Identifying Quality in the Delivery of Emergency General Surgery

A thesis presented for the degree of Doctor of Medicine at Imperial College London, Division of Surgery and Cancer

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For Wilfred and Marni

“Dream big little ones for tomorrow you will move mountains”

Abstract

The delivery of high-quality emergency general surgical care remains a concern for clinicians, healthcare providers and policy makers. Emergency admissions contribute to approximately half of a general surgeon's workload, however the morbidity and mortality figures seen in this cohort are up-to ten times higher than those seen in elective practice.

Despite considerable advances in surgical technology and peri/post-operative protocols over the past twenty years, there appears to be little improvement in outcome following emergency surgical admissions. It is therefore proposed that the delivery of emergency surgical services and hospital structure may significantly contribute to the poor outcomes seen in the acute setting and a greater understanding of the factors that contribute to high-quality care is required.

An introduction to the factors that contribute to the delivery of emergency general surgery is presented along with the concepts of examining and identifying quality both in healthcare and other high-risk industries.

A systematic review then examines the different models of care seen in the delivery of emergency general surgery across the world along with their effect on outcome and sets the scene for the areas of interest in this thesis.

A series of inter-linked, mixed methods studies combining: quantitative analyses of an international dataset, ethnographic observation, a healthcare failure mode effects analysis and audit to identify structural factors that lead to improved outcomes in the delivery of emergency general surgery.

The themes of high-quality care, hospital structure, international benchmarking and their association with outcome run throughout these studies in this thesis with outcome data from hospitals in Australia, the United Kingdom and the United States being compared.

This thesis highlights a series of unit-level quality indicators whose introduction can be associated with high-quality care and be directly translated into clinical practice using quality improvement methodologies to ultimately improve patient care.

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The undertaking of this thesis has been a hugely rewarding process however the journey has not been without its stresses and difficulties and I will be forever indebted to those who have helped me through.

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This is for you x

Declaration of Originality

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I declare that the work conducted in this thesis has been undertaken by me, under the supervision of: Professor the Lord Darzi of Denham, Miss Sonal Arora, Miss Elaine Burns and Mr Omar Faiz.

This thesis and the work described herein, is my own except where explicitly referenced and has not been previously submitted for a higher degree.

Prem Chana

7th June 2018

Peer Reviewed Publications Related to Thesis

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First Author

Chana P. Joy M. Casey N. Arora S. Burns E. Chang D. Darzi A. Faiz O. Peden C. **A cohort analysis of outcomes in 69,490 emergency general surgical admissions across an international benchmarking collaborative** BMJ Open – doi: 10.1136/bmjopen-2016-014484.

Chana P. Burns E. Arora S. Faiz O. Darzi A. **A systematic review of the impact of dedicated emergency surgical services on patient outcomes** Annals of Surgery 2016; 263(1): 20-27

Other Publications

Faiella G. Parand A. Dean-Franklin B. Chana P. Cesarelli M. Stanton N. Sevdalis N. **Expanding healthcare failure mode and effect analysis: a composite proactive risk analysis approach** Reliability Engineering and System Safety (Accepted for publication August 2017)

Johnston M. Chana P. Pucher P. Arora S. Darzi A. **Improving escalation of care: A double-blinded randomized controlled trial** Annals of Surgery 2016; 263(3): 421-426

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Chana P. Johnston M. Burns E. Faiz O. Arora S. Darzi A. **Identification and prevention of organisational failures in emergency general surgery: A healthcare failure mode effects analysis** - British Journal of Surgery

Chana P. Arora S. Appleton S. Brown W. Burns E. Faiz O. Darzi A. **Examining the burden of acute gallstone disease in hospitals participating in an international benchmarking collaborative** – Annals of Surgery

Presentations Related to Thesis

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International

2016 **Management of gallstone disease in hospitals within The Dr Foster Global Comparators Project**
Dr Foster Global Comparators Meeting
Los Angeles, USA

2015 **Developing research opportunities within The Dr Foster Global Comparators Project**
Dr Foster Global Comparators Meeting
Shanghai, China

2015 **Examining global outcomes in emergency general surgery**
Dr Foster Global Comparators Meeting
Oslo, Norway

2014 **Identification and prevention of organisational failures in emergency surgery: A healthcare failure mode effects analysis**
American College of Surgeons Annual Congress
San Francisco, USA

2014 **Training in emergency general surgery can be improved in acute care surgical models**
Association of Surgical Education
Chicago, USA

2014 **The impact of dedicated emergency services on outcomes**
European Congress on Emergency Surgery
Frankfurt, Germany

National

2017 **Quality Improvement; more than just a tick-box**
National Quality Improvement and Audit Conference
Aylesbury, UK

2015 **Do differences in global outcomes in emergency surgery exist?**
Digestive Disorders Federation
London, UK

2015 **Emergency surgery: the current climate**
Royal College of Surgeons of England EGS Congress
Cardiff, UK

2014 **Identifying quality in the delivery of emergency surgery**
Royal College of Surgeons Meeting
Taunton, UK

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List of Abbreviations

ACS	Acute Care Surgery
ACSu	American College of Surgeons
ASA	American Society of Anaesthesiologists
ASGBI	Association of Surgeons of Great Britain and Ireland
CT	Computerised Tomography Scan
EBM	Evidence Based Medicine
ED	Emergency Department
EGS	Emergency General Surgery
ERAS	Enhanced Recovery After Surgery
F1	Foundation Year One Doctor
GC	Dr Foster Global Comparators Project
GDP	Gross Domestic Product
GP	General Practitioner
HES	Hospital Episodes Statistics
HFMEA	Healthcare Failure Mode Effects Analysis
ICD	International Classification of Diseases
ICU	Intensive Care Unit
NHS	National Health Service
NELA	National Emergency Laparotomy Audit
NOS	Newcastle – Ottawa Scale
OR	Odds Ratio
OECD	Organisation for Economic Co-operation & Development
PRISMA	Preferred Reporting Items for Systematic Review & Meta Analyses
QI	Quality Improvement

RCS	Royal College of Surgeons of England
RCT	Randomised controlled trial
SAU	Surgical Admissions Unit
SHO	Senior House Officer
UK	United Kingdom
USA	United States of America

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Preface

As a general surgical trainee working in the NHS, the one element of my job that often fills me with both fear and dread is a looming “on-call” shift. This feeling seems to be echoed by many of my colleagues, not only general surgeons, but also those in other acute hospital specialties.

