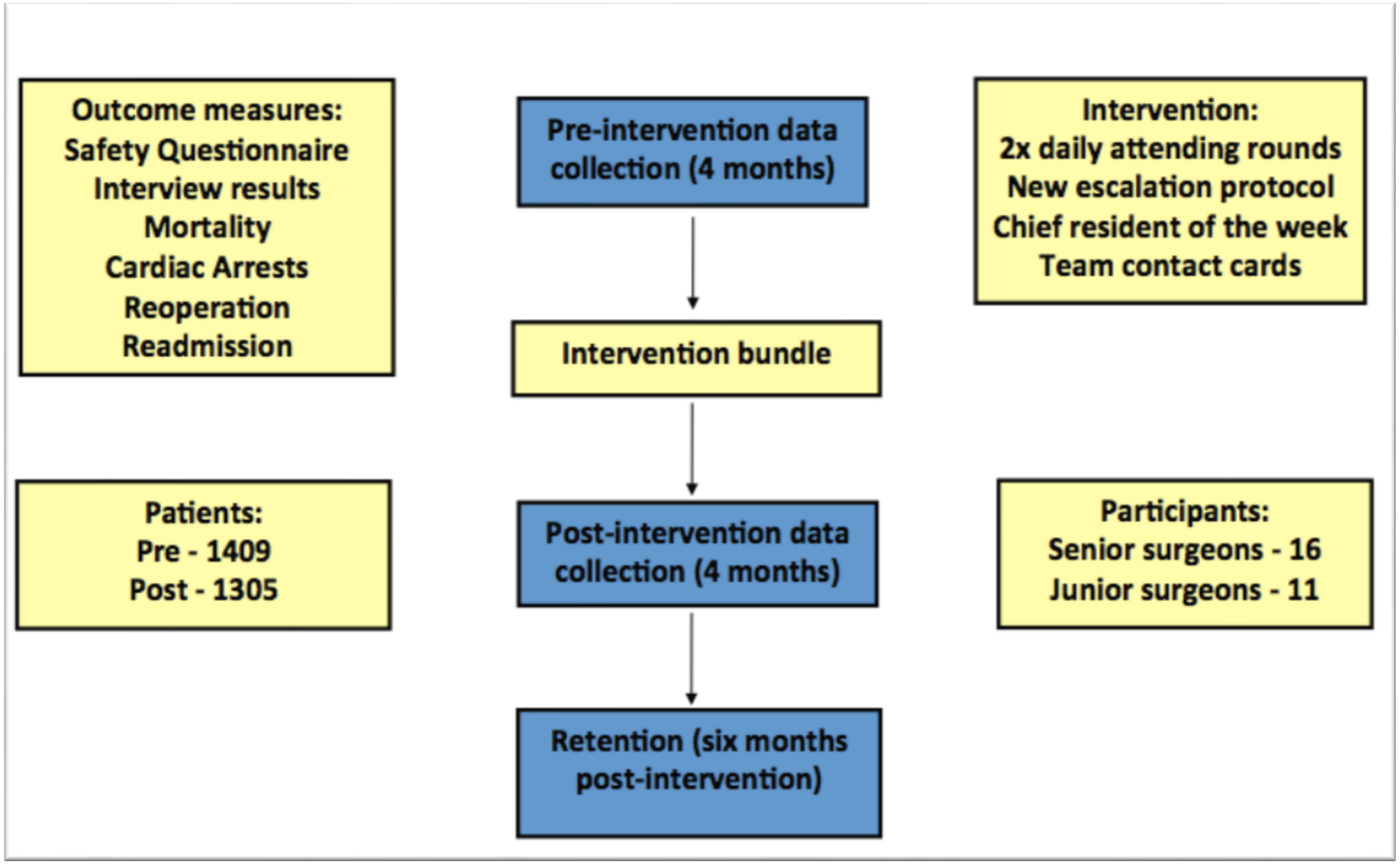
To allow collection of clinical data, all patients admitted under the surgical service during the four-month and pre-and-post intervention periods were entered onto a prospective database. Data collected for patients included their admission date and whether it was on an emergent or elective basis. All study patients were followed up to either discharge from hospital or death.

9.3.8 Measures

All senior and junior surgeons were asked to complete a questionnaire that was developed by the research team to establish the supervision and escalation of care landscape in the pre-and-post intervention periods. The questionnaire was based on Sexton's safety attitudes questionnaire and underwent several iterations prior to its use[287]. Responses were indicated for both normal hours and out of hours using seven-point Likert-type scales ranging from disagree strongly (1) to agree strongly (7). Data from the questionnaires were reported using the median and range. Analysis for differences between the junior and senior surgeons, pre and post intervention periods and normal hours and out of hours working periods was performed using the Mann-Whitney test for between-subjects comparison and the Wilcoxon test for within-subjects comparison.

Additionally, participants were submitted to semi-structured interview during the post-intervention period using the same methods of data collection and analysis as described previously[117]. The aim was to gather rich data to help explain the results of the questionnaires and the impact of the intervention on patient safety and culture within the surgical department. Clinical outcome measures were derived from the prospective database and the pre-and-post intervention periods were compared. The outcome measures that were explored were inpatient mortality, cardiac arrests, re-admission within 30 days of discharge and reoperation during the index admission. These outcomes were selected in accordance with other interventional studies in surgery from the published literature. In addition, they are consistent with some of the outcome measures reported in the literature review in chapter 2 (other than failure to rescue which could not be calculated in this study due to practical reasons). The chi-squared or Fisher's exact tests were used for statistical analysis. Statistical significance was taken when $p<0.05$. As this intervention was part of a hospital approved quality improvement initiative, ethical approval was waived for this study.

Figure 9A Study procedure



9.4 Results

The results of the questionnaires are reported first, followed by the qualitative interviews. Lastly, the clinical data is reported.

9.4.1 Questionnaire results

A total of 16 senior surgeons answered the questionnaire pre and post-intervention (response rate 80%). There were 13 consultants and three registrars. The registrars answering the questionnaire were the same for the pre and post-intervention periods but had rotated to a different hospital for the six-month retention questionnaire so the new registrars were queried instead; the consultants remained the same for all three time-points. There were 11 junior surgeons who answered the questionnaires (response rate 69%). Similarly, the junior surgeons were the same for the pre and post-intervention questionnaires but new junior surgeons were in rotation at the time of conducting the 6-month retention questionnaire.

Comparing the pre and post-intervention and 6-month retention questionnaires for junior and senior surgeons: Overall, for senior surgeons during normal hours 11 of 18 items demonstrated improvement post-intervention, of which two were significantly improved (see **Table 9Ai and 9Aii**). For the retention period a further seven items had significantly improved. For senior surgeons out of hours 10 of 18 items demonstrated post-intervention improvement, of these three were significant, for the retention period a further six had improved significantly. For junior surgeons during normal hours, 11 of 19 items were improved post-intervention; of these five were significant improvements, a further four improved significantly by the retention period. For junior surgeons during out of hours care, 15 of 19 items improved, of which five were significant improvements, by the retention period a further three had demonstrated significant improvement, whilst a single item had declined to the baseline established during the pre-intervention period.

Regarding clinical exposure, junior surgeons felt that they were asked to perform tasks outside their competence level more frequently at during the pre-intervention period compared to post-intervention, during normal hours and out of hours. This effect was temporary however; the results by the retention period had declined to baseline levels. The juniors also felt they were less likely to be asked to work outside the limits of their competence post-intervention compared to pre-intervention for both out of hours care and during normal hours. However, this effect had disappeared by the retention period.

Regarding supervision, both the junior and senior surgeons felt that supervision of the junior surgeons by their senior colleagues had improved post-intervention during normal hours. The senior surgeons also felt supervision had improved post-intervention during out of hours care but no improvement was seen with the junior surgeons results. This effect was retained for the retention period for senior surgeons during out of hours only. The junior surgeons also felt that their senior colleagues were more approachable during normal hours post-intervention compared to pre-intervention and that they were more likely to know whom they were supposed to call for help if they needed it out of hours post-intervention compared to pre-intervention. These effects were both retained by the retention period.

Regarding the interactions between junior and senior surgeons, the junior surgeons felt significantly more able to speak-up about problems with patient care during normal hours after the introduction of the intervention bundle, this effect was retained during the retention period.

Regarding the organisational structure of the surgical department, the junior surgeons felt that they were better able to prioritise patient care over administrative tasks during normal hours and that the balance of training and service provision out of hours had improved after the intervention. Both of these effects were retained by the retention period.

Regarding feedback between junior and senior surgeons, both groups felt that there had been no improvements after the intervention for both feedback delivery and receipt. However, the amount of feedback that both groups felt they could provide back to their employers had increased between the post-intervention and retention periods.

Regarding the safety culture within the department, both the junior and senior surgeons would have felt safer being treated as a patient after the intervention outside of normal hours. This effect was retained for the retention period for both groups, as neither returned to baseline levels, and results for the junior surgeons continued to improve between the post-intervention and retention periods. There was no initial improvement, between the pre and post-intervention periods, regarding the degree to which junior and senior surgeons felt encouraged to report safety concerns. However, results by the retention period were better than the pre and post-intervention periods, indicating ongoing improvement with regard to reporting of concerns by surgeons within the department.

Table 9Ai Senior surgeon questionnaire responses with comparison of each time point

Item	Normal hours						Out of hours					
	T1 median (range)	T2 median (range)	T3 median (range)	T1 vs. T2 p-value	T1 vs. T3 p-value	T2 vs. T3 p-value	T1 median (range)	T2 median (range)	T3 median (range)	T1 vs. T2 p-value	T1 vs. T3 p-value	T2 vs. T3 p-value
Exposure												
I have a satisfactory balance of elective vs. emergency work	5(2-7)	6(2-7)	6(2-7)	0.959	0.308	0.344	5(1-7)	5.5(4-7)	6 (2-7)	0.081	**0.050**	0.797
Supervision												
My juniors know who to call for help if they need it	6(1-7)	7(2-7)	6(2-7)	**0.012**	0.107	0.796	6(1-7)	7(5-7)	6(2-7)	**0.031**	0.060	0.943
My juniors are adequately supervised by senior surgeons	5(3-7)	7(3-7)	7(3-7)	**0.002**	0.365	0.856	5(2-6)	6(5-7)	7(6-7)	**0.003**	**0.020**	0.070
Senior surgeons are accessible to juniors for advice and support	6(3-7)	7(2-7)	7(6-7)	0.339	**0.010**	0.739	6(3-7)	6.5(4-7)	7(6-7)	0.359	0.058	0.739
Senior surgeons are approachable to juniors wishing to escalate care	7(5-7)	7(3-7)	7(6-7)	0.914	**0.020**	**0.020**	7(6-7)	6.5(5-7)	7(6-7)	0.480	**0.025**	**0.020**
Trainee-trainer interactions												
Junior surgeons speak up about concerns with patient care	6.5(4-7)	7(4-7)	7(6-7)	0.340	**0.034**	**0.034**	7(5-7)	6(5-7)	7(6-7)	0.564	0.206	**0.014**
I criticize my juniors for not calling for help when necessary	5(1-6)	2(1-6)	2(1-7)	0.117	0.164	0.888	5(1-7)	2.5(1-6)	2(1-7)	0.123	0.413	0.734
I criticize my juniors for calling for help unnecessarily	1.5(1-6)	1(1-5)	1(1-6)	0.317	0.838	0.758	1(1-5)	1(1-6)	1(1-7)	0.458	0.442	0.592
Organisational structure												
Handover meetings are well organised	5(1-6)	5.5(1-6)	6(2-7)	0.149	0.302	0.895	5(1-7)	6(5-6)	6(2-7)	0.073	0.142	0.850
There is a good balance between training and service provision	4(2-7)	4.5(2-7)	5(3-7)	0.943	0.114	0.270	5(1-7)	4.5(2-6)	5(3-7)	0.163	0.094	0.533
I can prioritise patient care over administrative tasks	5(2-7)	5(2-7)	6(5-7)	0.942	**0.004**	**0.006**	6(3-7)	6(3-7)	6.5(6-7)	0.180	0.107	**0.029**
I know my educational supervisee's name	5(2-7)	5(4-7)	7(5-7)	0.170	**0.007**	**0.004**	3(2-7)	5(2-6)	7(4-7)	0.156	**0.007**	**0.006**
I know my junior's name	6(1-7)	6(1-7)	7(4-7)	0.170	**0.005**	**0.016**	6(1-7)	6(3-7)	7(4-7)	0.399	**0.007**	0.053
Feedback												
I am able to provide feedback and	6(3-7)	6(4-7)	6(5-7)	0.524	0.071	0.070	6(2-7)	5.5(3-6)	6.5(2-7)	0.194	**0.036**	**0.015**

raise concerns about my job												
I regularly give my junior feedback on their clinical skills	5(2-7)	6(3-7)	6(3-7)	0.103	0.155	0.719	5(2-7)	6(3-7)	6(4-7)	0.731	0.802	0.904
Patient safety												
Patient safety is a priority in my department	5(2-7)	5(2-7)	6(2-7)	0.596	0.095	0.073	5(2-7)	5.5(3-7)	6.5(2-7)	0.116	0.086	0.210
I would feel safe being treated as patient in this department	4(1-7)	5(1-7)	5(1-7)	0.187	0.169	0.436	3(1-6)	4.5(3-7)	4(1-7)	**0.021**	0.136	0.837
I am encouraged to report safety concerns by colleagues	6(2-7)	6(2-7)	7(5-7)	0.276	**0.026**	0.061	6(4-7)	6(4-7)	7(6-7)	1.000	**0.020**	**0.033**

N.B. T1=pre-intervention period, T2=post-intervention period and T3=retention period.