What has interested me over the course of my training is that if I ask myself or my peers why we have chosen to follow our selected career paths and why we make the sacrifices that we do in subjecting ourselves to the “on-call” and its associated long working hours, night shifts and weekend work, the answers received will almost universally be the same and are based upon the satisfaction of looking after acutely unwell patients and making a real difference in their care.

This is where the dichotomy of the “on-call” arises, as it is during these shifts that we meet our acutely sick patients and can make the biggest difference to outcomes. So why do we all dread it so much?

Again the answers to this question are worryingly similar. The “on-call” has been described to me as: stressful, chaotic, understaffed and resourced and often unsafe. One colleague described their walk to work on an “on-call” day as “mental preparation for a thirteen hour battle”.

As a UK trainee who has been fortunate enough to visit hospitals in countries across both the developed and developing world, I strongly believe that we go through the most thorough, rigorous and robust surgical training programme of any nation. Therefore why do we fear the “on-call” so much as it is the best opportunity available to us to hone our skills? I believe the answer to this question lies with the system in which we work; emergency services in the NHS have always played a supporting role to elective care. Healthcare policy has often focused towards improving outcomes in elective practices, such as cancer care and therefore these areas have received substantial funding and support. Junior members of the medical team, often with little senior support, have classically run emergency services. These doctors then have to fight against systems barriers such as: understaffing, working time directives (with the introduction of shift work at the expense of continuity of care), emergency department breaches driving unmanageable workloads and lack of access to appropriate support services such as radiology and intensive care.

It is not unusual for me to complete an “on-call” week, working fourteen-hour shifts from 07:30 – 21:30. On each different day I may have different SHOs and F1s with me due to their rota pattern, meaning that they do not know the patients admitted on the previous day. Often I will be expected to work with an SHO from another specialty who has a limited knowledge of general surgery. The technologies that I am expected to use such as: pagers and paper-based request forms for investigations are inefficient and cumbersome. As the registrar “on-call” with the support of my consultant, we can be asked to review up-to thirty new patients in a shift (from a combination of general

practice and emergency department referrals and inpatient ward reviews). This is coupled with the requirement of having to complete an acute post-take inpatient ward round. We 'fight' with radiologists and intensive care physicians to ensure our patients receive the best quality care, knowing they too are drowning in their own workload. We finally have the task of running the emergency-operating list, which can have cases ranging from 5-minute abscess drainage to a six-hour laparotomy.

My non-medical friends often ask me and family to describe what I do when "on-call" as the common misconception is that I go to work at night and sleep! The way I describe my working environment is perfectly illustrated by the picture below from the cover of a video game called 'Hysteria Hospital'

Figure - Preface 1: Hysteria Hospital

The conditions in which we are expected to work are often comical in the degree of chaos seen and the phrase “I don’t know whether to laugh or cry” is often thought.

We therefore find ourselves in the situation where we have the world’s best-trained clinicians working in a chaotic system and it is leading to: poor morale, a reluctance of juniors willing to embark on careers in acute specialties (as seen in the reduction of numbers of applicants to acute specialties like general surgery over the past five years) and most importantly to poor patient outcomes.

At the time of starting this thesis I believed that the future for emergency general surgery was bleak. There was a shift towards creating a new acute emergency surgical specialty at consultant level and even this was widely viewed as an inferior specialty; “for those who can’ get a proper consultant post” were the words of one of my consultants and this thought stemmed from the environment in which he thought emergency surgeons were expected to work in.

Avedis Donabedian first described the association of the system in healthcare being directly linked to outcomes in the 1960’s; despite this little work has been done to develop a strong evidence base in determining how the systems in which we work can be modified to improve outcomes for our emergency surgical patients.

I chose to embark on this project for two reasons, firstly, the opportunity to work at Imperial, in its internationally recognised patient safety unit, as it has allowed me to join a forward-thinking, world-leading and inspirational institution of which I am incredibly proud.

Also and most importantly I am committed to being a surgeon who strives to offer the best possible care I can to my most vulnerable patients in a safe environment for them and my colleagues who are at the forefront of delivering high-quality healthcare.

In order to do this I believe we need to develop an understanding of what constitutes quality in our healthcare systems using the Donabedian model as a start point. I also hope that by understanding and modifying the systems in which we work along with embracing modern-day technological advances will mean that we can work in a safer and more efficient manner, which will end the dread of the “on-call” and mark the end of ‘Hysteria Hospital’.

Introduction

Chapter One

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1.1 Background

The following introductory chapter aims to provide the backdrop for this thesis project entitled 'Identifying Quality in the Delivery of Emergency General Surgery'. It will define the area of interest and explore the conceptual background behind how emergency surgical care is delivered in the United Kingdom (UK) and across the world. It will then examine the constituents of quality and how this term can be applied to healthcare delivery and patient safety. These elements will all be tied together in an assessment of current practice in the UK and overseas in order to gain insight into the current problem of delivering high-quality emergency general surgical care. The issues raised in this chapter will provide the basis for the work reported in this thesis.

1.2 What is emergency general surgery?

Although there remains no agreed definition, emergency general surgery (EGS) involves the assessment, management and care of patients with acute abdominal organ pathology. The vast scope of this specialty covers the entire spectrum of our population and its associated burden means that EGS now

accounts for approximately 50% of a general surgeon's workload (Royal College of Surgeons, 2011).

This thesis will focus on EGS as it has historically been a much-neglected sub-specialty within general surgery and its associated surgical research making the evidence base behind EGS practices and outcomes limited; we also have a poor understanding of what constitutes optimal service delivery (Parks, 2017) . This is because EGS has traditionally formed an additional part of a general surgeon's workload, (on top of their elective practice) rather than as its own dedicated specialty despite the volume of work it generates. The term "on-call" which is used to describe EGS work in the United Kingdom (UK) is rooted in the idea that clinicians are required to provide service for EGS patients when required rather than part of their core practice, highlighting the difficulties in defining what constitutes high-quality care. EGS has therefore not seen the influx of resources and attention to improving outcomes/meeting targets that have been witnessed in elective surgical care and healthcare policy makers in the UK have often referred to EGS as a 'Cinderella' specialty (Behar, 2013).