Table 9Aii Junior surgeon questionnaire responses with comparison of each time point

Item	Normal hours						Out of hours					
	T1 median (range)	T2 median (range)	T3 median (range)	T1 vs. T2 p-value	T1 vs. T3 p-value	T2 vs. T3 p-value	T1 median (range)	T2 median (range)	T3 median (range)	T1 vs. T2 p-value	T1 vs. T3 p-value	T2 vs. T3 p-value
Exposure												
I only undertake tasks I feel competent to perform	5(2-6)	6(3-7)	7(5-7)	**0.026**	**0.003**	**0.029**	5(1-6)	6(2-6)	5(3-7)	**0.015**	**0.017**	0.166
I am asked to work beyond the limits of my competence	5(2-6)	3(1-6)	6(5-7)	0.059	**0.021**	**0.012**	5(2-7)	4(2-7)	6(3-7)	**0.023**	0.352	0.081
Supervision												
I know who to call for help if I need it	6(1-7)	6(2-7)	6(3-7)	0.176	0.079	0.458	4(2-7)	6(2-7)	5(3-7)	**0.040**	0.226	0.796
I am adequately supervised by senior surgeons	4(2-7)	6(2-7)	6(3-7)	**0.039**	**0.012**	0.096	4(2-7)	5(2-7)	5(3-7)	0.129	0.105	0.185
Senior surgeons are accessible to me for advice and support	5(2-7)	6(2-7)	6(3-7)	0.129	**0.024**	0.458	5(2-6)	6(2-7)	5(3-7)	0.063	0.083	0.470
Senior surgeons are approachable to me when I wish to escalate care	5(2-7)	6(2-7)	6(3-7)	**0.047**	0.103	1.000	5(2-7)	6(2-7)	5(4-7)	0.288	0.629	0.713
Trainee-trainer interactions												
I speak up about concerns with patient care	5(2-7)	6(2-7)	6(2-7)	**0.039**	**0.047**	1.000	5(3-6)	6(3-7)	4(2-7)	0.202	0.885	0.250
I have been criticized for not calling for help when necessary	2(1-7)	2(1-6)	1(1-5)	0.414	0.201	0.248	3(1-7)	3(1-6)	2(1-5)	0.129	0.063	0.190
I have been criticized for calling for help unnecessarily	2(1-6)	2(1-5)	2(1-5)	0.157	0.301	0.465	3(1-6)	3(1-6)	2(1-6)	0.317	0.157	0.480
Organisational structure												
Handover meetings are well organised	3(1-6)	5(1-7)	5(2-6)	0.068	**0.011**	0.121	4(2-7)	5(2-7)	5(2-6)	1.000	0.952	0.856
There is a good balance between training and service provision	1(1-6)	5(1-6)	3(1-6)	0.059	0.215	0.929	3(1-5)	4(1-5)	2(1-6)	**0.024**	0.615	0.133
I can prioritise patient care over administrative tasks	2(1-6)	4(1-6)	4(2-7)	**0.016**	**0.017**	0.234	3(1-7)	4(1-6)	4(2-6)	0.123	**0.011**	0.396
I know my educational supervisor’s name	7(1-7)	7(3-7)	7(3-7)	0.317	0.581	0.785	7(1-7)	7(3-7)	7(4-7)	0.317	0.285	0.655
I know my senior’s name	7(1-7)	7(1-7)	7(2-7)	0.180	0.216	0.715	7(1-7)	7(1-7)	7(4-7)	0.180	0.414	1.000
Feedback												

I am able to provide feedback and raise concerns about my job	6(1-7)	6(1-7)	6(1-7)	0.068	0.135	0.473	4(1-6)	6(1-6)	5(2-7)	0.072	0.272	0.541
I regularly receive feedback on my clinical skills	2(1-5)	4(1-6)	5(2-7)	0.066	0.053	0.201	3(1-5)	4(1-6)	4(1-7)	0.109	**0.046**	0.258
Patient safety												
Patient safety is a priority in my department	4(1-7)	6(1-7)	6(4-7)	0.068	0.064	0.719	4(2-7)	5(2-7)	5(2-7)	0.084	0.388	0.569
I would feel safe being treated as patient in this department	4(1-7)	4(1-7)	5(2-7)	0.197	**0.011**	**0.042**	3(1-5)	4(1-6)	4(1-7)	**0.034**	0.098	0.680
I am encouraged to report safety concerns by colleagues	4(1-6)	4(1-7)	6(3-7)	0236	**0.007**	**0.025**	2(1-5)	4(1-7)	4(2-7)	0.121	**0.013**	0.541

Comparing junior vs. senior surgeons questionnaire responses: During the pre-intervention period (T1) it is clear that the senior surgeons did not perceive that issues with the surgical department were as bad as the junior surgeons did, both during normal hours and out of hours (see **Table 9B**). The junior surgeons were significantly less likely to feel that their senior colleagues were approachable and accessible than the senior colleagues themselves perceived. Additionally, the junior surgeons did not feel as able to speak up regarding problems with patient care as their senior colleagues thought they did. Furthermore, the juniors thought the organisational structure of the department was poorer; opportunities to give and receive feedback were sparser and that they were encouraged to report patient safety concerns less frequently than their senior colleagues. Similar results were also obtained at T2 and T3, indicating that the perceptions of junior and senior surgeons were consistently different. The potential reasons for this disparity are highlighted in the discussion.

9.4.2 Interview results

The first question the participants were asked during the interviews was "how have things in the department changed since the introduction of the intervention bundle?" In response senior surgeons reported increased medical cover, greater senior staff presence on the ward, increased junior supervision and improved cover arrangements at the weekend for ward-based patients. However, the new system of working did lead to a significantly increased workload on-call for several of the senior surgeons, *"I am much more tired after doing an on-call shift* *using the new system, especially when I have to do 3 straight days over the weekend."*

Junior surgeons felt the intervention bundle had a positive impact, reporting greater supervision and support on the ward from senior surgeons and that it was much easier to escalate care after the intervention bundle. One of the junior surgeons said, *"the presence of a registrar on the ward at all times is very reassuring, escalation of care is now quicker and safer."*

Participants were also asked "if the WRW wasn't available would you contact the consultant on-call" (as per the new escalation protocol). This question was met with mixed responses. A third of the senior surgeons and half the junior surgeons said that the consultant would be contacted but it did not appear to be universal. One of the senior surgeons stated, *"the less confident juniors still hold back a bit and may delay contacting the consultant in the hope that the situation resolves itself."* However, there did appear to be some improvements in this area for the juniors, *"If the registrar is unavailable, which isn't often, I have contacted the Consultant which is something I didn't do before and would now continue to do when required."*

All surgeons felt that the juniors knew who to call for help if they wanted to escalate care and found the team-contact cards helpful. The final question participants were asked was "how has the intervention bundle affected you personally?" Several senior surgeons stated that they were more tired and were spending increased time in the hospital. However, others stated they were receiving less calls out of hours, *"I am having to take calls about deteriorating patients in the middle of the night far less frequently, the fact we see all the* *emergency patients at least twice every 24 hours means that problems can be anticipated and the emergency operating schedule can be planned better."* Several of the junior surgeons felt less work-related stress and believed the working relationships between members of the surgical team had improved.

When questioned about how the intervention bundle had affected their training the chief registrar explained that it had a negative impact as they were regularly tied to the ward, however, all three registrars felt that patient safety had significantly improved. One registrar explained that *"my elective work is now easier but those days when you are the ward registrar are difficult as that now takes precedence over attending the emergency theatre. I think the system overall is safer but some tweaks are needed."*

9.4.3 Clinical data

During the pre-intervention period 1409 patients were admitted under the general surgical service, of these 273 were elective admissions and 1136 were emergency admissions. During the post-intervention period, 1305 patients were admitted under the surgical service, 202 electively and 1103 as an emergency (no significant difference between groups, p=0.07). None of the outcomes measured demonstrated any significant differences between the pre and post-intervention periods. Inpatient mortality decreased from 1.92% pre-intervention to 1.38% post-intervention but this was not statistically significant (p=0.40). Similarly, cardiac arrests decreased from 0.34% to 0.23% but this was also not significantly different. Readmission increased post-intervention, from 2.13% to 3.30% (p=0.06) and reoperations increased from 1.63% to 1.84% (p=0.69). These findings are further explored in the discussion section.

Table 9B Comparing senior and junior surgeon questionnaire responses at time point 1 (T1)

	Normal			Out of hours		
	Senior	**Junior**		**Senior**	**Junior**	
Items	Median (Range)	Median (Range)	p-value	Median (Range)	Median (Range)	p-value
Supervision						
Juniors know who to call for help	6 (1-7)	6 (1-7)	0.574	6 (1-7)	4 (2-7)	0.107
Juniors are adequately supervised by senior surgeons	5 (3-7)	4 (2-7)	0.577	5 (2-6)	4 (2-6)	0.721
Senior surgeons are accessible to give juniors advice	6 (3-7)	5 (2-7)	**0.047**	6 (3-7)	5 (2-6)	**0.011**
Senior surgeons are approachable to juniors	7 (5-7)	5 (2-7)	**0.020**	7 (6-7)	5 (2-7)	**0.002**
Trainee-trainer interactions						
Juniors are able to speak up regarding problems with patient care	6.5 (4-7)	5 (2-7)	**0.006**	7 (5-7)	5 (3-6)	**<0.001**
Juniors are criticised for not calling for help when necessary	5 (1-6)	2 (1-7)	0.149	5 (1-7)	3 (1-7)	0.494
Juniors are criticised for calling for help unnecessarily	1.5 (1-6)	2 (1-6)	0.212	1 (1-5)	3 (1-6)	0.087
Organisational Structure						
The handover meeting is well organised	5 (1-6)	3 (1-6)	**0.036**	5 (1-7)	4 (2-7)	0.413
There is a good balance between training and service provision	4 (2-7)	1 (1-6)	**0.039**	5 (1-7)	3 (1-5)	0.077
I can prioritise patient care over administrative tasks	5 (2-7)	2 (1-6)	**0.001**	6 (3-7)	3 (1-7)	**<0.001**
I know the name of my educational supervisor/ee?	5 (2-7)	7 (1-7)	**0.035**	3 (2-7)	7 (1-7)	**0.010**
I know my senior/junior’s name?	6 (1-7)	7 (1-7)	0.294	6 (1-7)	7 (1-7)	0.134
Feedback						
I can provide feedback or raise concerns regarding my post	6 (3-7)	6 (1-7)	0.212	6 (2-7)	4 (1-6)	0.121
I receive/deliver feedback regularly on clinical skills	5 (2-7)	2 (1-5)	**0.005**	6 (3-7)	3 (1-5)	**<0.001**
Patient safety						
Patient safety is a priority in my workplace	5 (2-7)	4 (1-7)	0.716	5 (2-7)	4 (2-7)	0.838
I Would feel safe being treated as a patient here	4 (1-7)	4 (1-7)	0.231	3 (1-6)	3 (1-5)	0.259
I am encouraged by colleagues to report patient safety concerns	6 (2-7)	4 (1-6)	**0.009**	6 (4-7)	3 (1-5)	**<0.001**

9.5 Discussion

This pre-post intervention study aimed to establish the impact a human factors intervention bundle could have on the safety culture, levels of supervision, escalation of care practices and patient outcomes in a struggling UK surgical department. Significant barriers to high quality of care had insidiously crept into standard practice within this department and it is known that the culture of a workplace must change before its results can improve[288,289]. The complexity of the escalation of care process and its relationship with supervision and safety culture have been described in previous chapters and the novelty of this study is the multi-faceted nature of the intervention bundle which encompassed changes to the workings of the surgical department from top-to-bottom.

The aims of this study were to develop and implement a human factors intervention bundle in a UK surgical department, to describe the impact of the intervention on supervision, escalation of care and safety culture within the department and explore the impact of the intervention on process and outcome measures. The findings of this study will be discussed in relation to these aims and the wider literature. Following this, the implications for the field of surgery will be discussed, taking the strengths and limitations of this research methodology into account before some conclusions from this chapter are drawn. Following this, a wider discussion of the findings, context, implications and limitations of the research described in this thesis will be presented in chapter 10 and the plan for future work in this area will be described.

9.5.1 Summary of findings and context within the literature

Development and implementation of the intervention bundle: As far back as the systematic literature review in chapter 2 and the interviews in chapter 3, it was suggested that human factors would have an important role to play in improvement of the escalation of care process. The development and implementation of a human factors intervention bundle required extensive literature review and a great deal of consideration. This was accomplished using the data from previous chapters to develop the initial iteration of the intervention bundle. However, chapters 6 and 7 demonstrated how crucial it is to scope the opinion of potential end-users prior to introducing disruption into a clinical environment. This is of the greatest importance when the changes suggested will significantly impact on the working life of busy professionals. This process was facilitated in this particular study as the junior surgeons in the study hospital had already voiced concerns regarding their supervision and the ease with which they could escalate the care of a deteriorating patient to a senior colleague. Furthermore, the development phase of this study involved extensive consultation with multiprofessional staff that helped to produce and iterate the intervention to suit their working environment. The final intervention bundle included a twice-daily consultant ward round, a WRW, a new escalation protocol and team contact cards.

Impact of the intervention bundle on supervision, escalation of care and safety culture: The data from the questionnaires showed that team working, supervision, escalation of care and safety practices in the department improved after the introduction of the intervention. Furthermore, for some of the items that did not demonstrate significant improvement during the post-intervention period, the intervention bundle continued to work within the department and several of these items had improved significantly when the questionnaires were repeated six-months later.

The improvement in whether juniors felt they were asked to work outside their competence levels is important as it implies improved supervision; unfortunately this improvement was only transient. However, when asked directly about supervision, both junior and senior surgeons felt it had improved significantly after the intervention was introduced and this positive effect was retained after six-months. Similarly, the approachability of senior surgeons and knowledge of who to call for help with a patient significantly improved and this effect was also retained after six-months. This demonstrates that crucial aspects of the escalation of care process improved after introduction of the intervention. The readiness of juniors to assess deteriorating patients (recognition), knowledge of who to call (communication) and senior approachability (response) represent the three phases of the escalation of care process and sustained change in these practices is very positive.

It was also encouraging that both junior and senior surgeons felt significantly more able to report safety concerns after the intervention. The reporting of safety concerns, adverse events and near-misses is the cornerstone of high-performance, safe healthcare systems and indicated a shift in culture within the department[290].

The interview data within this study allowed a deep and rich understanding of how and why clinical practice had changed within the department post-intervention. Both junior and senior surgeons felt that the intervention had a positive impact, citing better supervision and escalation of care. Senior surgeons did, however, report an increased workload. Despite this, only a third of senior and half of the junior surgeons reported that juniors were following the new escalation protocol and contacting the consultant if the registrar was unavailable. This indicates that there is further room for improvement and that some hierarchical barriers may still be in place.

It was noticeable from the questionnaires that the senior surgeons felt that improvements were greater and ongoing problems were less significant, than the junior surgeons. The senior surgeons agreed with positive statements and disagreed with negative statements more than the juniors, both pre and post-intervention. This tendency was also seen in the results of the interviews meaning that the results need to be considered with this discrepancy between junior and senior surgeons taken into account. There are several potential reasons underlying this discrepancy. Firstly, the senior surgeons have an inherent stake in the safety culture in their workplace and the happiness of their juniors so may reflect the situation in a more positive light. Secondly, the junior surgeons begin their career under a great deal of pressure and stress, some of which they may place onto themselves. They are inexperienced in taking care of deteriorating patients but also may not be used to a working life and will certainly not be used to working night shifts and weekends. The potential for stress and fatigue to produce a more negative mindset in these junior surgeons compared to their experienced seniors must be considered.

Lastly, the senior surgeons (especially the consultants) are usually more permanent members of staff then junior surgeons who rotate between different hospitals and specialties. This means that if changes in the safety culture were to occur insidiously, the senior surgeons may not notice them whilst junior surgeons may become aware of the issues more readily.

Impact of the intervention on process and outcome measures: There were fewer deaths in the post-intervention period compared to pre-intervention but this was not significant. Similarly, there were no significant differences or improvements in the cardiac arrest, readmission and reoperation rates between the two periods. There are three potential reasons for this lack of a difference. Firstly, as is common with any large-scale pre-post intervention study, there are a large number of confounders that could not be controlled for. We were unable to adjust for patient comorbidities, age, and other important factors such as changes in staffing and bed occupancy. The sample size, whilst considerable, may not have been large enough to reliably detect any difference in outcomes. Lastly, there is likely to be a considerable time lag between when an improvement in supervision and safety culture can be demonstrated, and when any improvement in patient outcomes begins to occur. It is possible that a longer degree of follow-up was required for this study to identify any difference in outcomes. Unfortunately, this was not possible due to the time constraints mentioned previously.

The findings in this pre-post intervention study echo those of several other interventional studies that have aimed to improve escalation of care and patient outcomes. Adelstein et al., Robb et al. and Kansal et al. all introduced new escalation protocols or triggering systems on hospital wards in Australia, they reported an improvement in escalation practices but were unable to demonstrate an improvement in cardiac arrest rates and/or mortality[58,78,88]. Conversely, several intervention studies exploring human factors and escalation of care have demonstrated improvement in patient outcome measures. Mitchell et al. introduced a multi-faceted intervention to encourage early recognition of hospital patient deterioration and reported reduced ICU admission and mortality[82]. Catchpole et al. used human factors engineering to overcome communication failures in trauma care and showed reduced length of stay for patients[45].

Importantly, this study explored the retention of the intervention after it had been allowed to gain traction within the department. If the impact of an intervention is only analysed immediately after its introduction, there may have not been enough time for the intervention to exert it greatest effects. Haynes et al. allude to this argument in a response to an article exploring the impact of surgical safety checklists in Canada by Urbach et al[291,292]. Furthermore, Lucian Leape argued, in his editorial, that the mandating of safety checklists may have led to lower compliance than that reported and a watering-down of the impact of the checklist on patient outcomes over time[293]. These factors may also be relevant in this study because the institution being studied needed to introduce a change in practice in response to multiple complaints from staff.

9.5.2 Implications

This study has a number of important implications. The most important of which is that a human factors intervention can improve the supervision of junior surgeons. In order to prevent avoidable patient harm, junior surgeons must be appropriately supervised, until such time as they gain proficiency in the recognition and management of patient deterioration[277]. The feedback from senior surgeons indicated that consultant-led ward rounds should occur at least twice daily for emergency surgical admissions to maintain patient safety. Furthermore, the findings in this study indicate that escalation protocols and increased supervision can improve escalation of care despite only moderate overall adherence to the protocol. Future efforts may need to work at ensuring compliance with escalation protocols and the impact of 100% compliance could be very impressive. This human factors intervention bundle has demonstrated that changing the culture within a department is possible over a short to medium period if those at the sharp end (i.e. staff and patients) are engaged with early and are involved in development of the intervention[294].

9.5.3 Strengths and limitations

This study explored the retention of the intervention 6 months after the post-intervention period. This length of follow-up for a non-treatment intervention strengthens the findings of the study. The qualitative data from the interviews supplements the findings from the questionnaires, allowing a more detailed understanding of the impact of the intervention on staff members and culture within the department.

This study also has a number of limitations. Firstly, there is no interview data from the six-month retention period. This may have provided further understanding of the factors that led to an improvement in patient safety in the surgical department but failed to produce an improvement in outcomes. Secondly, the database used to provide this data did not, unfortunately, provide sufficient information to appropriately perform case-mix adjustment. Without performing case-mix adjustment it is difficult to ensure the cohorts being studied are truly comparable[295]. Thirdly, due to logistical resources, direct observation of the clinical environment during the pre and post-intervention periods was not performed. This may have lead to a greater understanding of how well the escalation protocol was adhered to by staff and if it was not followed, the reasons why not. Pronovost et al. have shown how improving care requires a team-based approach and direct observation may have been helpful in this study[296]. Lastly, this was a single-center study with a small sample so may not be wholly generalisable to other institutions.

9.5.4 Conclusions

Simple measures such as increased senior support and a clear escalation protocol can improve supervision and escalation of care in surgery and may lead to a change in both culture and safety practices. Future work needs to further evaluate the effect these measures have on process measures and outcomes and implement rollout of the intervention to other healthcare institutions. In addition, the QUIT tool could be used to measure the quality of information transfer during escalation of care to ascertain whether the intervention bundle improves this.

10 Thesis conclusions

10.1 Outline

This final chapter discusses the work presented in this thesis as a whole. Firstly, the background within which this research was conducted is briefly revisited. Following this, the aims of the thesis will be re-stated and accompanied by a discussion of how each aim was addressed. The key findings, important limitations and implications for future research work and the field of surgery are discussed. Lastly, the chapter will conclude with my personal reflections of completing the research in this thesis.

10.2 Background summary and rationale for researching in this area

The prevention of avoidable patient harm is the principle that underpins surgical practice and research into patient safety. There are many approaches to achieving this but the final aim remains the same. Traditionally, surgical researchers have attempted to improve patient outcomes through studies investigating treatment interventions and technical skills. This approach is commendable and significant steps forward have been taken recently, therefore it should continue[297]. Moving away from technical skills but remaining in the operating theatre, the WHO checklist has also succeeded in improving patient outcomes and can be translated to developed countries as well[298,299]. Items in the checklist do touch on the issue of non-technical skills such as leadership (senior surgeon and anaesthetist need to be present to complete it), communication and teamwork (each team member identifies themselves and their role). However, away from the operating theatre, the clinical role surgeons perform on the ward is not well researched. Ward-based care is still perceived by some surgeons (in the UK at least) as being for the juniors in their team to deal with. Thankfully, this paradigm is changing. The training of non-technical skills is now becoming standard in UK medical courses and postgraduate training regimes. Whilst it is clear that a technically competent surgeon is paramount to good outcome, the post-operative care of the patient (which is so dependent on non-technical skill) is also crucial, hence the advent of failure to rescue and escalation of care research.

In the context of a deteriorating post-operative patient on the ward, the recognition of complications is an important, yet difficult, skill. Similarly, once the complication has been recognised, communication with a senior colleague and a prompt response with implementation of definitive treatment must follow recognition of the complication to complete the escalation of care process and avoid failure to rescue. The situation is yet more complex in the context of surgery. Some complications (e.g. intra-abdominal bleeding or faecal peritonitis) require emergent return to the operating theatre, whilst others (e.g. venous thromboembolism (VTE) or pneumonia) are managed medically. In the event of the latter complications, a junior surgeon who can arrange appropriate investigations (ultrasound scan or chest x-ray) and commence initial treatment (anticoagulants or antibiotics) may manage the patient initially, before contacting their senior. However, this simplifies the situation, a patient with severe pneumonia may require urgent ventilator support in the ICU or a patient with a VTE may require surgical intervention.

The complexity and unpredictability of the post-operative course of a patient mandates the frequent involvement of senior surgeons, which is one of the key challenges to junior surgeons wishing to escalate care. All grades of clinician are constantly subject to competing demands and must learn to prioritise in order of clinical need. Unfortunately this skill is traditionally acquired as experience is accrued, one of the key challenges of this thesis is how to accelerate the acquisition of these key non-technical skills to improve escalation of care, and ultimately, patient safety.

10.3 Original thesis aims and how they were addressed

The overarching aim of this thesis was to make a novel and valuable contribution to the scientific evidence base concerning the escalation of care for deteriorating surgical patients.

The original aims of this thesis were:

1. *To explore the link between the quality of escalation of care and patient outcome measures including failure to rescue.* This was achieved through a systematic literature review to evaluate the published literature concerning escalation of care and failure to rescue in surgery (chapter 2).

2. *To identify facilitators and barriers to escalation of care in surgery.* This was achieved through an interview study with healthcare professionals and a questionnaire study with patients (chapters 3 and 4).

3. *To risk assess escalation of care in surgery so as to identify areas with potential for intervention.* This was achieved through a Healthcare Failure Mode Effects Analysis of the escalation of care process that allowed the identification of areas amenable to intervention (chapter 5).

4. *To investigate communication pathways and the role of communication technology in escalation of care.* This was achieved using a combined literature review and focus group study to investigate the potential role of ABCS for surgical teams (chapter 6). Subsequently, a mixed-methods study was conducted to explore the use of WhatsApp, an instant messaging app, for communication in surgical teams (chapter 7).

5. *To develop and validate a metric aiming to assess and improve information transfer during escalation of care.* This was achieved through development, validation and feasibility testing of the QUality of Information Transfer tool (chapter 8).

6. *To develop a human factors intervention bundle and assess its impact on supervision, escalation of care and safety culture in a UK surgical department.* This was achieved through a pre-post intervention study using mixed-methods including interviews, questionnaires and clinical data analysis (chapter 9).

10.4 Summary of key findings by aim

1. To explore the link between the quality of escalation of care and patient outcome measures including failure to rescue. A systematic literature review was conducted to identify and evaluate literature exploring escalation of care and failure to rescue in surgery (chapter 2)[56]. This review found that recognition, communication and response to deterioration are the key components of escalation care and, when performed well, may prevent avoidable patient harm. The review concluded that multiple factors (including organisational and human factors) might affect escalation of care and failure to rescue in surgery. It suggested that targeted interventions aiming to improve escalation of care be developed and implemented to enhance patient outcomes.

2. To identify facilitators and barriers to escalation of care in surgery. One of the most striking findings from chapter 2 was the absence of research exploring the potential role of human factors in the prevention of failure to rescue. Several articles described how human factors were important in escalation of care but none extrapolated this to hypothesise that human factors may be critical in ward-based patient safety or investigated their impact on outcomes. To address this a semi-structured interview study was conducted with interprofessional surgical and ICU staff in three London hospitals (chapter 3)[117]. To address the lack of patient-centered research in escalation of care and ensure that each stakeholder group was included in the exploratory phase of this thesis a questionnaire study was conducted with patients to explore the factors that affect their decision to call for help and commence the escalation of care process (chapter 4).

3. To risk assess escalation of care in surgery so as to identify areas with potential for intervention. Chapter 2 demonstrated the importance of escalation of care to patient safety and the prevention of harm. Chapters 3 and 4 identified the factors that may facilitate or impede the escalation of care process and also suggested some preliminary areas amenable to intervention. To allow a more structured and considered approach, chapter 5 involved an HFMEA that aimed to identify the areas of greatest risk in the escalation process and prioritise those with the scope for the greatest benefit from intervention[277]. Two principle areas amenable to intervention emerged. Firstly, the innovation of communication technology from outdated pager devices to smartphone platforms and secondly, human factor-based intervention into the escalation of care process.

4. To investigate communication pathways and the role of communication technology in escalation of care. Following on from chapter 5, a combined literature review and focus group study identified the potential of app-based communication systems in surgery (chapter 6)[155]. The identification of smartphones as a preferred platform, inclusion of patient identifiable information and associated information governance concerns were key themes from the focus groups. There were also interesting differences between the views of doctors and nurses, who would be the primary users so these would need to be taken into account should the system be developed. The study concluded with a detailed guide to production of an ABCS. However, I realised that some preliminary data for communication apps would be required before production of any new innovation to ensure that app-based communication is feasible within a surgical team with multiple, rotating members whom are often working in disparate locations.

To investigate this, a mixed-methods study was conducted that explored the use of WhatsApp, an instant messaging service, for communication within a busy, acute general surgery team (chapter 7)[300]. This study demonstrated that surgeons welcome app-based communication and reinforced the importance of the correct hospital infrastructure to such a system. Furthermore, the potential for pan-team communication and constant senior supervision helped to flatten the hierarchy within the team and improve escalation of care.

5. To develop and validate a metric aiming to assess and improve information transfer during escalation of care. As one of the key components of the escalation of care process, it is surprising that the quality of information transfer to a senior colleague is not currently measured. To address this paucity within the literature and allow the impact of future interventions in the escalation process to be measured, the QUality of Information Transfer (QUIT) was developed, validated and assessed for feasibility in a mixed simulated and clinical study in chapter 8. The QUIT tool was found to be face, content, construct and concurrently valid. It was also found to be reliable and feasible for use in the clinical environment. The QUIT tool can be used to assess interventions in the escalation of care process and structure training for junior surgeons to improve their communication skills.

6. *To develop a human factors intervention bundle and assess its impact on supervision, escalation of care and safety culture in a UK surgical department.* To follow-up on the recommendations from the HFMEA in chapter 5 and evidence

accrued in chapters 2,3 and 4 a human factors intervention bundle was developed to help a struggling surgical department improve supervision and escalation of care for their junior clinical staff (chapter 9). A pre-post intervention study utilising participant interviews, questionnaires and clinical data was conducted and positive effects were seen. The quality of supervision and escalation of care and the safety culture within the department appeared to improve and remained at a high-level more than 6 months post-intervention. There were no differences seen in patient outcomes however, reflecting the difficulty involved with changing institutional culture and gathering sufficient high-quality data to analyse outcome measures without using retrospective, administrative databases.

10.5 Summary of limitations in this thesis and the lessons learnt

The limitations of the individual studies within this thesis have been discussed at the end of each chapter. The section that follows presents the overarching limitations of this research within the field of surgery and leads into a discussion of the plan for future work. The sub-sections will be divided and discussed according to the different types of methodology used in this thesis.

10.5.1 Methodology type 1: Literature review

I conducted a systematic literature review in chapter 2 and non-systematic reviews in chapters 6 and 8. The principal limitation of these is common to all literature reviews; namely that the quality of the literature review is dependent on the quality of the included articles. The inclusion of articles with methodological limitations also limits the findings of the overall review.

However, I felt it was important throughout this thesis to include all types of research methodology so did not exclude articles based on their quality. Most research rating scales; such as the Jadad or Newcastle-Ottawa, do not include criteria for qualitative research so the Alberta Heritage scale was chosen as it is an exception to this rule[57,301,302]. The quality assessment of literature is a subject of debate; Neyarapally et al. explored quality assessment scales for pharmaco-epidemiological studies and found that critical elements were frequently missing[303]. Therefore, until the science of quality assessment is more exact, the uses of existing scales or simply including literature based on relevance to the research hypothesis seem to be perfectly acceptable approaches, I selected the latter option. The majority of the limitations of this area of research stated in chapter 2 were addressed by later studies in this thesis.

10.5.2 Methodology type 2: Qualitative and mixed-methods

Semi-structured interviews were employed in chapter 3, 7, 8 and 9. Interviews can be a very valuable source of rich qualitative data and I enjoyed learning and using these techniques in this thesis[119]. However, it must be remembered that these studies are usually limited by small sample sizes and the subjective nature of participant's views. Mitigating for these limitations by including an interprofessional sample from multiple centres seems the best approach to address this limitation. The use of interview techniques to help with the development and evaluation of complex interventional has previously been successful and was a valuable methodology used in this thesis (chapters 7, 8 and 9).

Focus groups were utilised in chapters 5, 6 and 9 and I found this methodology to be particularly valuable when a research question was likely to be the subject of debate. Observing and recording the interactions between participants allows a deep understanding of the issues being discussed and steps that can be taken to address them. However, focus groups are limited by the presence of dominant personalities, something the facilitator must mitigate, and the lack of discussion of potentially sensitive issues. A participant in an individual interview may be more candid than they would be in a focus group. The application of mixed-methods has been shown to be useful in elucidating the details of how and why an intervention may or may not be successful and also to uncover the opinions of study participants, something which administrative data is not able to achieve[304]. Mixed-methods were employed in chapters 5, 7 and 9 and allowed a level of understanding and contextual findings that would not have been possible otherwise.

10.5.3 Methodology type 3: Questionnaire

Questionnaires were utilised in chapters 4 and 9 of this thesis. Chapter 4 used a questionnaire to identify facilitators and barriers to escalation of care for patients. The questionnaire was developed by the research team and myself and was easy to administer and comprehend leading to an excellent response rate. However, given another opportunity to conduct this study I would have done it differently. The specific examples of deterioration given are hypothetical in nature and, with hindsight, it may have been more valuable to have given questionnaires to patients who had already suffered a complication that asked what methods they used to call for help and what factors affected that decision.

This would bring the study into the real world and away from the hypothetical, which would be valuable. However, it may have decreased the sample size. Furthermore, I would also have interviewed a sample of patients in chapter 3 to help develop the items in the questionnaire, which may have increased their relevance. A contrast is seen with the questionnaire in chapter 9 which was based on the interview results and the published literature[287].

10.5.4 Methodology type 4: HFMEA

The main limitations of the HFMEA conducted in this thesis are discussed in chapter 5. I have participated in a further two HFMEAs since the one in chapter 5 and remain convinced that it is a useful and comprehensive method for prospectively assessing risk in the hazardous healthcare industry. There are limitations regarding subjectivity, mathematical validity and application. Shebl et al. eloquently discuss these limitations in their validity assessments of FMEA as a research methodology. However, I found it to be very useful as HFMEA allows the researcher to generate interventions, which are not only possible but also feasible. Essentially, HFMEA not only generates a list of interventions but also effectively prioritises them into those with the greatest potential for improvements in care quality and patient safety. Had I realised earlier on during this thesis how complex the process of information transfer during escalation of care is; I may have broken this process down into additional steps to add to the comprehensiveness of chapter 5.