Outcomes in EGS remain poor despite advances in surgical technique, technology and peri-operative care; an example of this being the emergency laparotomy (which remains the operation of choice for complex abdominal pathology) where mortality stands at approximately 15% with this figure rising to 25% in high-risk groups such as the elderly and co-morbid (NELA, 2015). This is over eight times worse than following elective surgery and there

remains little understanding as to why mortality remains so high despite advances in modern medicine and well understood management protocols being in place (Grier, 2012). In-hospital length of stay after an EGS admission remains significantly longer than elective admissions where enhanced recovery after surgery (ERAS) protocols are now routine and lead to a holistic, individualised, efficient rehabilitation programme for patients. The lack of established protocols in EGS, coupled with diagnostic challenges make it a resource heavy specialty (Royal College of Surgeons, 2011).

A greater understanding of how EGS is delivered in the UK is required in order to not only improve patient outcomes but also to address the huge financial burden emergency surgery places on already stretched healthcare services (Odor, 2016).

The specialty of General Surgery in the United Kingdom has evolved over the past fifteen years in keeping with innovations in technology and several key landmark policy documents that have resulted in greater scrutiny of clinical practice and assessment of outcomes (Francis, 2013). Traditionally a general surgeon would take responsibility for the elective and emergency care of a wide-range of conditions affecting the gastrointestinal tract as well as the urological and vascular systems in both adults and children. However as the complexities of caring for these patients, each requiring a unique skillset have increased so has the demand for increased sub-specialisation of care. As a result of this paediatric surgery, urology and vascular surgery each devolved to form their own sub-specialties with independent training programs and

provision for emergency practice (Earnshaw, 2012; Mitchell, 2011). They will therefore not be discussed within this thesis.

Trauma is another branch of acute surgery that is often confused with EGS. Trauma deals with injuries caused by an impact whereas EGS can be seen as the (operative or non-operative) management of acute abdominal pathology, which is not caused by trauma (Galante, 2010). The delivery of trauma services in UK have recently undergone significant changes with the introduction of the major trauma network and therefore the delivery of trauma care in the UK will also not be examined in this thesis (NICE, 2015).

Excluding the specialties discussed above, general surgery can now be broadly subdivided into the following five areas:

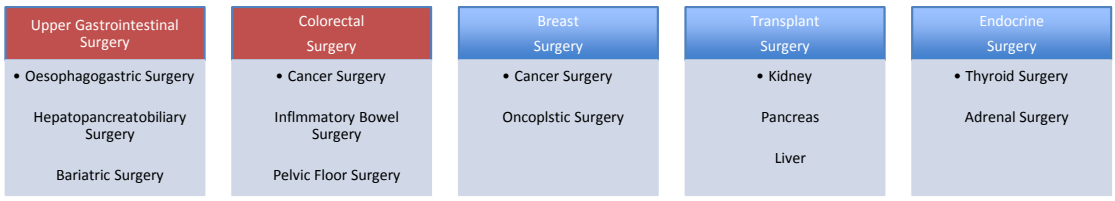

Figure - 1.1: Structure of General Surgical Services in the UK 2017

General surgeons and their trainees in the UK now practice in one of these specialties meaning that their elective workload (which includes all planned admissions for surgery or associated procedures) may be in a very specialist field. However many surgeons continue to maintain general surgical “on-call” commitments where they may be expected to cover emergencies covering the entire spectrum of general surgery. It is these conditions that make up the

specialty of EGS. Conditions affecting the gastrointestinal tract (upper gastrointestinal and colorectal seen in red in the above figure) by far make up the commonest EGS presentations and therefore this thesis will only focus upon this area and not breast, endocrine and transplant surgery.

1.21 The role of the emergency general surgeon

The role of a modern emergency general surgeon has been summarised in a joint statement published by The Royal College of Surgeons of England (RCS) and The Association of Surgeons of Great Britain and Ireland (ASGBI) (ASGBI, 2013).In this they describe seven key facets for the emergency general surgeon who should be expected to:

- Undertake emergency operations at any time, day or night
- Provide assessment and management of patients presenting with an acute surgical problem
- Provide ongoing care to patients who have had an operation and to other patients in the hospital (including ‘non-surgical’ patients who suddenly become unwell)
- Undertake further rescue operations for complications in patients who have recently undergone surgery whether following planned (elective) operations or after emergency surgery
- Provide assessment and advice for patients referred from other areas of the hospital, other hospitals in the network and from their GP

- Provide early and effective acute pain management and supervising out-of-hours palliative care
- Communicate with relatives

The complexities of delivering effective EGS can therefore begin to be understood, as surgeons are required to care for acutely unwell patients with a wide-range of pathology, which does not necessarily correlate to the surgeon's specialist interest and therefore competence.

Another key factor in providing effective emergency services is the unpredictability in the timing and workload generated by EGS. Acutely unwell patients may present to hospital any time of day or night requiring life-saving care by highly skilled clinicians and support staff (Royal College of Surgeons, 2011). This makes the planning of service delivery for healthcare providers extremely difficult and therefore an understanding of current practice and outcomes is required to truly identify what constitutes high-quality care. Some of the issues that are encountered in the current delivery of EGS will now be introduced.

1.3 How is emergency surgical care delivered in the UK?

1.31 Working Patterns

Traditionally the EGS services in the National Health Service (NHS) were provided by "on-call" teams, this was made up by a: consultant, registrar,

senior house officer and house officer. It would be the responsibility of this team to assess, admit and manage any patients presenting to hospital via the emergency department (ED) or general practitioner (GP). This work was often undertaken in addition to elective duties that continued despite the demands of caring for acutely unwell EGS patients. It was widely accepted that the EGS service was run from the "bottom-up" with junior doctors taking responsibility for ward-based care and registrars taking the lead in the operating theatre. On-call shifts would be regular and often last for in excess of 24-hours and any patients admitted during this time would be retained by the admitting team, regardless of their underlying pathology. The general surgeon was comfortable and competent to manage the full complement of conditions that may be seen in EGS (Lewis, 2013).

As the "front-line" a fundamental problem that affected junior doctors in all specialties, including surgery was the workload they faced. The in-hospital working hours required to manage a combination of EGS and elective patients in the 1980s and 1990s meant that it was not unusual for junior doctors to work in excess of 100-hours per week which inadvertently led to fatigue, low morale and crucially poor patient care.