10.5.5 Methodology type 5: Simulation

Chapter 8 was predominantly a simulated study. Using simulation is not equivalent to testing a metric or intervention in the clinical environment. A limitation we sought to address in phase 3 of the QUIT study. However, phase 3 supplied only limited evidence due to the small sample and number of centres involved. Ultimately, without correlating the outcomes of the study with those in a large-scale clinical trial, the impact of the study findings cannot be guaranteed. Despite this, there are many advantages to simulation; the most important being the avoidance of implementing untested interventions on real patients, even in the setting of ethically sound research. The utilisation of a high-fidelity, validated simulation environment combined with very strong evidence for the validity of the QUIT tool from study 8 is reassuring and simulation appears to be the most appropriate environment for initial validation, and interventional, studies in surgery. The uptake of simulation in surgical training has increased in recent years because educators and researchers have realised its true value and I will continue to use it when appropriate[305,306].

10.5.6 Methodology type 6: Interventional

The two interventional studies in this thesis appear in chapters 7 and 9. Chapter 7 involved the implementation of WhatsApp in an emergency surgical team but it was not a comparative study and this is discussed in detail in chapter 7 and earlier on in this chapter. Chapter 9 involved the implementation of a human factors intervention bundle within a surgical department in the UK. This was no small undertaking as this intervention affected all clinical and some non-clinical departmental staff of all grades. A common theme in both chapters was the approach to engaging with participants on the content of the intervention prior to its implementation. I was lucky enough to have the support of senior management and an intervention of some nature would have been introduced despite any staff objections. However, extensive engagement with staff and the fact I involved them in planning the interventions meant that the implementation and evaluation was a smooth and effective process. Instituting change in healthcare is a difficult process that must overcome barriers and numerous articles have discussed the cultural responses to potential change in healthcare[307-309].

10.6 Strengths of research methods utilised in this thesis

The structure of this thesis is one of its main strengths. The more qualitative work in the early chapters gave me excellent background on escalation of care, failure to rescue and the surgical ward. The middle chapters involved more focused analysis to identify areas and strategies for intervention in the escalation of care process. The final three chapters involve interventions to improve escalation of care and development of a metric to measure the impact of these interventions. This thorough approach to researching and immersing oneself in understanding a problem prior to intervention facilitated the identification of the findings in this thesis. It is always tempting to view the lack of any improvement in outcomes as a failure (as seen in chapter 9). However, I firmly believe this only serves to illustrate the complexity of working in a busy, resource-strained industry with a longstanding culture of hierarchy and blame.

The main learning point from this thesis is the multiplicity of factors that affect escalation of care and patient safety on surgical wards and how strategies to improve care must be developed with the utmost care and attention. There are multiple limitations to the interventional methodology used in this thesis; these limitations are common to many interventional studies. With more time I would have liked to compare the response times between pagers and WhatsApp in chapter 7 which may have leant greater validity to the findings. Furthermore, I would also have liked to obtain more comprehensive data for chapter 9. If greater detail on potential confounders could have been obtained then multivariate regression analysis of the outcomes may have produced more sensitive findings. However, the lack of improvement in patient outcomes seen in this thesis may simply be a reflection of the amount of work remaining if patients are to consider themselves safe from avoidable harm when undergoing surgery in a UK hospital.

10.7 Implications and future research

Implications for patient safety: The work presented in this thesis has the potential to improve patient safety in surgery. Deteriorating patients treated by junior surgeons and nurses who feel empowered to follow through with their instincts and are able to escalate care to supportive, approachable senior colleagues are less likely to suffer ongoing deterioration and avoidable harm. Surgical teams that adopt the learning points in this thesis will also be furnished with improved communication technology and transparent escalation protocols, increasing their clinical effectiveness and efficiency. The research in this thesis may well have a snowballing effect due to the nature of current working conditions in the NHS in the UK. Senior surgeons and nurses (who are usually more permanent staff than junior clinicians) can encourage an improved safety culture, supervision and escalation of care.

During the course of their rotations the junior surgeons can feed off this changing culture and take their learning to their next rotation. None of this will be simple but the recent explosion of research exploring patient safety and institutional culture suggests that there are enough interested parties to make it stick. Even if the interventions suggested in this thesis are not widely implemented, the earlier studies may make surgeons, nurses and managers who follow the emerging literature aware of the factors that can facilitate and impede escalation of care and patient safety. At the very least they will then be better equipped to ameliorate the negative consequences of barriers to escalation of care and supervision in surgery.

Implications for training programmes and surgical education: The work in this thesis touched on surgical education and training in chapter 8 and, given more time, is an area I would have really liked to explore further. The earlier studies in this thesis underlined the importance of communication and information transfer during escalation of care and chapter 8 demonstrated the rigorous methodology required to develop and validate an assessment tool in surgery. Despite the plethora of research articles exploring the use of simulation for education, training and metric development, few of these have been adopted formally into undergraduate or postgraduate training programmes. Surgery has, along with anaesthesia, been the specialty exception. As seen in chapter 8 the ACS has included simulation based scenarios to teach trainees both technical skills (e.g. laparoscopic cholecystectomy) but also ward-based skills.

The clinical scenario in chapter 8 was adapted from the ACS training curriculum and detailed a patient with a pulmonary embolism. The scenarios provided within the curriculum are very detailed and include caveats. For example, if the trainee doesn't provide the simulated patient with oxygen they continue to deteriorate. There are other scenarios including post-operative bleeding, sepsis and other common post-operative complications and this is an invaluable learning resource for trainees. The Royal Colleges of Surgeons in the UK uses the ACS-accredited ATLS course, which has a large simulation component and have started to introduce simulation into their other courses, human factors in clinical simulation being an example (www.rcseng.ac.uk). This progress is set to continue, as simulation becomes a common training paradigm. One of the main projects I intend to conduct following this thesis is to use the QUIT tool from chapter 8 to investigate the impact of several different training and educational interventions aiming to improve junior surgeon's assessment and information transfer skills.

Deliberate and mental practice are methods of improving and retaining skills that have been acquired through practice regimes and have been researched in the areas of technical skills and stress management in surgery[310-313]. These valuable educational tools have not been explored on the surgical ward. I hypothesise that they may be particularly useful strategies for the junior surgeons to train themselves to manage acutely deteriorating patients with post-operative complications. I plan to conduct several simulated and clinical studies with junior surgeons and nurses to establish the impact of deliberate and mental practice on their escalation of care skills. Just as ATLS teaches a systematic Airway, Breathing, Circulation approach to assessing and managing trauma patients, I believe that deteriorating patients should be assessed and managed within a similar structure to ensure a consistent approach and good outcomes.

Implications for communication technology in surgery: The work in this thesis also described the deficiencies of current communication technology in use within surgical teams in hospitals. Chapters 3 and 5 described how communication technology for escalation of care was limited and recommended intervention and innovation in this area. A detailed literature review in chapter 6 described the deficiencies of current communication devices and recommended the implementation of smartphone technology for communication in surgical teams. Following this, chapter 7 describes how smartphone technology could be implemented in surgical teams and the role it played in supervision, escalation of care and patient safety. Despite this work, I envisage that communication technology in surgery will continue to be used in an ad-hoc fashion by surgeons in the immediate future. Due to their innovative nature and concerns surrounding information governance, hospital information technology departments are currently reluctant to allow the inclusion of patient identifiable data on smartphones and apps.

The more forward thinking hospitals will allow clinical communication on smartphones (see chapter 7), but only within specific limits, such as using the patient's initials rather than name.[300] The issue with these limitations are that end-users are unlikely to fully switch over to smartphone communication unless apps are allowed to include patient identifiable data, which was identified as a key recommendation for an ABCS in chapter 6[155].

Despite these concerns, things must change. Therefore, the mHealth workgroup at Imperial College have started work on a project to produce an app-based communication system for surgical patients called 'Hark'.

This app began production in late-2013 and is in the final testing phase (a simulated study will be conducted throughout 2015). This app was produced according to a 'clarify, design, evaluate' framework[314]. The clarify phase included research to uncover issues with current methods of communication and involved a mixture of quantitative and qualitative research (see chapters 3, 5, 6 and 7). We also conducted novel observations with a mixed team of clinicians and specialist mHealth designers, an approach designed to ensure a user-centered problem solving method of research. After this, the design phase has involved the software and securities designers producing iterations of the app which are piloted tested within the team, following a PDSA cycle[225]. At the end of the design period we had a prototype app, which all team members were happy with and was ready for formal testing. We have designed a randomised controlled-trial to explore the performance of the app during handover and escalation of care scenarios compared to the current bleep system and will use the QUIT tool to score the referrals. The combination of the mental/deliberate practice studies and this comparative communication study represents a continuation of the main interventional themes within this thesis and constitutes a robust plan for future work in this research area.

10.8 Personal reflections

My position as a clinical researcher is unusual in that the majority of UK surgeons who undertake a PhD do so just before or during their specialist training (ST3 and above). I, however, elected to do my PhD after my foundation and before my core training. This gave me a unique perspective on research and I wanted to take advantage of this. Lots of research projects in surgery look at mainly registrars and consultants, neglecting the crucial role of nurses and junior surgeons in the care or surgical patients. Ward-based care is an under-researched area and the decision-making process that junior surgeons undergo when faced with a deteriorating patient had always fascinated me. The main reason I was interested in escalation of care as the basis of my thesis was that I had been faced with escalation scenarios on the wards many times during my own clinical practice, and it is really difficult. I've seen patients at 4am who are critically ill and known they needed senior intervention. However, despite my interest in this area and knowledge of how critical rapid escalation of care is, at the back of your mind there are still those little questions:

Do I really need to wake up the registrar? They might be angry.

Have I done everything I should?

Can I wait a bit? The patient might get better…

I think I've done everything they would; do I need to bother the consultant?

There are also some questions from the other way of thinking:

Am I out of my depth?

Might the registrar want to know, even though I have done what I should have?

If I don't contact them and the patient deteriorates, is that my fault?

You end up with a cartoon-like situation where the devil is on one shoulder whispering the first set of questions into your ear and your guardian angel is whispering the second set of questions. In the majority of cases I listened to the angel but not every time. That is why I believe junior surgeons need training in escalation of care. Hopefully some of the research presented in this thesis, which has been received positively by surgical journals and peers alike, raises awareness of the complexity of escalation of care. I hope that this work empowers juniors to escalate care and persuades seniors to be approachable and supportive of their junior colleagues. There will be times when a patient's care is escalated unnecessarily (i.e. a false negative) but this is a more desirable situation than if a patient's care is not escalated when it should have been. This second scenario is when avoidable harm occurs and is the situation this work is aiming to prevent.

I have immensely enjoyed my time at Imperial, gaining crucial skills for my future career as an academic surgeon (fingers crossed) and making some great friends over the years. I hope I have also demonstrated that junior surgeons can be successful in academia. I feel privileged to have been given the opportunity to research an area that I have always had great interest in and look forward to contributing to the ongoing work that is required in this research field.

References

1. Walshe K, Bennett J, Ingram D. Using adverse events in health-care quality improvement: results from a British acute hospital. Int J Health Care Qual Assur 1995;8:7-14.

2. Leape LL, Brennan TA, Laird N, et al. The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. N Engl J Med 1991;324:377-84.

3. Vincent C, Neale G, Woloshynowych M. Adverse events in British hospitals: preliminary retrospective record review. Bmj 2001;322:517-9.

4. Institute of Medicine. To Err Is Human: Building a Safer Health System 1999.

5. Institute of Medicine. Crossing the Quality Chasm: A New Health System for the 21st Century. 2001.

6. Darzi A. High Quality Care for all: NHS Next Stage Review final report2008 30/06/2008.

7. Department of Health. An organisation with a memory 2000.

8. Vincent C, Moorthy K, Sarker SK, Chang A, Darzi AW. Systems approaches to surgical quality and safety: from concept to measurement. Ann Surg 2004;239:475-82.

9. Sudan R, Lynch TG, Risucci DA, Blair PG, Sachdeva AK. American College of Surgeons Resident Objective Structured Clinical Examination: a national program to assess clinical readiness of entering postgraduate year 1 surgery residents. Ann Surg 2014;260:65-71.

10. The General Medical Council. Good practice in prescribing and managing medicines and devices 2013.

11. The Royal College of Surgeons of England. Surgical Specialties 2014.

12. Schauer P, Ikramuddin S, Hamad G, Gourash W. The learning curve for laparoscopic Roux-en-Y gastric bypass is 100 cases. Surg Endosc 2003;17:212-5.

13. The Royal College of Surgeons of England. The Leadership and Management of Surgical Teams 2007.

14. Endorf FW, Jurkovich GJ. Acute care surgery: a proposed training model for a new specialty within general surgery. J Surg Educ 2007;64:294-9.

15. Tincknell L, Burton S, Cooke C, et al. The emergency surgical team - the way forward in emergency care? Ann R Coll Surg Engl 2009;91:18-22.

16. Sorelli PG, El-Masry NS, Dawson PM, Theodorou NA. The dedicated emergency surgeon: towards consultant-based acute surgical admissions. Ann R Coll Surg Engl 2008;90:104-8.

17. Rodriguez-Jareno MC, Demou E, Vargas-Prada S, et al. European Working Time Directive and doctors' health: a systematic review of the available epidemiological evidence. BMJ Open 2014;4:e004916.

18. Hutter MM, Kellogg KC, Ferguson CM, Abbott WM, Warshaw AL. The impact of the 80-hour resident workweek on surgical residents and attending surgeons. Ann Surg 2006;243:864-71; discussion 71-5.

19. Fitzgerald JE, Caesar BC. The European Working Time Directive: a practical review for surgical trainees. Int J Surg 2012;10:399-403.

20. Achieving compliance with the European Working Time Directive in a large teaching hospital: A strategic approach. Clinical Medicine, Journal of the Royal College of Physicians of London 2004;4:427-30.

21. Beamish AJ, Gokani V, Radford P, Sinclair P, Fitzgerald JE, the Association of Surgeons in T. Association of Surgeons in Training Conference: Belfast 2014. Int J Surg 2014.

22. Stephens MR, Lewis WG, Brewster AE, et al. Multidisciplinary team management is associated with improved outcomes after surgery for esophageal cancer. Dis Esophagus 2006;19:164-71.

23. Wong K, Levy RD. Do surgeons need to look after unwell patients? The role of medical emergency teams. ANZ J Surg 2005;75:848-51.

24. Mohamed MS, Mufti GR. The surgical assessment unit--effective strategy for improvement of the emergency surgical pathway? J R Soc Med 2005;98:14-7.

25. Blakey JD, Fearn A, Shaw DE. What drives the 'August effect'? A observational study of the effect of junior doctor changeover on out of hours work. JRSM short reports 2013;4:2042533313489823.

26. Rogers S. Will patients really die this week because of new NHS hospital doctors? The Guardian 2012.

27. Young JQ, Ranji SR, Wachter RM, Lee CM, Niehaus B, Auerbach AD. "July effect": impact of the academic year-end changeover on patient outcomes: a systematic review. Ann Intern Med 2011;155:309-15.

28. McGinley A, Pearse RM. A national early warning score for acutely ill patients. Bmj 2012;345:e5310.

29. Rotella JA, Yu W, Ferguson J, Jones D. Factors influencing escalation of care by junior medical officers. Anaesth Intensive Care 2014;42:723-9.