Several legislative rulings, including "The New Deal" and "The European Working Time Directive" recognised the effect that such workload had on junior doctors and we are now in a situation where working hours are limited to 48-hours a week (Pickersgill, 2001). Although this has not fundamentally altered the structure of the on-call team it means that novel working patterns,

notably shift work, have now been introduced in order to improve working conditions. This has however raised several concerns in how EGS services can be safely provided, particularly in ensuring continuity of patient care. Another challenge faced by today's junior doctors is the ability to receive appropriate training and experience in EGS in an environment that is time-pressured and the workload can be extremely variable (Fitzgerald, 2012).

There also remains no consensus within the NHS as to how best to structure consultant working patterns and there remains much variation in this (O'Riordan, 2007).

As the most senior member of the clinical team consultants would often continue their elective duties leaving their registrars to lead the EGS service, they would be available for help and advice if necessary. This meant that dedicated EGS time was not built into a consultant's working week and they would be on-site during office hours whilst on-call and then take calls from home as needed. This remains the case in some NHS hospitals today. However as the demands for EGS have increased with greater senior involvement expected (as described in the aforementioned duties of an EGS surgeon) many hospitals have provided surgeons with dedicated EGS time built into their job plans. During this on-call period the surgeon would be cleared of elective duties and focus purely on their EGS workload. There is again variation in the structure of this as a majority of UK surgeons continue to only provide this service during office hours and then take calls from home whilst some provide 24-hour on-site cover. Further variation occurs in

hospitals where surgeons may handover daily whereas others will remain on-call for a whole week. How this variation in working pattern affects patient care remains unknown and will be explored further in this thesis.

1.32 Centralisation of Services and Resource Allocation

The change in working patterns has occurred at the same time as possibly the greatest set of technological advances in surgery since the advent of anaesthesia and asepsis in the nineteenth and twentieth centuries. General surgeons have been at the forefront in the innovation of both minimally invasive surgery and enhanced peri-operative/recovery care (Dhruva, 2014). The technical expertise required to keep up with these technological advances has now lead to greater sub-specialisation within a surgeon's chosen field being recognised as best practice. As the figure illustrated earlier in this chapter demonstrates, the general surgeon no longer exists, in gastrointestinal surgery alone we now have upper gastrointestinal surgeons and colorectal surgeons and further still surgeons within these fields choose to sub-specialise. Each of these sub-specialties may not be present in every hospital due to resource allocation. Much work has been completed in examining the effect of centralising services in elective surgery and have demonstrated that centralising care in fields such as oesophago-gastric, cardiac and paediatric surgery are all associated with improved outcomes. However all of this work has been conducted in elective surgery and little is known as to how it has impacted upon the delivery of EGS.

An example of how centralisation is affecting EGS care is that, twenty years ago if a patient presented to hospital as an emergency with a perforated oesophagus, the general surgeon on-call and their supporting team would manage the condition and would be expected to perform an oesophagectomy if required. This is now no longer the case and this patient would now be transferred to a centralised unit where they would be managed by a specialist oesophago-gastric surgeon. The pro's and con's of providing such specialist services will be explored in further detail in later chapters.

The delivery of effective EGS requires not only surgical care but also input from numerous support teams including the ED, ICU and radiology (Odor, 2016). These services all require significant staffing and resource investment in order to function effectively. Most NHS trusts continue to provide EGS care and therefore place demands on hospital infrastructure. The question of whether centralisation of EGS services in the UK should take place remains unanswered with clinicians and policy makers providing sensible arguments for and against centralisation. As previously mentioned EGS patients present with complex needs that often require urgent intervention. One side of the argument is that if we centralised into specialised EGS centres, hospitals would be better equipped to deal with these patients' unique needs by providing access to specialist teams with appropriate support care which may not be available in smaller centres. It is widely accepted that mortality rates following emergency laparotomy are approximately 15% however it is not unusual for EGS patients to return to a ward following surgery due to shortages of ITU bed availability (NELA, 2015). However following the

restructuring of cardiac surgery to specialist centres almost all cardiac patients are now routinely admitted to cardiac ITU post-operatively and mortality following this technically demanding surgery is 1.6% (NICOR, 2017). Advocates for centralised services feel that similar results can be seen in EGS if we move to a system that has fewer, better-equipped centres with greater expertise and resources. Those against centralisation argue that all hospitals that perform elective GI surgery should have access to EGS in order to deal with any complications that may arise from the elective work. Many patients and clinicians also believe that all patients should have access to emergency services for commonly occurring pathology (such as EGS) in their local hospital. This is in contrast to services such as cardiac and vascular surgery, which are less common, and therefore the increased expertise and volume seen in centralised units can be justified. There remains no evidence as to which method of delivering care is most appropriate for NHS hospitals.

Another factor that requires consideration is the variation in distances between hospitals in the UK. In heavily populated urban areas it is not unusual to have several hospitals each providing EGS services within a small geographical area, following recent restructuring, London now has 19 hospitals with emergency departments making centralisation of specialist and high-risk services achievable due to small geographical distances between units. However looking at the other end of the spectrum, Cornwall only has one emergency department in the county and if services were centralised to its closest teaching hospital in Plymouth, patients living near Penzance would be required to travel over 85 miles to attend hospital/visit relatives. Therefore

any initiatives to restructure emergency services must take the needs of all areas of the country into account and not adopt a ‘one size fits all’ policy as is so often seen in sweeping government legislation (Bidgood, 2013).

The huge variation in hospital structure and working patterns described across EGS teams in the NHS, from the most junior staff to consultant level, implies that we are yet to identify how to optimally provide EGS services and staff rotas in order to deliver high-quality care. An evidence base needs to be created to inform healthcare professionals, policy makers and patients of how best to serve their needs by providing safe and high-quality care.

1.4 Governmental and legislative initiatives to improve emergency surgical care

The delivery of emergency services across the NHS remains a topic of contention in this time of austerity and therefore the provision of EGS is under ever-increasing scrutiny. As we have established, the aim of high-quality care is to deliver effective EGS services 24-hours a day, 7-days a week. The UK government has recognised this and the Health Secretary alongside the Chief Executive of the NHS, is in the process of examining how round the clock care can be effectively delivered. However it is essential that any policy recognises the multidisciplinary nature of providing emergency care and that resources are placed into improving all aspects of EGS service and not focusing on isolated areas such as the ED (Gillies, 2017).

Another factor in determining how the delivery of emergency services will be shaped over the coming years is the cost of providing a satisfactory level of care. As we have described providing high-quality EGS is complex and therefore will come at considerable expense. The burden of the problem will also remain with EGS pathology affecting the entire spectrum of our population and contributing to approximately 50% of a general surgeon's workload. In 2017, the NHS costs approximately £2-billion a week to run and emergency services make up a large part of this budget (UK Treasury, 2015.). We need to develop a system that is safe yet effective in order to provide the best care for our patients but without placing extra strain of already stretched resources. The issue of funding EGS services is complex and beyond the remit of this thesis however issues relevant to efficiency saving and improved care will be discussed in later chapters.

The RCS is also striving to improve the delivery of EGS by producing valuable guidance in the form of The Unscheduled Care document and the formation of an emergency surgical taskforce. Unscheduled Care was produced in response to growing concerns from clinicians and policy makers that EGS delivery required modification to ensure that high-risk EGS patients received appropriate care (Royal College of Surgeons, 2011). The profile of the RCS means that any guidance produced by them will have a significant impact with policy makers and clinicians however any guidance must be examined with caution as the RCS is not an academic institution and there remains very little evidence base behind their current recommendations. Unscheduled Care remains a consensus statement from a small group of surgeons and its

findings may not be applicable to all hospitals as already discussed in this chapter.

The key document examining EGS services in the UK is the recently published National Emergency Laparotomy Audit (NELA, 2015). This was a prospective audit carried out by anaesthetists and surgeons that assessed over 20,000 patients who underwent an emergency laparotomy in England between December 2013 and November 2014. The findings of this audit emphasised the importance of examining the delivery of EGS as it showed that much needs to be done to improve outcomes. Key findings from the audit were that after emergency laparotomy:

- Overall 30-day inpatient mortality was 11%
- Over 25% of patients had a hospital stay of greater than 20 days
- There was large variation in time to consultant review
- 41% of patients having surgery after midnight had a consultant perform their procedure
- 68% of patients had a pre-operative CT scan reported by a consultant radiologist
- 60% of patients were admitted to intensive care after surgery

These findings require consideration as they are subject to inclusion bias and reporting error however forms an excellent start point for further research into the delivery of high-quality EGS (NELA, 2015).

1.5 International delivery of EGS

In order to better understand how the NHS can develop the delivery of EGS services it is important to understand how care is delivered in comparable healthcare systems across the world in order to share ideas for improvement and best practice. The United States of America (US) have been at the forefront of delivering emergency surgical services and therefore it would be wrong not to examine the American system when looking at ways to identify high-quality care in the delivery of EGS in the UK.

Trauma surgery plays a pivotal role in US emergency care due to the prevalence of both knife and gun crime across all 50 states. This combined with the lessons learnt from treating trauma during conflicts in the Middle East over the past 30 years, means that the US has led the field in providing pioneering and effective trauma care (Blackwell, 2003). However at the turn of the 21st Century the US found it was producing large volumes of trauma surgeons without the demand for attending posts at the end of their training (Spain, 2005). The American College of Surgeons and American Association for the Surgery of Trauma recognised this along with the increasing fragmentation of general surgery (as previously described in Chapter 1.2). This led to the creation of a new surgical sub-specialty that became known as acute care surgery (ACS) (American Association for the Surgery of Trauma, 2017.). This is a triad of: EGS, trauma and surgical critical care meaning that the US is now able to produce highly trained surgeons who are capable of dealing with a wide-spectrum of acutely unwell patients in their hospitals. ACS

also freed up general surgeons to pursue elective interests in their chosen field without the burden of dealing with emergencies.

The US also faces a second quandary in the enormous variation seen in its hospitals ranging from large academic medical centres through to small cottage hospitals that serve sparse rural communities. This sort of variation is not seen in the UK with even the smallest NHS Hospital Trust serving a population of 212,000 patients (Weston Area Health NHS Trust, 2017.). Therefore the US has introduced a system of centralisation for ACS services where acutely unwell surgical patients may be transferred to a larger ACS unit where specialist care can be provided. Little is known as to whether this centralised method of delivering EGS services has been associated with improved outcomes.

A similar system of ACS is being introduced across much of the developed world and can now be commonly seen in Australia and Europe, whether a similar way of managing trauma and EGS patients may be suitable for the NHS will be explored and discussed in later chapters.

1.6 What is the role of patient safety in EGS delivery?

The importance of patient safety in healthcare delivery cannot be underestimated. The phrase ‘Primum non nocere’ (first, do no harm) is ingrained in the bedrock of the practice of medicine and is recited at the beginning of the oath taken by newly qualified doctors across the world

(Sokol, 2013). Despite this promise, healthcare continues to harm patients on a daily basis and can often be the cause of greater morbidity than the patient's presenting condition. Patients are subjected to: hospital-acquired infections, medication errors and numerous other vectors of harm on a daily basis, with significant consequences. Worryingly there is often little awareness from healthcare professions that the harm we inflict is almost always avoidable (Leape, 1998). The prevalence of avoidable harm in hospital was summarised in a landmark study conducted by Professor Charles Vincent that demonstrated that at least one-in-ten patients admitted for elective surgery experienced an adverse event during their hospital stay as a direct result of the care that they received (Vincent, 2001). High-profile academics and surgeons, such as Charles Vincent, Ara Darzi and now Atul Gawande are at the forefront of patient safety and promote the message that improving patient outcomes and safety is vital to improving the quality of healthcare delivery.

Patient safety does not require the search for new knowledge however a critical assessment of current practice to examine how we can do better and this theory will be examined later in this chapter.

The subject of patient safety is too broad to examine in all aspects for this thesis, however its relevance to the delivery of high quality EGS must be assessed as several key components of EGS delivery may put patients at increased risk of harm.