30. Martin JA, Regehr G, Reznick R, et al. Objective structured assessment of technical skill (OSATS) for surgical residents. Br J Surg 1997;84:273-8.

31. Grantcharov TP, Bardram L, Funch-Jensen P, Rosenberg J. Laparoscopic performance after one night on call in a surgical department: prospective study. Bmj 2001;323:1222-3.

32. Yule S, Flin R, Paterson-Brown S, Maran N. Non-technical skills for surgeons in the operating room: a review of the literature. Surgery 2006;139:140-9.

33. Pucher PH, Aggarwal R, Srisatkunam T, Darzi A. Validation of the Simulated Ward Environment for Assessment of Ward-Based Surgical Care. Ann Surg 2013.

34. Jalil R, Akhter W, Lamb BW, et al. Validation of team performance assessment of multidisciplinary tumor boards. The Journal of urology 2014;192:891-8.

35. Sevdalis N, Wong HW, Arora S, et al. Quantitative analysis of intraoperative communication in open and laparoscopic surgery. Surg Endosc 2012;26:2931-8.

36. Velanovich V. Laparoscopic vs open surgery: a preliminary comparison of quality-of-life outcomes. Surg Endosc 2000;14:16-21.

37. Ghaferi AA, Birkmeyer JD, Dimick JB. Variation in hospital mortality associated with inpatient surgery. N Engl J Med 2009;361:1368-75.

38. Silber JH, Williams SV, Krakauer H, Schwartz JS. Hospital and patient characteristics associated with death after surgery. A study of adverse occurrence and failure to rescue. Med Care 1992;30:615-29.

39. Pucher PH, Aggarwal R, Singh P, Srisatkunam T, Twaij A, Darzi A. Ward Simulation to Improve Surgical Ward Round Performance: A Randomized Controlled Trial of a Simulation-Based Curriculum. Ann Surg 2014.

40. Nagpal K, Abboudi M, Fischler L, et al. Evaluation of postoperative handover using a tool to assess information transfer and teamwork. Ann Surg 2011;253:831-7.

41. Gawande AA, Zinner MJ, Studdert DM, Brennan TA. Analysis of errors reported by surgeons at three teaching hospitals. Surgery 2003;133:614-21.

42. Reason J. Human error: models and management. Bmj 2000;320:768-70.

43. Prytherch DR, Smith GB, Schmidt PE, Featherstone PI. ViEWS--Towards a national early warning score for detecting adult inpatient deterioration. Resuscitation 2010;81:932-7.

44. Yang J, Hong-Zhong H, Li-Ping H, Shun-Peng Z, Dunwei W. Risk evaluation in failure mode and effects analysis of aircraft turbine rotor blades using Dempster–Shafer evidence theory under uncertainty. Engineering Failure Analysis 2011;18:2084-92.

45. Catchpole K, Ley E, Wiegmann D, et al. A Human Factors Subsystems Approach to Trauma Care. JAMA surgery 2014.

46. Davis RE, Koutantji M, Vincent CA. How willing are patients to question healthcare staff on issues related to the quality and safety of their healthcare? An exploratory study. Qual Saf Health Care 2008;17:90-6.

47. Hands C, Reid E, Meredith P, et al. Patterns in the recording of vital signs and early warning scores: compliance with a clinical escalation protocol. BMJ Qual Saf 2013;22:719-26.

48. Prytherch DR, Smith GB, Schmidt P, et al. Calculating early warning scores--a classroom comparison of pen and paper and hand-held computer methods. Resuscitation 2006;70:173-8.

49. The Nursing & Midwifery Council. The Code: Standards of conduct, performance and ethics for nurses and midwives 2010.

50. The General Medical Council. Good Medical Practice 2013.

51. The Royal College of Surgeons of England. Good Surgical Practice 2014.

52. Zuckerman JD, Skovron ML, Koval KJ, Aharonoff G, Frankel VH. Postoperative complications and mortality associated with operative delay in older patients who have a fracture of the hip. J Bone Joint Surg Am 1995;77:1551-6.

53. Mazzocco K, Petitti DB, Fong KT, et al. Surgical team behaviors and patient outcomes. Am J Surg 2009;197:678-85.

54. Pucher PH, Aggarwal R, Singh P, Darzi A. Enhancing surgical performance outcomes through process-driven care: a systematic review. World J Surg 2014;38:1362-73.

55. Pronovost PJ, Weast B, Holzmueller CG, et al. Evaluation of the culture of safety: survey of clinicians and managers in an academic medical center. Qual Saf Health Care 2003;12:405-10.

56. Johnston MJ, Arora S, King D, et al. A systematic review to identify the factors that affect failure to rescue and escalation of care in surgery. Surgery 2014.

57. Kmet LM, Lee RC, Cook LS. Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields Alberta Heritage Foundation for Medical Research; 2004.

58. Adelstein BA, Piza MA, Nayyar V, Mudaliar Y, Klineberg PL, Rubin G. Rapid response systems: a prospective study of response times. J Crit Care 2011;26:635 e11-8.

59. Almoudaris AM, Burns EM, Mamidanna R, et al. Value of failure to rescue as a marker of the standard of care following reoperation for complications after colorectal resection. Br J Surg 2011;98:1775-83.

60. Jones D, Drennan K, Hart GK, Bellomo R, Web SA. Rapid Response Team composition, resourcing and calling criteria in Australia. Resuscitation 2012;83:563-7.

61. Bapoje SR, Gaudiani JL, Narayanan V, Albert RK. Unplanned transfers to a medical intensive care unit: causes and relationship to preventable errors in care. J Hosp Med 2011;6:68-72.

62. Bobay KL, Fiorelli KL, Anderson AJ. Failure to rescue: a preliminary study of patient-level factors. J Nurs Care Qual 2008;23:211-5.

63. Brooke BS, Dominici F, Pronovost PJ, Makary MA, Schneider E, Pawlik TM. Variations in surgical outcomes associated with hospital compliance with safety practices. Surgery 2012;151:651-9.

64. Cabrini L, Monti G, Plumari VP, et al. Observed versus predicted hospital mortality in general wards patients assisted by a medical emergency team. Signa Vitae 2012;7:38-42.

65. Calzavacca P, Licari E, Tee A, et al. A prospective study of factors influencing the outcome of patients after a Medical Emergency Team review. Intensive Care Med 2008;34:2112-6.

66. Chen J, Bellomo R, Hillman K, Flabouris A, Finfer S. Triggers for emergency team activation: a multicenter assessment. J Crit Care 2010;25:359 e1-7.

67. Cooper S, Kinsman L, Buykx P, McConnell-Henry T, Endacott R, Scholes J. Managing the deteriorating patient in a simulated environment: nursing students' knowledge, skill and situation awareness. J Clin Nurs 2010;19:2309-18.

68. Downey AW, Quach JL, Haase M, Haase-Fielitz A, Jones D, Bellomo R. Characteristics and outcomes of patients receiving a medical emergency team review for acute change in conscious state or arrhythmias. Crit Care Med 2008;36:477-81.

69. Endacott R, Kidd T, Chaboyer W, Edington J. Recognition and communication of patient deterioration in a regional hospital: a multi-methods study. Aust Crit Care 2007;20:100-5.

70. Friese CR, Earle CC, Silber JH, Aiken LH. Hospital characteristics, clinical severity, and outcomes for surgical oncology patients. Surgery 2010;147:602-9.

71. Ghaferi AA, Birkmeyer JD, Dimick JB. Hospital volume and failure to rescue with high-risk surgery. Med Care 2011;49:1076-81.

72. Ghaferi AA, Osborne NH, Birkmeyer JD, Dimick JB. Hospital characteristics associated with failure to rescue from complications after pancreatectomy. J Am Coll Surg 2010;211:325-30.

73. Ghaferi AA, Birkmeyer JD, Dimick JB. Complications, failure to rescue, and mortality with major inpatient surgery in medicare patients. Ann Surg 2009;250:1029-34.

74. Glance LG, Dick AW, Meredith JW, Mukamel DB. Variation in hospital complication rates and failure-to-rescue for trauma patients. Ann Surg 2011;253:811-6.

75. Glance LG, Dick AW, Osler TM, Mukamel DB, Li Y, Stone PW. The association between nurse staffing and hospital outcomes in injured patients. BMC Health Serv Res 2012;12:247.

76. Haas B, Gomez D, Hemmila MR, Nathens AB. Prevention of complications and successful rescue of patients with serious complications: characteristics of high-performing trauma centers. J Trauma 2011;70:575-82.

77. Jones D, Baldwin I, McIntyre T, et al. Nurses' attitudes to a medical emergency team service in a teaching hospital. Qual Saf Health Care 2006;15:427-32.

78. Kansal A, Havill K. The effects of introduction of new observation charts and calling criteria on call characteristics and outcome of hospitalised patients. Crit Care Resusc 2012;14:38-43.

79. Kaplan LJ, Maerz LL, Schuster K, et al. Uncovering system errors using a rapid response team: cross-coverage caught in the crossfire. J Trauma 2009;67:173-8; discussion 8-9.

80. Kendall-Gallagher D, Aiken LH, Sloane DM, Cimiotti JP. Nurse specialty certification, inpatient mortality, and failure to rescue. J Nurs Scholarsh 2011;43:188-94.

81. Ludikhuize J, de Jonge E, Goossens A. Measuring adherence among nurses one year after training in applying the Modified Early Warning Score and Situation-Background-Assessment-Recommendation instruments. Resuscitation 2011;82:1428-33.

82. Mitchell IA, McKay H, Van Leuvan C, et al. A prospective controlled trial of the effect of a multi-faceted intervention on early recognition and intervention in deteriorating hospital patients. Resuscitation 2010;81:658-66.

83. Moriarty JP, Finnie DM, Johnson MG, Huddleston JM, Naessens JM. Do pre-existing complications affect the failure to rescue quality measures? Qual Saf Health Care 2010;19:65-8.

84. Pattison N, Eastham E. Critical care outreach referrals: a mixed-method investigative study of outcomes and experiences. Nurs Crit Care 2012;17:71-82.

85. Peebles E, Subbe CP, Hughes P, Gemmell L. Timing and teamwork--an observational pilot study of patients referred to a Rapid Response Team with the aim of identifying factors amenable to re-design of a Rapid Response System. Resuscitation 2012;83:782-7.

86. Quach JL, Downey AW, Haase M, Haase-Fielitz A, Jones D, Bellomo R. Characteristics and outcomes of patients receiving a medical emergency team review for respiratory distress or hypotension. J Crit Care 2008;23:325-31.

87. Rattray JE, Lauder W, Ludwick R, et al. Indicators of acute deterioration in adult patients nursed in acute wards: a factorial survey. J Clin Nurs 2011;20:723-32.

88. Robb G, Seddon M. A multi-faceted approach to the physiologically unstable patient. Qual Saf Health Care 2010;19:e47.

89. Shearer B, Marshall S, Buist MD, et al. What stops hospital clinical staff from following protocols? An analysis of the incidence and factors behind the failure of bedside clinical staff to activate the rapid response system in a multi-campus Australian metropolitan healthcare service. BMJ Qual Saf 2012;21:569-75.

90. Trinh QD, Bianchi M, Hansen J, et al. In-hospital Mortality and Failure to Rescue After Cytoreductive Nephrectomy. Eur Urol 2013;63:1107-14.

91. Wright JD, Herzog TJ, Siddiq Z, et al. Failure to rescue as a source of variation in hospital mortality for ovarian cancer. J Clin Oncol 2012;30:3976-82.

92. Wong K, Levy RD. Do surgeons need to look after unwell patients? The role of medical emergency teams. ANZ J Surg 2005;75:848-51.

93. Wynn JD, Engelke MK, Swanson M. The front line of patient safety: staff nurses and rapid response team calls. Qual Manag Health Care 2009;18:40-7.

94. Yasunaga H, Hashimoto H, Horiguchi H, Miyata H, Matsuda S. Variation in cancer surgical outcomes associated with physician and nurse staffing: a retrospective observational study using the Japanese Diagnosis Procedure Combination Database. BMC Health Serv Res 2012;12:129.

95. Andrews T, Waterman H. Packaging: a grounded theory of how to report physiological deterioration effectively. J Adv Nurs 2005;52:473-81.

96. Donohue LA, Endacott R. Track, trigger and teamwork: communication of deterioration in acute medical and surgical wards. Intensive Crit Care Nurs 2010;26:10-7.

97. Cioffi J, Salter C, Wilkes L, Vonu-Boriceanu O, Scott J. Clinicians' responses to abnormal vital signs in an emergency department. Aust Crit Care 2006;19:66-72.

98. Mackintosh N, Sandall J. Overcoming gendered and professional hierarchies in order to facilitate escalation of care in emergency situations: the role of standardised communication protocols. Soc Sci Med 2010;71:1683-6.

99. Mackintosh N, Rainey H, Sandall J. Understanding how rapid response systems may improve safety for the acutely ill patient: learning from the frontline. BMJ Qual Saf 2012;21:135-44.

100. Bobay KL, Fiorelli KL, Anderson AJ. Failure to rescue: a preliminary study of patient-level factors. J Nurs Care Qual 2008;23:211-5.

101. Almoudaris AM, Burns EM, Mamidanna R, et al. Value of failure to rescue as a marker of the standard of care following reoperation for complications after colorectal resection. Br J Surg 2011;98:1775-83.

102. Andrews T, Waterman H. Packaging: a grounded theory of how to report physiological deterioration effectively. J Adv Nurs 2005;52:473-81.

103. Sevdalis N, Lyons M, Healey AN, Undre S, Darzi A, Vincent CA. Observational teamwork assessment for surgery: construct validation with expert versus novice raters. Ann Surg 2009;249:1047-51.

104. van Beuzekom M, Boer F, Akerboom S, Hudson P. Patient safety: latent risk factors. Br J Anaesth 2010;105:52-9.

105. Dimick JB, Greenberg CC. Understanding gaps in surgical quality: learning to count what cannot be counted. Ann Surg 2013;257:6-7.

106. Silber JH, Romano PS, Rosen AK, Wang Y, Even-Shoshan O, Volpp KG. Failure-to-rescue: comparing definitions to measure quality of care. Med Care 2007;45:918-25.

107. Waldron N, Dey I, Nagree Y, Xiao J, Flicker L. A multi-faceted intervention to implement guideline care and improve quality of care for older people who present to the emergency department with falls. BMC geriatrics 2011;11:6.

108. Manser T, Foster S, Flin R, Patey R. Team communication during patient handover from the operating room: more than facts and figures. Hum Factors 2013;55:138-56.

109. Shouhed D, Gewertz B, Wiegmann D, Catchpole K. Integrating human factors research and surgery: a review. Arch Surg 2012;147:1141-6.

110. Anderson O, Brodie A, Vincent CA, Hanna GB. A systematic proactive risk assessment of hazards in surgical wards: a quantitative study. Ann Surg 2012;255:1086-92.

111. Birkmeyer NJ, Finks JF, Greenberg CK, et al. Safety culture and complications after bariatric surgery. Ann Surg 2013;257:260-5.

112. The Higher Risk General Surgical Patient: towards improved care for a forgotten group: Royal College of Surgeons of England; 2011.

113. Symons NR, Almoudaris AM, Nagpal K, Vincent CA, Moorthy K. An observational study of the frequency, severity, and etiology of failures in postoperative care after major elective general surgery. Ann Surg 2013;257:1-5.

114. Sydor DT, Bould MD, Naik VN, et al. Challenging authority during a life-threatening crisis: the effect of operating theatre hierarchy. Br J Anaesth 2013;110:463-71.