Surgery is inherently a high-risk industry (Sarker, 2005). Errors caused by the surgeon or members of the surgical team (such as anaesthetists) can directly lead to harm or even death. Surgeons put the lives of their patients in their hands on a daily basis and therefore patient safety should be at the forefront of all decision-making and management. Never more was this more apparent than following the enquiry into paediatric cardiac deaths at Bristol Children's' Hospital. The outcome of this event pushed the importance of patient safety to the forefront of how care is delivered in the UK (Teasdale, 2002). However as Vincent describes, much needs to be done to ensure we continue to keep our patients safe. Unfortunately the key components of EGS actually put patients at even greater risk of harm than those admitted for elective treatment, the aforementioned role of the emergency surgeon covered the following points (Royal College of Surgeons, 2011):

- Undertake emergency operations at any time, day or night
- Provide assessment and management of patients presenting with an acute surgical problem
- Provide ongoing care to patients who have had an operation and to other patients in the hospital (including 'non-surgical' patients who suddenly become unwell)
- Undertake further rescue operations for complications in patients who have recently undergone surgery whether following planned (elective) operations or after emergency surgery
- Provide assessment and advice for patients referred from other areas of the hospital, other hospitals in the network and from their GP

- Provide early and effective acute pain management and supervising out-of-hours palliative care
- Communicate with relatives

Each one of the points listed raises concerns. This stems from factors already discussed such as the unpredictable nature of the workload encountered in EGS. Operations may also be performed by surgeons who have a different subspecialty interest to that seen on-call. EGS patients are also potentially very unwell with severe abdominal pathology requiring the input of lots of specialist teams, such as: ICU and radiology working with surgeons and anaesthetists. An EGS surgeon therefore needs to be a leader who can organise teams, prioritise workload and communicate well with colleagues, patients and their families in order to make difficult decisions that may have far-reaching consequences. Therefore the key-components of safety must be at the forefront of a surgeon's mind at all-times. How these elements of safety can be incorporated into a surgeon's everyday practice will be a theme that continuously runs through this chapter and the remainder of this thesis.

1.7 Lessons learnt from other industries

As previously discussed surgery is a high-risk industry and therefore the problems faced by surgeons in their attempts to deliver high-quality and safe care must be addressed. An examination of other high-risk industries and errors made in them can provide a valuable insight how problems have been

overcome to encourage productivity and safety and whether these findings can be translated into improving surgical practice.

1.71 The aviation industry

The association between surgery and commercial aviation has long been recognised due to many similar characteristics seen been the two industries (Kapur, 2016). They are both high-risk and rely on the skill of individuals (the pilot and the surgeon) often working in stressful situations and needing to combine manual skill with technology in order to keep their passengers and patients safe.

Many of the skills of a pilot are transferrable to surgery and are based around non-technical skills, dealing with stressful situations and the use of checklists to standardise practice (Haynes, 2009). An example of how a sharp focus on safety can influence outcome was seen in 2009 when US Airways Flight 1549-experienced massive engine failure due to several bird strikes shortly after take-off from New York's La Guardia Airport. The actions of the pilot, Captain Chesley Sullenberger, over the next six minutes culminating in the landing of the aircraft in the Hudson River ensured that all 155 passengers and crewmembers on-board survived (Merlin, 2009). This was possible due to the compressive training that the captain had received regularly during his career in how to deal with adverse events and also a series of protocols that were followed by means of checklists to ensure that the plane could be safely landed in the Hudson (Eisen, 2009). On-board voice recordings show how the

pilot recognised the problem of the engine failure and remained calm, he then crucially made the decision to land the plane in the Hudson early and set about following a pre-rehearsed protocol using the aid of a checklist to land the plane and cause minimal harm those on-board. This sequence of events draws numerous comparisons with how EGS patients should be managed both in and out of the operating theatre as surgeons are often expected to deal with unexpected events that require urgent and calm intervention to avoid harm (Eisen, 2009). Therefore there has been a focus upon training surgeons in both technical and non-technical skills in a simulated environment to prepare them for the unexpected.

This thesis will not examine a surgeon's individual personality traits and training that allows them to deal with stressful situations but it recognises its importance and the work carried out by my colleagues at Imperial into this crucial area of patient safety. It will however explore how standardising protocols may allow for a surgeon to work more efficiently and effectively in providing high quality care.

1.72 The motor industry

The automobile industry has been at the forefront of creating safe and efficient processes for manufacturing to ensure that cars are produced safely and profitably. It also has embraced the use of information technology to improve manufacturing processes and productivity. An example of this is the

lean theory used by Toyota that will be discussed in later chapters (Shang, 2014).

Important parallels between the processes and associated quality control checks developed in the motor industry and safe surgical practice will be explored in the failure modes effect analysis conducted later in this thesis.

1.73 Sport

Although sport cannot be described as high-risk in the same manner as aviation and motor sport; the huge financial sums invested in sporting franchises means that owners, sponsors and supporters of high-profile teams no longer tolerate failure and therefore much work has been done to enhance all aspects of a sportsman/woman's environment in order to help them thrive.

Three of the England's highest profile and greatest sporting successes over the past seventeen years have come in football, road cycling and rugby union.

In football we have seen Manchester United dominate both the domestic league and European competitions, becoming one of the world's most successful clubs.

The English rugby team had its proudest moment in lifting the 2003 World Cup and Team Sky has dominated world cycling producing the winner of five of the last six Tour de France competitions.

A key factor that links these success stories is enigmatic and effective leadership. Sir Alex Ferguson, Sir Clive Woodward and Sir Dave Brailsford each lead their teams with razor sharp focus and crucially each has been lauded for getting the most out of their teams by motivation and also developing the 'marginal gains' philosophy (Hall, 2012). Marginal gains is based upon the theory of examining all factors around an athletes life and trying to maximise the potential of small elements which individually may not seem to make a huge difference but by combining them with others may contribute to enhanced performance (Clear, 2016). The philosophy is based upon maximising all components of an athlete's life. Therefore huge investments have been made to assess the effect of diet, sleep and travel as examples of marginal gain. An example used by Team Sky in cycling is the Tour de France and prior training, rather than stay in different hotels and expose their athletes to different environments that the team could not control Team Sky invested in mobile home for the cyclists which contained their own beds. It was felt that by Sir Dave Brailsford that by providing a stable and familiar environment for the cyclists during the three weeks of the tour that they were less likely to get fatigued.

1.74 Applying lessons from other industries to medical care

The above is an example of the innovative thinking that Vincent, Gawande and others in the world of patient safety are championing and perhaps a marginal gains approach should be applied to the delivery of EGS to improve

outcomes and reduce harm for our patients. This thesis will attempt to use the lessons learnt from this philosophy to examine the EGS admissions pathway to see whether improving small aspects of patients care can have a cumulative effect on improving productivity and outcomes. It has already been effectively implemented in surgery with the development of enhanced recovery after surgery (ERAS) protocols. The rationale behind ERAS was to make minor adjustments to all aspects of a patient's peri-operative care; the cumulative effect of these interventions was an overall improvement in outcomes and reduction in peri-operative compilation/length of stay (Dhruva Rao, 2014).