115. Kennedy TJ, Regehr G, Baker GR, Lingard L. Preserving professional credibility: grounded theory study of medical trainees' requests for clinical support. Bmj 2009;338:b128.

116. Vincent C, Taylor-Adams S, Stanhope N. Framework for analysing risk and safety in clinical medicine. Bmj 1998;316:1154-7.

117. Johnston M, Arora S, King D, Stroman L, Darzi A. Escalation of care and failure to rescue: a multicenter, multiprofessional qualitative study. Surgery 2014;155:989-94.

118. Bradley EH, Curry LA, Devers KJ. Qualitative data analysis for health services research: developing taxonomy, themes, and theory. Health Serv Res 2007;42:1758-72.

119. Mays N, Pope C. Qualitative research in health care. Assessing quality in qualitative research. Bmj 2000;320:50-2.

120. Francis R. Report of the Mid Staffordshire NHS Foundation Trust Public Inquiry2013.

121. Breen KJ, Hogan AM, Mealy K. The detrimental impact of the implementation of the European working time directive (EWTD) on surgical senior house officer (SHO) operative experience. Ir J Med Sci 2013;182:383-7.

122. Lonergan PE, Mulsow J, Tanner WA, Traynor O, Tierney S. Analysing the operative experience of basic surgical trainees in Ireland using a web-based logbook. BMC Med Educ 2011;11:70.

123. Yiu CJ, Khan SU, Subbe CP, Tofeec K, Madge RA. Into the night: factors affecting response to abnormal Early Warning Scores out-of-hours and implications for service improvement. Acute Med 2014;13:56-60.

124. Husain T, Gatward JJ, Hambidge OR, Asogan M, Southwood TJ. Strategies to prevent airway complications: a survey of adult intensive care units in Australia and New Zealand. Br J Anaesth 2012;108:800-6.

125. Ryan M, Hamilton V, Bowen M, McKenna P. The role of a high-dependency unit in a regional obstetric hospital. Anaesthesia 2000;55:1155-8.

126. Madhok R. Crossing the quality chasm: lessons from health care quality improvement efforts in England. Proceedings 2002;15:77-83; discussion -4.

127. Davis RE, Sevdalis N, Neale G, Massey R, Vincent CA. Hospital patients' reports of medical errors and undesirable events in their health care. J Eval Clin Pract 2013;19:875-81.

128. Davis RE, Sevdalis N, Vincent CA. Patient involvement in patient safety: the health-care professional's perspective. Journal of patient safety 2012;8:182-8.

129. Kelley K, Clark B, Brown V, Sitzia J. Good practice in the conduct and reporting of survey research. Int J Qual Health Care 2003;15:261-6.

130. Davis R, Briggs M, Arora S, Moss R, Schwappach D. Predictors of health care professionals' attitudes towards involvement in safety-relevant behaviours. J Eval Clin Pract 2014;20:12-9.

131. Ananthakrishnan AN, McGinley EL, Saeian K. Effect of hospital volume and teaching status on outcomes of acute liver failure. Liver transplantation : official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society 2008;14:1347-56.

132. Frosch DL, May SG, Rendle KA, Tietbohl C, Elwyn G. Authoritarian physicians and patients' fear of being labeled 'difficult' among key obstacles to shared decision making. Health Aff (Millwood) 2012;31:1030-8.

133. Gonzalo JD, Kuperman E, Lehman E, Haidet P. Bedside interprofessional rounds: Perceptions of benefits and barriers by internal medicine nursing staff, attending physicians, and housestaff physicians. J Hosp Med 2014;9:646-51.

134. Boniatti MM, Azzolini N, Viana MV, et al. Delayed Medical Emergency Team Calls and Associated Outcomes. Crit Care Med 2013.

135. National Patient Safety Goals 2014: The Joint Commission.

136. Stalhandske E, DeRosier J, Wilson R, Murphy J. Healthcare FMEA in the Veterans Health Administration. Patient Safety & Quality Healthcare2009.

137. Dale BG, Shaw P. Failure mode and effects analysis in the UK motor industry: A state-of-the-art study. Quality and Reliability Engineering International 1990;6:179-88.

138. DeRosier J, Stalhandske E, Bagian JP, Nudell T. Using health care Failure Mode and Effect Analysis: the VA National Center for Patient Safety's prospective risk analysis system. The Joint Commission journal on quality improvement 2002;28:248-67, 09.

139. Catchpole KR, Dale TJ, Hirst DG, Smith JP, Giddings TA. A multicenter trial of aviation-style training for surgical teams. Journal of patient safety 2010;6:180-6.

140. Aiken LH, Clarke SP, Sloane DM, Sochalski J, Silber JH. Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. JAMA : the journal of the American Medical Association 2002;288:1987-93.

141. Zhu XW, You LM, Zheng J, et al. Nurse staffing levels make a difference on patient outcomes: a multisite study in Chinese hospitals. J Nurs Scholarsh 2012;44:266-73.

142. Kane RL, Shamliyan T, Mueller C, Duval S, Wilt TJ. Nurse staffing and quality of patient care. Evidence report/technology assessment 2007:1-115.

143. Solvoll T, Scholl J, Hartvigsen G. Physicians interrupted by mobile devices in hospitals: understanding the interaction between devices, roles, and duties. J Med Internet Res 2013;15:e56.

144. Paine LA, Rosenstein BJ, Sexton JB, Kent P, Holzmueller CG, Pronovost PJ. Republished paper: assessing and improving safety culture throughout an academic medical centre: a prospective cohort study. Postgrad Med J 2011;87:428-35.

145. Ahmed M, Arora S, Tiew S, et al. Building a safer foundation: the Lessons Learnt patient safety training programme. BMJ Qual Saf 2014;23:78-86.

146. Hull L, Arora S, Symons NR, et al. Training faculty in nontechnical skill assessment: national guidelines on program requirements. Ann Surg 2013;258:370-5.

147. Coiera E, Tombs V. Communication behaviours in a hospital setting: an observational study. Bmj 1998;316:673-6.

148. Thomson RL, D. Healey, F. Scobie, S. Safer Care for the Acutely Ill Patient: Learning from Serious Incidents.
: National Patient Safety Agency; 2007.

149. Smith F. Who invented that bleeping thing. Br Med J (Clin Res Ed) 2003;327:719.

150. Aziz O, Panesar SS, Netuveli G, Paraskeva P, Sheikh A, Darzi A. Handheld computers and the 21st century surgical team: a pilot study. BMC Med Inform Decis Mak 2005;5:28.

151. Joseph B, Pandit V, Khreiss M, et al. Improving communication in level 1 trauma centers: replacing pagers with smartphones. Telemed J E Health 2013;19:150-4.

152. Boulos MN, Wheeler S, Tavares C, Jones R. How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX. Biomed Eng Online 2011;10:24.

153. Quan SD, Wu RC, Rossos PG, et al. It's not about pager replacement: an in-depth look at the interprofessional nature of communication in healthcare. J Hosp Med 2013;8:137-43.

154. Brenke C, Lassel EA, Terris D, et al. On-Call Service of Neurosurgeons in Germany: Organization, Use of Communication Services, and Personal Acceptance of Modern Technologies. J Neurol Surg A Cent Eur Neurosurg 2013.

155. Johnston MJ, King D, Arora S, et al. Requirements of a new communication technology for handover and the escalation of patient care: a multi-stakeholder analysis. J Eval Clin Pract 2014;20:486-97.

156. Putzer GJ, Park Y. Are physicians likely to adopt emerging mobile technologies? Attitudes and innovation factors affecting smartphone use in the southeastern United States. Perspect Health Inf Manag 2012;9:1b.

157. Ammenwerth E, Buchauer A, Bludau B, Haux R. Mobile information and communication tools in the hospital. Int J Med Inform 2000;57:21-40.

158. Ernst AA, Weiss SJ, Reitsema JA. Does the addition of Vocera hands-free communication device improve interruptions in an academic emergency department? South Med J 2013;106:189-95.

159. Haroon M, Yasin F, Eckel R, Walker F. Perceptions and attitudes of hospital staff toward paging system and the use of mobile phones. Int J Technol Assess Health Care 2010;26:377-81.

160. Ighani F, Kapoor KG, Gibran SK, et al. A comparison of two-way text versus conventional paging systems in an academic ophthalmology department. J Med Syst 2010;34:677-84.

161. Jacques PS, France DJ, Pilla M, Lai E, Higgins MS. Evaluation of a hands-free wireless communication device in the perioperative environment. Telemed J E Health 2006;12:42-9.

162. Katz-Sidlow RJ, Ludwig A, Miller S, Sidlow R. Smartphone use during inpatient attending rounds: prevalence, patterns and potential for distraction. J Hosp Med 2012;7:595-9.

163. Lapinsky SE, Weshler J, Mehta S, Varkul M, Hallett D, Stewart TE. Handheld computers in critical care. Critical Care 2001;5:227-31.

164. Lo V, Wu RC, Morra D, Lee L, Reeves S. The use of smartphones in general and internal medicine units: a boon or a bane to the promotion of interprofessional collaboration? Journal of Interprofessional Care 2012;26:276-82.

165. Mejia DA, Favela J, Moran AL. Understanding and supporting lightweight communication in hospital work. IEEE Trans Inf Technol Biomed 2010;14:140-6.

166. Mendonca EA, Chen ES, Stetson PD, McKnight LK, Lei J, Cimino JJ. Approach to mobile information and communication for health care. Int J Med Inform 2004;73:631-8.

167. Menzies OH, Thwaites J. A survey of personal digital assistant use in a sample of New Zealand doctors. N Z Med J 2012;125:48-59.

168. Munoz MA, Rodriguez M, Favela J, Martinez-Garcia AI, Gonzalez VM. Context-Aware Mobile Communication in Hospitals. Computer 2003;36:38-46.

169. Nguyen TC, Battat A, Longhurst C, Peng PD, Curet MJ. Alphanumeric paging in an academic hospital setting. Am J Surg 2006;191:561-5.

170. O'Connor C, Friedrich JO, Scales DC, Adhikari NK. The use of wireless e-mail to improve healthcare team communication. J Am Med Inform Assoc 2009;16:705-13.

171. Patel R, Reilly K, Old A, Naden G, Child S. Appropriate use of pagers in a New Zealand tertiary hospital. N Z Med J 2006;119:U1912.

172. Richards JD, Harris T. Beam me up Scotty! Impact of personal wireless communication devices in the emergency department. Emerg Med J 2011;28:29-32.

173. Richardson JE, Ash JS. The effects of hands free communication devices on clinical communication: balancing communication access needs with user control. AMIA Annu Symp Proc 2008:621-5.

174. Smith CN, Quan SD, Morra D, et al. Understanding interprofessional communication: a content analysis of email communications between doctors and nurses. Appl Clin Inform 2012;3:38-51.

175. Thompson BW. The transforming effect of handheld computers on nursing practice. Nurs Adm Q 2005;29:308-14.

176. Volpp KG, Grande D. Residents' suggestions for reducing errors in teaching hospitals. N Engl J Med 2003;348:851-5.

177. Wong WW, Gupta SC. Plastic surgery marketing in a generation of "tweeting". Aesthet Surg J 2011;31:972-6.

178. Wu RC, Morra D, Quan S, et al. The use of smartphones for clinical communication on internal medicine wards. J Hosp Med 2010;5:553-9.

179. Wu R, Rossos P, Quan S, et al. An evaluation of the use of smartphones to communicate between clinicians: a mixed-methods study. J Med Internet Res 2011;13:e59.

180. Wu RC, Lo V, Morra D, et al. The intended and unintended consequences of communication systems on general internal medicine inpatient care delivery: a prospective observational case study of five teaching hospitals. J Am Med Inform Assoc 2013;20:766-77.

181. Wong WW, Gupta SC. Plastic surgery marketing in a generation of "tweeting". Aesthetic Surgery Journal 2011;31:972-6.

182. Egdell P, Finlay L, Pedley DK. The PAWS score: validation of an early warning scoring system for the initial assessment of children in the emergency department. Emerg Med J 2008;25:745-9.

183. Information needs of residents during inpatient and outpatient rotations: identifying effective personal digital assistant applications. AMIA Annual Symposium proceedings / AMIA Symposium AMIA Symposium 2003;784.

184. Etchells E, Adhikari NK, Cheung C, et al. Real-time clinical alerting: effect of an automated paging system on response time to critical laboratory values--a randomised controlled trial. Qual Saf Health Care 2010;19:99-102.

185. De Meester K, Verspuy M, Monsieurs KG, Van Bogaert P. SBAR improves nurse-physician communication and reduces unexpected death: A pre and post intervention study. Resuscitation 2013;84:1192-6.

186. Solet DJ, Norvell JM, Rutan GH, Frankel RM. Lost in translation: challenges and opportunities in physician-to-physician communication during patient handoffs. Acad Med 2005;80:1094-9.

187. Jeffcott SA, Evans SM, Cameron PA, Chin GS, Ibrahim JE. Improving measurement in clinical handover. Qual Saf Health Care 2009;18:272-7.

188. Karoo RO, Whitaker IS, Sharpe DT. Hyperlinking with your tablet personal computer: enhancing your surgical logbook. Ann Plas Surg 2006;56:702-3.

189. Andersen P, Lindgaard AM, Prgomet M, Creswick N, Westbrook JI. Mobile and fixed computer use by doctors and nurses on hospital wards: multi-method study on the relationships between clinician role, clinical task, and device choice. J Med Internet Res 2009;11:e32.

190. Woolf SH, Grol R, Hutchinson A, Eccles M, Grimshaw J. Clinical guidelines: potential benefits, limitations, and harms of clinical guidelines. Bmj 1999;318:527-30.

191. Storm-Versloot MN, Vermeulen H, van Lammeren N, Luitse JS, Goslings JC. Influence of the Manchester Triage System on waiting time, treatment time, length of stay and patient satisfaction; a before and after study. Emerg Med J 2013.

192. Neumann PG. Robust Open-Source Software. Communications of the ACM1998:128.

193. DocCom company website. 2007. (Accessed 16/04/2014, at http://www.doccom.info/.)

194. Relay Health company website. 2012. (Accessed 16/04/2014, at http://www.relayhealth.com/solutions/clinical-solutions.)

195. Lapointe L, Rivard S. Clinical information systems: understanding and preventing their premature demise. Healthc Q 2005;8:92-100.

196. Coiera E. Communication systems in healthcare. The Clinical biochemist Reviews / Australian Association of Clinical Biochemists 2006;27:89-98.

197. Gans D, Kralewski J, Hammons T, Dowd B. Medical groups' adoption of electronic health records and information systems. Health Aff (Millwood) 2005;24:1323-33.

198. Kaplan B, Harris-Salamone KD. Health IT success and failure: recommendations from literature and an AMIA workshop. J Am Med Inform Assoc 2009;16:291-9.

199. Hoeksma J. Turning doctors into coders. Bmj 2013;347:f5142.

200. Watt IS, Franks AJ, Sheldon TA. Health and health care of rural populations in the UK: is it better or worse? Journal of epidemiology and community health 1994;48:16-21.

201. Lorenzi NM, Riley RT. Managing change: an overview. J Am Med Inform Assoc 2000;7:116-24.

202. Powell-Cope G, Nelson AL, Patterson ES. Patient Care Technology and Safety. In: Hughes RG, ed. Patient Safety and Quality: An Evidence-Based Handbook for Nurses. Rockville (MD)2008.

203. Nagpal K, Arora S, Vats A, et al. Failures in communication and information transfer across the surgical care pathway: interview study. BMJ Qual Saf 2012;21:843-9.

204. Lingard L, Regehr G, Espin S, Whyte S. A theory-based instrument to evaluate team communication in the operating room: balancing measurement authenticity and reliability. Qual Saf Health Care 2006;15:422-6.