High-risk industries lead the way in safety and this is driven by: commercial, social, political and humanitarian goals. Medicine often seems to be behind these innovative fields when it comes to incorporating safety culture into practice. An example of this is the difficulty in establishing a national electronic patient records system in the NHS (Hoc, 2011). Lessons learnt from aviation show the importance of effective communication and the motor industry has shown that efficiency leads to increased productivity. It is widely accepted that medical records are a vital component to providing safe care so should be accessible to any healthcare professional to understand the treatment that a patient has received. This is particularly important in EGS delivery where patients may be transferred between numerous departments (emergency department, operating theatre, intensive care, inpatient ward and out-patient follow up). The risks associated with error in transfers of information in surgery are well recognised. Despite this there remains huge

variation in the quality of note keeping in the NHS and often notes are not available for clinicians when they initially review EGS patients potentially leading to errors in management and delays in treatment.

Example case:

A surgeon reviews a confused patient in the emergency department; a junior doctor whose shift has now finished had initially seen the patient. The patient has a penicillin allergy that was reported by the patient's relative who has also left the hospital. The surgeon cannot find the emergency department notes and therefore goes on to prescribe a penicillin-based antibiotic to treat a severe abdominal infection). An electronic notes system would have the ability to flag up this allergy to all clinicians who review the patient and combined with electronic prescribing systems would not allow for the prescription to be made therefore terminating any potential for error at the source.

The NHS attempted to introduce a national electronic note system that would be accessible to any healthcare professional in any hospital or community setting. However the spiralling costs and potential security breaches of storing confidential patient records led to the process being stopped in its infancy (Hoc, 2011).

This is an example of the unique challenges faced by healthcare providers when attempting to improve the quality of care for our patients and often leads

us to question whether medicine can be compared to other high-risk industries?

The examples described above show how a standardisation of protocols and working patterns in a variety of industries can improve outcomes and experiences. This is because they are essentially reliant on technology as the final outcome (planes, cars and bicycles). The endpoint in healthcare is different and should always be centred upon the patient. This is where the complexity in delivering high-quality healthcare occurs as there are so many unpredictable variables when dealing with patients, (especially in the emergency setting) including co-morbidity, patient wishes and available resources. Therefore any lessons learnt from industry must be appropriately adapted to ensure we continue to put our patients first rather than rely on fixed protocols that work for an Airbus A380 but may not be appropriate for a patient who presents to hospital with perforated diverticulitis. It may therefore be more appropriate to utilise other methods of identifying quality and safety that are specific to healthcare. An example of this could be to examine models of care delivery across the world rather than rely on industry.

1.8 What is the association between healthcare structure and quality?

The description of quality in healthcare is almost impossible to qualify given the complexity of the subject. Every medical encounter between a patient and healthcare profession is riddled with variation and factors that make the objective assessment of quality very difficult. This is due sheer number of

variables in pathology and patient factors that are seen; we know that no two patients are the same and it has led academics to question whether medicine should be described as an art or science.

Despite this several attempts have been made to describe quality and perhaps the easiest way of defining this is to look at how healthcare is structured, as this is less subject to variation. Avedis Donabedian first described the importance of understanding structure and its effect on healthcare delivery in the 1960's (Avedis Donabedian, 1966). The Donabedian model consisted of:

Figure – 1.2: The Donabedian Model

This model demonstrates the inherent link between the way in which healthcare is delivered and outcome.

When examining this model:

- Structure assesses how care is organised
- Process looks at what is done
- Outcome determines what happens to the patient's health

Donabedian deliberately described this as a linear model to emphasise the importance of structure in influencing how healthcare is delivered.

Examples of factors that contribute to structure include: hospital design, access to operating theatres and radiology, staffing, intensive care bed ratios and centralisation of services.

Despite the importance of structure in this model much of the research conducted in emergency general surgery has focused upon the process of care delivery. The practice of surgery has been revolutionised over the past two decades with the advent of minimally invasive surgery coupled with the increased availability of information/research now instantly accessible to clinicians with the Internet and mobile technology. It can be argued that we have now reached the limit of what is possible using current technologies available and therefore focus should now shift to improving the environments in which we work.

1.81 Defining Quality

The Institute of Medicine in the US defined quality in healthcare by creating a list of key factors that were present in a high-quality healthcare system (Institute of Medicine & Committee on Quality of Healthcare in America, 2001).

- Effective
- Efficient
- Equitable
- Patient-centered
- Safe
- Timely.

The importance of these factors to the delivery of high-quality EGS in the NHS is something that must be considered when planning service delivery.

It can be argued that the delivery of EGS in the UK at this time does not fulfil any of the mentioned criteria for quality other than ‘equitable’. A founding principle of NHS care is that is should be for all and regardless of social status and wealth, care should be distributed equally. However the other factors mentioned are often lacking and may be responsible for the poor outcomes seen in the delivery of EGS.

However as clinicians whether we can say that the EGS care we provide is: evidence based (effective), avoids waste (efficient), establishes partnerships of trust between patient and provider, respects patients wishes (patient-centred), avoids harm (safe), and reduces delays (timely) remains an unanswered question.

1.82 The role of quality improvement

The concept of Quality Improvement (QI) is essential to not only understanding the environments in which we work (structure) but also how they can be improved upon to improve patient outcomes and experience.

The studies that are used to create this thesis are based upon QI principles and aim to improve our understanding of which factors contribute to high-quality care in the delivery of EGS.

QI has been defined by Dr John Øvretveit as:

"Better patient experience and outcomes achieved through changing provider behaviour and organisation through using a systematic change method and strategies." (Øvretveit, 2000)

The Health Foundation described how QI could be conducted (The Health Foundation, 2011):

- Understanding the problem, with a particular emphasis on what the data tell you
- Understanding the processes and systems within the organisation – particularly the patient pathway – and whether these can be simplified
- Analysing the demand, capacity and flow of the service
- Choosing the tools to bring about change, including leadership and clinical engagement, skills development, and staff and patient participation
- Evaluating and measuring the impact of a change.

This thesis aims to identify quality using the tools listed above to help understand provider organisation/structure and the behaviours that may influence outcome. The list above will form the basis of the studies used to investigate the research question.