205. Cook KE, Ludens GM, Ghosh AK, Mundell WC, Fleming KC, Majka AJ. Improving Efficiency and Reducing Administrative Burden through Electronic Communication. Perm J 2013;17:26-30.

206. Koh S, Cattell GM, Cochran DM, Krasner A, Langheim FJ, Sasso DA. Psychiatrists' use of electronic communication and social media and a proposed framework for future guidelines. J Psychiatr Pract 2013;19:254-63.

207. Franko OI, Tirrell TF. Smartphone app use among medical providers in ACGME training programs. J Med Syst 2012;36:3135-9.

208. Hughes HK, Korthuis PT, Saha S, et al. A mixed methods study of patient-provider communication about opioid analgesics. Patient Educ Couns 2015.

209. Shiyanbola OO, Mort JR. Patients' perceived value of pharmacy quality measures: a mixed-methods study. BMJ Open 2015;5:e006086.

210. Silverman AT, Goldfarb MA, Baker T. When should a surgical resident call an attending surgeon? J Surg Educ 2008;65:206-12.

211. Lingard L, Espin S, Whyte S, et al. Communication failures in the operating room: an observational classification of recurrent types and effects. Qual Saf Health Care 2004;13:330-4.

212. Nagpal K, Arora S, Abboudi M, et al. Postoperative handover: problems, pitfalls, and prevention of error. Ann Surg 2010;252:171-6.

213. Sutcliffe KM, Lewton E, Rosenthal MM. Communication failures: an insidious contributor to medical mishaps. Acad Med 2004;79:186-94.

214. Payne KB, Wharrad H, Watts K. Smartphone and medical related App use among medical students and junior doctors in the United Kingdom (UK): a regional survey. BMC Med Inform Decis Mak 2012;12:121.

215. Mickan S, Tilson JK, Atherton H, Roberts NW, Heneghan C. Evidence of Effectiveness of Health Care Professionals Using Handheld Computers: A Scoping Review of Systematic Reviews. J Med Internet Res 2013;15:e212.

216. Macfarlane F, Barton-Sweeney C, Woodard F, Greenhalgh T. Achieving and sustaining profound institutional change in healthcare: case study using neo-institutional theory. Soc Sci Med 2013;80:10-8.

217. Brigic A, Bloor J, Clark A, Thomas M. How will health-care organizations meet venous thromboembolism targets? British Journal of Hospital Medicine 2011;72:35-8.

218. Whittaker R. Issues in mHealth: findings from key informant interviews. J Med Internet Res 2012;14:e129.

219. McElroy LM, Ladner DP, Holl JL. The role of technology in clinician-to-clinician communication. BMJ Qual Saf 2013;22:981-3.

220. Hull L, Birnbach D, Arora S, Fitzpatrick M, Sevdalis N. Improving surgical ward care: development and psychometric properties of a global assessment toolkit. Ann Surg 2014;259:904-9.

221. Csonka LN, Ikeda TP, Fletcher SA, Kustu S. The Accumulation of Glutamate Is Necessary for Optimal-Growth of Salmonella-Typhimurium in Media of High-Osmolality but Not Induction of the Prou Operon. J Bacteriol 1994;176:6324-33.

222. Sevdalis N, Davis R, Koutantji M, Undre S, Darzi A, Vincent CA. Reliability of a revised NOTECHS scale for use in surgical teams. Am J Surg 2008;196:184-90.

223. Cunningham NJ, Weiland TJ, van Dijk J, Paddle P, Shilkofski N, Cunningham NY. Telephone referrals by junior doctors: a randomised controlled trial assessing the impact of SBAR in a simulated setting. Postgrad Med J 2012.

224. Taylor TS, Nisker J, Lingard L. To stay or not to stay? A grounded theory study of residents' postcall behaviors and their rationalizations for those behaviors. Acad Med 2013;88:1529-33.

225. Taylor MJ, McNicholas C, Nicolay C, Darzi A, Bell D, Reed JE. Systematic review of the application of the plan-do-study-act method to improve quality in healthcare. BMJ Qual Saf 2014;23:290-8.

226. Polit DF, Beck CT. The content validity index: are you sure you know what's being reported? Critique and recommendations. Res Nurs Health 2006;29:489-97.

227. Wynd CA, Schmidt B, Schaefer MA. Two quantitative approaches for estimating content validity. West J Nurs Res 2003;25:508-18.

228. Pett MA. Nonparametric Statistics in Health Care Research: SAGE Publications, Inc; 1997.

229. Adhiyaman V, Oke A, White AD, Shah IU. Diagnoses in discharge communications: how far are they reliable? Int J Clin Pract 2000;54:457-8.

230. Agarwal H, Wang W, Saville B, et al. Development and assessment of structured hand-off process in a multi-disciplinary, multispecialty pediatric intensive care unit. Crit Care Med 2010;Conference:40th Critical Care Congress of the Society of Critical Care Medicine San Diego, CA United States. Conference Start: 20110115 Conference End: 9. Conference Publication: (var.pagings). 38 (pp A26).

231. Anwari JS. Quality of handover to the postanaesthesia care unit nurse. Anaesthesia 2002;57:488-93.

232. Archbold RA, Laji K, Suliman A, Ranjadayalan K, Hemingway H, Timmis AD. Evaluation of a computer-generated discharge summary for patients with acute coronary syndromes. The British journal of general practice : the journal of the Royal College of General Practitioners 1998;48:1163-4.

233. Bertrand D, Francois P, Bosson JL, Fauconnier J, Weil G. Quality assessment of discharge letters in a French university hospital. International journal of health care quality assurance incorporating Leadership in health services 1998;11:90-5.

234. Catchpole K, Sellers R, Goldman A, McCulloch P, Hignett S. Patient handovers within the hospital: translating knowledge from motor racing to healthcare. Qual Saf Health Care 2010;19:318-22.

235. Clark CJ, Sindell SL, Koehler RP. Template for success: using a resident-designed sign-out template in the handover of patient care. J Surg Educ 2011;68:52-7.

236. Craig R, Moxey L, Young D, Spenceley NS, Davidson MG. Strengthening handover communication in pediatric cardiac intensive care. Paediatr Anaesth 2012;22:393-9.

237. Fair JF. Hospital discharge and death communications. Br J Hosp Med 1989;42:59-61.

238. Foster DS, Paterson C, Fairfield G. Evaluation of immediate discharge documents--room for improvement? Scottish medical journal 2002;47:77-9.

239. Greenberg CC, Regenbogen SE, Studdert DM, et al. Patterns of communication breakdowns resulting in injury to surgical patients. J Am Coll Surg 2007;204:533-40.

240. Horwitz LI PV, Shah NR, Schuur JD, Meredith T, Jenq GY, Kulkarni RG. Evaluation of an Asynchronous Physician Voicemail Sign-out for Emergency Department Admissions. Annals of Emergency Medicine 2009;54:368-78.

241. Joy BF, Elliott E, Hardy C, Sullivan C, Backer CL, Kane JM. Standardized multidisciplinary protocol improves handover of cardiac surgery patients to the intensive care unit. Pediatr Crit Care Med 2011;12:304-8.

242. Karakaya A, Moerman AT, Peperstraete H, Francois K, Wouters PF, de Hert SG. Implementation of a structured information transfer checklist improves postoperative data transfer after congenital cardiac surgery. Eur J Anaesthesiol 2013.

243. Kendrick AR, Hindmarsh DJ. Which type of hospital discharge report reaches general practitioners most quickly? Bmj 1989;298:362-3.

244. Kripalani S, LeFevre F, Phillips CO, Williams MV, Basaviah P, Baker DW. Deficits in communication and information transfer between hospital-based and primary care physicians: implications for patient safety and continuity of care. JAMA : the journal of the American Medical Association 2007;297:831-41.

245. Lissauer T, Paterson CM, Simons A, Beard RW. Evaluation of computer generated neonatal discharge summaries. Arch Dis Child 1991;66:433-6.

246. Mageean RJ. Study of "discharge communications" from hospital. Br Med J (Clin Res Ed) 1986;293:1283-4.

247. Manser T, Foster S. Effective handover communication: an overview of research and improvement efforts. Best Pract Res Clin Anaesthesiol 2011;25:181-91.

248. Manser T, Foster S, Gisin S, Jaeckel D, Ummenhofer W. Assessing the quality of patient handoffs at care transitions. Qual Saf Health Care 2010;19:e44.

249. Marks MK, Hynson JL, Karabatsos G. Asthma: communication between hospital and general practitioners. Journal of paediatrics and child health 1999;35:251-4.

250. Evaluation of postoperative handover using a tool to assess information transfer and teamwork. Ann Surg 2011;253:831-7.

251. Nagpal K, Vats A, Ahmed K, Vincent C, Moorthy K. An evaluation of information transfer through the continuum of surgical care: a feasibility study. Ann Surg 2010;252:402-7.

252. Pantilat SZ, Lindenauer PK, Katz PP, Wachter RM. Primary care physician attitudes regarding communication with hospitalists. Disease-a-month : DM 2002;48:218-29.

253. Penney TM. Delayed communication between hospitals and general practitioners: where does the problem lie? Bmj 1988;297:28-9.

254. Petrovic MA, Aboumatar H, Baumgartner WA, et al. Pilot implementation of a perioperative protocol to guide operating room-to-intensive care unit patient handoffs. Journal of Cardiothoracic & Vascular Anesthesia 2012;26:11-6.

255. Pickering BW, Hurley K, Marsh B. Identification of patient information corruption in the intensive care unit: using a scoring tool to direct quality improvements in handover. Crit Care Med 2009;37:2905-12.

256. Rao P, Andrei A, Fried A, Gonzalez D, Shine D. Assessing quality and efficiency of discharge summaries. Am J Med Qual 2005;20:337-43.

257. Rudiger-Sturchler M, Keller DI, Bingisser R. Emergency physician intershift handover - can a dINAMO checklist speed it up and improve quality? Swiss medical weekly 2010;140:w13085.

258. Salerno SM, Arnett MV, Domanski JP. Standardized sign-out reduces intern perception of medical errors on the general internal medicine ward. Teach Learn Med 2009;21:121-6.

259. Sandler DA, Mitchell JR. Interim discharge summaries: how are they best delivered to general practitioners? Br Med J (Clin Res Ed) 1987;295:1523-5.

260. Scott LA, Brice JH, Baker CC, Shen P. An analysis of paramedic verbal reports to physicians in the emergency department trauma room. Prehosp Emerg Care 2003;7:247-51.

261. Smith AF, Mishra K. Interaction between anaesthetists, their patients, and the anaesthesia team. Br J Anaesth 2010;105:60-8.

262. Symons NR, Wong HW, Manser T, Sevdalis N, Vincent CA, Moorthy K. An observational study of teamwork skills in shift handover. Int J Surg 2012;10:355-9.

263. Telem DA, Buch KE, Ellis S, Coakley B, Divino CM. Integration of a formalized handoff system into the surgical curriculum: resident perspectives and early results. Arch Surg 2011;146:89-93.

264. Tulloch AJ, Fowler GH, McMullan JJ, Spence JM. Hospital discharge reports: content and design. Br Med J 1975;4:443-6.

265. van Walraven C, Laupacis A, Seth R, Wells G. Dictated versus database-generated discharge summaries: a randomized clinical trial. CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne 1999;160:319-26.

266. Wayne JD, Tyagi R, Reinhardt G, et al. Simple standardized patient handoff system that increases accuracy and completeness. J Surg Educ 2008;65:476-85.

267. Webster JL, Cao CGL. Lowering communication barriers in operating room technology. Hum Factors 2006;48:747-58.

268. Zavalkoff SR, Razack SI, Lavoie J, Dancea AB. Handover after pediatric heart surgery: a simple tool improves information exchange. Pediatr Crit Care Med 2011;12:309-13.

269. Smith AF, Pope C, Goodwin D, Mort M. Interprofessional handover and patient safety in anaesthesia: observational study of handovers in the recovery room. Br J Anaesth 2008;101:332-7.

270. Wayne JD, Tyagi R, Reinhardt G, et al. Simple standardized patient handoff system that increases accuracy and completeness. J Surg Educ 2008;65:476-85.

271. Agarwal HS, Saville BR, Slayton JM, et al. Standardized postoperative handover process improves outcomes in the intensive care unit: a model for operational sustainability and improved team performance*. Crit Care Med 2012;40:2109-15.

272. Greenberg CC, Regenbogen SE, Studdert DM, et al. Patterns of communication breakdowns resulting in injury to surgical patients. J Am Coll Surg 2007;204:533-40.

273. Smith AF, Pope C, Goodwin D, Mort M. Interprofessional handover and patient safety in anaesthesia: observational study of handovers in the recovery room. Br J Anaesth 2008;101:332-7.

274. Webster JL, Cao CG. Lowering communication barriers in operating room technology. Hum Factors 2006;48:747-58.

275. Symons NRA, Wong HWL, Manser T, Sevdalis N, Vincent CA, Moorthy K. An observational study of teamwork skills in shift handover. Int J Surg 2012;10:355-9.

276. Marshall S, Harrison J, Flanagan B. The teaching of a structured tool improves the clarity and content of interprofessional clinical communication. Qual Saf Health Care 2009;18:137-40.

277. Johnston M, Arora S, Anderson O, King D, Behar N, Darzi A. Escalation of Care in Surgery: A Systematic Risk Assessment to Prevent Avoidable Harm in Hospitalized Patients. Ann Surg 2014.

278. Curtis JR, Back AL, Ford DW, et al. Effect of communication skills training for residents and nurse practitioners on quality of communication with patients with serious illness: a randomized trial. JAMA : the journal of the American Medical Association 2013;310:2271-81.

279. Falcone JL, Claxton RN, Marshall GT. Communication skills training in surgical residency: a needs assessment and metacognition analysis of a difficult conversation objective structured clinical examination. J Surg Educ 2014;71:309-15.

280. Steinemann S, Berg B, DiTullio A, et al. Assessing teamwork in the trauma bay: introduction of a modified "NOTECHS" scale for trauma. Am J Surg 2012;203:69-75.

281. Seymour NE, Cooper JB, Farley DR, et al. Best practices in interprofessional education and training in surgery: experiences from American College of Surgeons-Accredited Education Institutes. Surgery 2013;154:1-12.

282. Korndorffer JR, Jr., Kasten SJ, Downing SM. A call for the utilization of consensus standards in the surgical education literature. Am J Surg 2010;199:99-104.

283. Starmer AJ, Spector ND, Srivastava R, et al. Changes in medical errors after implementation of a handoff program. N Engl J Med 2014;371:1803-12.

284. Harris AD, McGregor JC, Perencevich EN, et al. The use and interpretation of quasi-experimental studies in medical informatics. J Am Med Inform Assoc 2006;13:16-23.

285. Golomb BA, Criqui MH, White HL, Dimsdale JE. The UCSD Statin Study: a randomized controlled trial assessing the impact of statins on selected noncardiac outcomes. Controlled clinical trials 2004;25:178-202.

286. Donner A, Klar N. Pitfalls of and controversies in cluster randomization trials. Am J Public Health 2004;94:416-22.

287. Sexton JB, Helmreich RL, Neilands TB, et al. The Safety Attitudes Questionnaire: psychometric properties, benchmarking data, and emerging research. BMC Health Serv Res 2006;6:44.

288. Catchpole K. Toward the modelling of safety violations in healthcare systems. BMJ Qual Saf 2013;22:705-9.

289. Flin R, Bromiley M, Buckle P, Reid J. Mid Staffs inquiry. Changing behaviour with a human factors approach. Bmj 2013;346:f1416.

290. A promise to learn - a commitment to act: National Advisory Group on the Safety of Patients in England; 2013.

291. Haynes AB, Berry WR, Gawande AA. Surgical safety checklists in ontario, Canada. N Engl J Med 2014;370:2350.

292. Urbach DR, Govindarajan A, Saskin R, Wilton AS, Baxter NN. Introduction of surgical safety checklists in Ontario, Canada. N Engl J Med 2014;370:1029-38.

293. Leape LL. The checklist conundrum. N Engl J Med 2014;370:1063-4.

294. Hutchinson E. Safety at the sharp end: A guide to non-technical skills. Psychologist 2008;21:687-.

295. Lucas DJ, Ejaz A, Bischof DA, Schneider EB, Pawlik TM. Variation in Readmission by Hospital After Colorectal Cancer Surgery. JAMA surgery 2014.

296. Pronovost P, Goeschel C. Improving ICU care: it takes a team. Healthcare executive 2005;20:14-6, 8, 20 passim.

297. Birkmeyer JD, Finks JF, O'Reilly A, et al. Surgical skill and complication rates after bariatric surgery. N Engl J Med 2013;369:1434-42.

298. Haynes AB, Weiser TG, Berry WR, et al. A surgical safety checklist to reduce morbidity and mortality in a global population. N Engl J Med 2009;360:491-9.

299. Kasatpibal N, Senaratana W, Chitreecheur J, Chotirosniramit N, Pakvipas P, Junthasopeepun P. Implementation of the World Health Organization surgical safety checklist at a university hospital in Thailand. Surgical Infections 2012;13:50-6.

300. Johnston MJ, King D, Arora S, et al. Smartphones let surgeons know WhatsApp: an analysis of communication in emergency surgical teams. Am J Surg 2014;209:45-51.

301. Jadad AR, Moore RA, Carroll D, et al. Assessing the quality of reports of randomized clinical trials: is blinding necessary? Controlled clinical trials 1996;17:1-12.

302. Stang A. Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. European journal of epidemiology 2010;25:603-5.

303. Neyarapally GA, Hammad TA, Pinheiro SP, Iyasu S. Review of quality assessment tools for the evaluation of pharmacoepidemiological safety studies. BMJ Open 2012;2.

304. Farquhar MC, Ewing G, Booth S. Using mixed methods to develop and evaluate complex interventions in palliative care research. Palliat Med 2011;25:748-57.

305. Stefanidis D, Arora S, Parrack DM, et al. Research priorities in surgical simulation for the 21st century. Am J Surg 2012;203:49-53.

306. Stefanidis D, Sevdalis N, Paige J, et al. Simulation in Surgery: What's Needed Next? Ann Surg 2014.

307. Scott T, Mannion R, Davies HT, Marshall MN. Implementing culture change in health care: theory and practice. Int J Qual Health Care 2003;15:111-8.

308. Davies HT, Nutley SM, Mannion R. Organisational culture and quality of health care. Quality in health care : QHC 2000;9:111-9.

309. Weber V, Joshi MS. Effecting and leading change in health care organizations. The Joint Commission journal on quality improvement 2000;26:388-99.

310. Arora S, Aggarwal R, Sirimanna P, et al. Mental practice enhances surgical technical skills: a randomized controlled study. Ann Surg 2011;253:265-70.

311. Arora S, Aggarwal R, Moran A, et al. Mental practice: effective stress management training for novice surgeons. J Am Coll Surg 2011;212:225-33.

312. Ericsson KA. Deliberate practice and acquisition of expert performance: a general overview. Acad Emerg Med 2008;15:988-94.

313. Crochet P, Aggarwal R, Dubb SS, et al. Deliberate practice on a virtual reality laparoscopic simulator enhances the quality of surgical technical skills. Ann Surg 2011;253:1216-22.

314. Johnston M, Mobasheri M, King D, Darzi A. The Clarify, Design and Evaluate (CDE) approach to mHealth app development. BMJ Innovations 2015 [Epub ahead of print].

Appendices

Appendix A Escalation of care interview topic guide for junior surgeons (Chapter 3)

Introduction: We want to ask some questions about some of the problems that we have been having on the wards to try & improve things. This interview and the questionnaires will be ANONYMOUS and CONFIDENTIAL.

Scope	Questions
1. Basic demographics	Please can you tell me your level and specialty?
2. Identifying the problem	Do you think there is a problem in getting senior support here/calling for help? *Prompt: By calling for help, I mean junior doctors feeling that they are outside their limits and asking someone else to help them, either because they don't know what to do next or because the patient is deteriorating clinically*
3. Establish current landscape	Imagine you are on the ward during normal working hours. You are called by a nurse on the phone and asked to review a sick patient on the ward. What information do you require from a ward nurse prior to reviewing a patient? *Prompt: Do you request EWS or observations before agreeing to a task (e.g. IV cannulation)* You go to the ward, examine the patient and realise you need help. Who would you call for help? (wait for answer) What if you get no answer? Who do you call next? *Prompt (Team SHO, on-call SHO, Team SPR, on-call SPR, crisis team etc…)* So when you have called for help, What response do you generally get from your seniors when you call for help? Would you contact the consultant directly if other team members are unavailable? (remember this refers to a couple of months ago, not now) Would you contact the ITU SPR if other team members are available? At what point would you call for help generally if asked to see a sick patient? *Prompt (Before going to the ward, prior to initial assessment, after initial assessment, after implementing initial treatment/resuscitation)* How do you try to obtain support? *Prompt (Bleep, mobile phone, face-to-face)* What about if is out of hours – does that change your responses to the above?

4. Prioritisation of tasks	You have a list of jobs to perform in a limited time period (*some are routine tasks – prescriptions, TTOs and some are reviewing unwell patients)* Which jobs would you perform first and why? If seeing patients first, how would you decide which one to see first? *Prompt: would you see the patient with the highest EWS or the patient who had been waiting longer?*
5. Barriers to getting support	Do you know of a time when you or someone else had a sick patient and they could not get support? What happened? *Prompt: what happened to you and what happened to the patient?* More generally, Can you tell me what factors you consider when you decide whether you need to call for help? *Prompt: Clinical factors* *Unfamiliar disease? Unknown patient?* *Non-clinical factors* *Time of day? Gender? Hierarchy?* *Concerns regarding own competency ? Concerns regarding competency of a senior colleague?* *Trainee Desire for independence?* *Concerns regarding professional interest/lack of interest of a senior colleague?* *Availability of senior? Approachability of senior?* *Concerns regarding your professional relationship with a colleague?* *Technological failure of hospital bleep system?* *Failure to charge your own mobile/bleep device*
6. Facilitators to getting support	Have you have any good experiences when trying to get help? What are the facilitators you use/have experienced when calling for help?
7. Improvements	The problem is that you can ask people to call for help over and over but simply telling them is not enough. It's difficult. Do you have any ideas as to how we can improve the process? How can we demonstrate that things have improved? Can we measure anything? Would a protocol be useful? What do you feel about the use of new communication technology to distribute jobs between healthcare workers?
8. Final points	Finally, how have things changed in the last couple of weeks? Is it easier to get help? Do you feel more supported? Do you know who to call if there are any problems? Would you now call the consultant directly?

Appendix B Patient socio-demographic questionnaire (Chapter 4)

Name: **Age:**

Gender: Male Female

Job Status: Employed Unemployed Retired Student
Other (specify) ______________________

Ethnic group:

☐White British
☐White (other)
☐Mixed (White & Black Caribbean)
☐Mixed (White & Black African)
☐Mixed (White & Asian)
☐Mixed (all other)
☐Asian/Asian British (Indian)
☐Asian/Asian British (Pakistani)
☐Asian/Asian British (Bangladeshi)
☐Asian/Asian British (all other)
☐Black/Black British (Caribbean)
☐Black/Black British (African)
☐Black/Black British (all other)
☐Chinese
☐All other ethnic groups
☐Not given

What is the reason you are in hospital? (i.e., presenting health complaint)
____

Were you admitted to hospital electively or as an emergency (through A&E)
____

Appendix C Focus Group Topic Guide (Chapter 6)

Location:

Date:

Time:

Supplies:
Large table and chairs
A quiet room
Audio recording equipment (plus back-up equipment)
Name plates for participants
Flip chart/ Whiteboard
Markers
Pens
Financial Incentives

Time Estimate:
1 hour
Number of Participants:
6-12

Introduction

- **Thank you** for coming along today and agreeing to take part in this focus group.
- Please allow us to briefly **introduce** ourselves; we are x and y, medical students at Imperial College; currently undertaking research here at St. Marys into current communication methods in use. I (X) will be leading the focus group today and asking questions, (Y) may also ask questions.
- The **aim of our focus group** today is to explore methods for communicating with your colleagues and the technology you use. We are looking forward to hearing your opinions today.
- We estimate the **time** take to conduct the focus group will be 1hr.
- We would like to **record the audio** in this focus group for our own record, do we have your **permission** to do so? To facilitate this we would like to refer to you as Nurse 1/Doctor 1 to enable anonymisation and make transcription of the audio easier.
- Please be aware that any information that you do provide us with will be pooled together. Although what you say here may be quoted in our study, all information will remain anonymous. We would also ask that you respect each other's right to privacy and refrain from discussing the opinions of others outside this focus group.
- You are welcome to **refuse to answer** any question or **withdraw** from the study at any time.

General Question to Build Rapport

- If we could begin by going around the table and each **introduce yourselves** by telling us your **name** and **role**.

Explanation of Focus Group

- Have any of you ever participated in a **focus group before**?
- For those of you who are not familiar with focus groups, focus groups are a research technique by which questions about your perceptions and opinions are asked in a group setting that allows us to **learn** and **gather information** from you. We encourage you to discuss answers to the questions amongst yourselves. We are equally interested in BOTH your positive and negative opinions and experiences and are not looking for a consensus.
- And at this point I would like to reiterate that any information that you do provide will be kept anonymous.

Ground Rules

- It is important that we set a few ground rules for the duration of the focus group before we begin.
- Do you have any ideas of important rules for whilst we are here in order to have a successful focus group this afternoon?

*have some preset ground rules e.g. Silent when someone else is talking, all should participate etc. Feel free to ask any questions at any time

- Do we have any questions before we begin?
- I am going to **turn the recorder on** now

Definition of Key Terms

Bleep/pager –
Communication –
Smartphone –

Topic 1. Evaluating the Current System

1 To begin could you tell us what you would normally do if you thought a patient was deteriorating. What forms of communication would you normally use?
2 (assuming they talk about bleeps/other than the communication that you have mentioned) Do you use any other form of communication to contact other physicians/nurses? Can you tell us how that works?
(e.g. mobile phones)
3 Does the current pager system meet your needs? In what ways?
4 What difficulties have you encountered, if any, with this system? Why?

Topic 2. Current Smartphone/tablet usage & acceptability

We'd now like to explore other methods of communication that you use.

These questions should be quick, in order to give the participants the correct context of using smartphones before moving on to using them in the workplace.

1 How many of you here own a smartphone?
-Show of hands

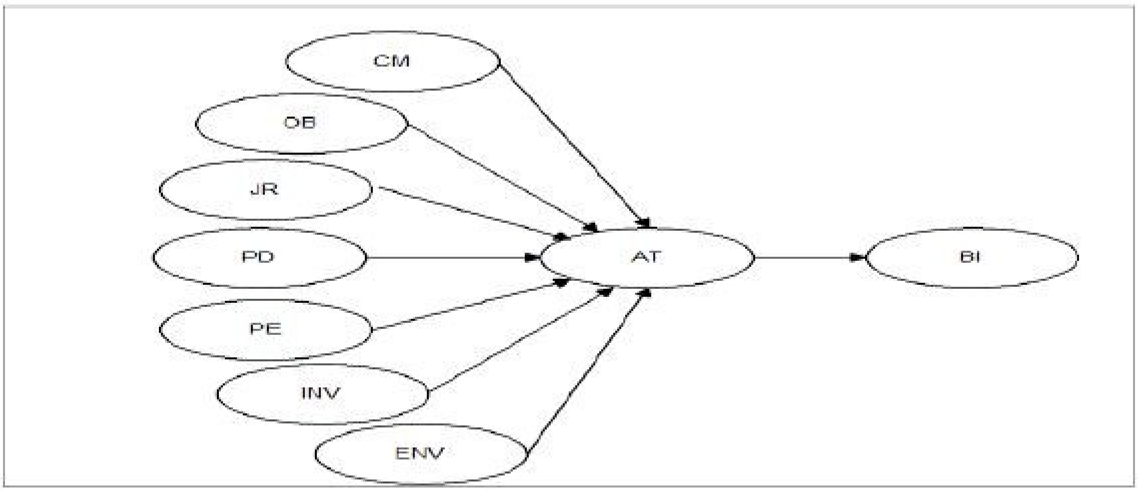
How many of you have used a smartphone before?
-Show of hands
2 How many of you here own a tablet e.g an iPad or Google Nexus?
-Show of hands
3 Do you use apps?

Probe: what? who? where? why?

4 Prompt: Do you use apps for communication?
Probe: WhatsApp? Viber?

Figure 1

Research Model



Key:
BI: Behavioral intention to use smartphone
AT: Attitude toward using smartphone
CM: Compatibility
OB: Observability
JR: Job relevance
PD: Personal demographics
PE: Personal experience
INV: Internal environment
EXV: External environment

5 How would you feel about using a smartphone application for communication with other clinicians in the hospital setting?
Do you think using a smartphone application for communication with colleagues would fit into your working style? How? Why?

6 Have you ever seen other clinical staff at St Mary's using smartphone applications for communication at work? How do you feel about it? Why?

7 Do you think that using a smartphone app for communication would have an impact on your job performance? In what way? Why?

8 Which clinical staff do you think would be more likely to use/are using smartphone technology at work?

9 What personal experience do you have of using smartphone apps, or other technologies? Why?

10 What role do you think hospital management has in bringing about a communication system using smartphones? Why?

11 How important is the availability of external support when it comes to using a smartphone/app at work? (e.g. technical support)

12 How would you feel about using a smartphone app for communication at work?

13 Would you use a smartphone app? Why/why not?

Topic 3. <u>Suggested specifications for a Smartphone-based communication platform</u>

If an app were made for the purpose of communicating with colleagues:

1. Is there anything that you think could increase the likelihood of you using mobile technology for escalation of care?
   What functions do you think the technology should have?
2. We have a preliminary vision for what the process of escalation of care, aided by an app, may look like. Z will take you through his process now.
   (NEED TO WRITE PROCESS)
3. How do you find this app aided process of managing escalation of care? Does it work in your opinion? How? Why?
4. Do you see any limitations associated with this process? Where? Why? Do you see any strengths? (risks and benefits)
5. Would you change anything in that process? Why?
6. Finally, we would like each one of you to brainstorm and make a list of the 5 most important features to include in the proposed app.
   (e.g. Individual/ Team Phones? Login? Touchscreen/ Blackberry?)

<u>Conclusion</u>

That concludes our Focus Group today. Thank you so much again for agreeing to take part and your participation this afternoon.
We have one final item of housekeeping to do and that is these evaluation forms, we have really appreciated the time you have taken to talk to us already today and would be even more grateful if you could fill out these forms, which include a section for any comments you would have like to, but were unable to make during the discussion today.

Statement of future action

For your information, the information that you have given us will be used in a project looking into creating a software platform for the escalation of patient care.

If you have any questions or queries at any time now or after the focus group has finished you can contact Dr Johnston at m.johnston@imperial.ac.uk who will answer any questions you may have.

Thank you again.