1.9 Thesis Aims

This introduction demonstrates how the problem of delivering high quality EGS is multifactorial and complex.

The aim of this research is to identify which structural factors within healthcare delivery contribute to high-quality care and improved patient outcomes in EGS. It will use a mixed methods design, based on the principles of quality improvement and will combine quantitative and qualitative research methodologies through a series of inter-linked studies, to provide evidence-based recommendations for clinicians and policy makers on the optimal factors required to deliver safe and effective EGS.

1.10 Summary

This overview of current practice demonstrates the importance of effective EGS services in providing care for patients with acute surgical pathology. It has introduced the problems that clinicians face in delivering high-quality care. There remains huge variation in the structure of EGS services both in the UK and across the world and outcomes following emergency surgery remain

poor. Work needs to be done to find the optimal model for delivering safe care for EGS patients.

How Can We Identify Structural Factors That Influence Quality Within An Emergency General Surgical Service?

Chapter Two

……..

2.1 Background

This chapter will examine the current published literature to determine which structural factors within hospitals influence outcomes in the delivery of EGS across the developed world. An understanding of these factors will determine whether the facets that contribute to high-quality care in EGS are already known.

The inclusion of a systematic review within this thesis will also provide a greater understanding of the contemporary landscape in how emergency services are delivered and will be used to provide key background information for the empirical studies described in the upcoming chapters.

2.2 Introduction

The introductory chapter demonstrated that the delivery of EGS services differ across the developed world, in particular since the introduction of the acute care surgery (ACS) model, which encompasses the triad of: trauma, EGS, and surgical critical care with specialist care being provided in centralised units. The improvements seen in patient outcome since the introduction of

ACS over the past two decades has led to the restructuring of emergency surgical services across the US to a more standardised system (Galante, 2010). However across other health care systems, (including within the UK) it is unclear which model of emergency surgical care offers the optimal balance between patient need and economic/political constraints.

Like many other countries, general surgeons in the UK continue to manage both elective and emergency patients simultaneously with emergency patients contributing significantly to surgical workload (with few increases in resource allocation to support the needs of these patients) (Royal College of Surgeons, 2011). There is now an increasing drive to deliver optimal outcomes in emergency surgery from both patients and clinicians with public reporting of surgeon and hospital outcomes (Walker, 2013).

The associated pressure may result in surgeons working on emergency rotas risking fatigue, stress, and job dissatisfaction. It is also increasingly challenging for trainees in the UK to gain sufficient competencies to deliver effective emergency care. This is potentially more acute since the introduction of the European Working Time Directive that has limited working hours to 48 hours per week, raising questions as to how emergency services can be effectively delivered (Fitzgerald, 2012). In view of these issues, the delivery of EGS in the UK needs to be restructured to encourage high-quality care.

Prior to the widespread implementation of dedicated emergency surgical services such as ACS, evidence of the efficacy and suitability of such a

service is needed.

This review will explore the variation in models of emergency surgical care delivery reported in the published literature and assesses their impact on clinical processes and outcome.

2.3 Why perform a systematic review?

A systematic review provides a critical analysis and summary of all available evidence from contemporary published studies related to a particular research question. It can examine either randomised-controlled trials (RCTs) or cohort studies. The amalgamation of a series of individual studies provides a rich and detailed understanding of key outcomes, in the case of this thesis key hospital-level quality indicators in the delivery of EGS.

The methodology of systematic reviews has been standardised globally with the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) (Moher, 2009). This was a Canadian, Italian and UK collaboration and aimed to improve the quality of reporting in systematic reviews by proving a 27-item checklist and four-phase flow diagram to ensure standardisation. The schematics of the PRISMA model can be seen in the appendices.

In the field of evidence based medicine (EBM), systematic reviews provide the highest level of evidence available to academics/clinicians meaning that their inference carries the greatest validity/strength as seen in the figure below.

Level of Evidence	Type of Study
1a	Systematic reviews of randomized controlled trials (RCTs)
1b	Individual RCTs with narrow confidence interval
2a	Systematic reviews of cohort studies
2b	Individual cohort studies and low-quality RCTs
3a	Systematic reviews of case-control studies
3b	Case-control studies
4	Case series and poor quality cohort and case-control studies
5	Expert opinion

Figure – 2.1: Levels of Evidence in EBM

Another benefit of performing a systematic review in this setting is that the quality indicators being studied were unknown. Therefore it would have been impossible to design a trial to examine their influence, as the variables would be based on speculation/opinion thus introducing significant bias. The exploration of contemporary literature allows for these factors to be identified and studied in further detail later in this thesis.

The pinnacle of EBM is the meta-analysis. This is a subset of the systematic review which involves combining findings from a series of studies but adding a statistical analysis in order to determine a conclusion. This cumulative analysis is much stronger than those of the individual studies being examined because of the accumulative effect of the greater numbers and diversity seen from multiple studies. For this methodology to be successful, the results from the combined studies need to be relatively homogenous in order to perform a statistical analysis. The examination of quality indicators in EGS is a very

heterogeneous subject, (as seen in the results section) and therefore a meta-analysis will not be possible.

2.4 Method

A systematic review of the English language literature was performed in accordance with PRISMA recommendations. Inclusion criteria were: empirical studies (both prospective and retrospective) that assessed: systems processes, models of care, and structural factors affecting the delivery of EGS. Studies focusing upon the process in the Donabedian model seen in the introduction, for example surgical decision-making and technical skills were excluded.

2.41 Study question and definition

A systematic review requires a clear question to be answered along with clear definitions of key subject areas.

The question that would be examined in this study was:

'A Systematic Review of the Impact of Dedicated Emergency Surgical Services on Patient Outcomes'

As previously described the definition of EGS required clarifying. For the purposes of this study, EGS encompasses gastrointestinal surgery performed

on adult patients with acute conditions that may threaten life with the exclusion of urology, trauma, and vascular surgery. These latter specialties are now established as independent subspecialties with their own emergency services.

2.42 Search strategy

The MEDLINE, Embase, and Psych-Info databases were searched for abstracts and articles published in English over a 16-year period between January 1997 and June 2014 according to the predefined inclusion criteria. This ensured that irrelevant articles and those that were now out-of-date and not relevant to contemporary practice were excluded.

The search strategy, (listed in the appendix) was based on keywords taken from key consensus statements, previously referenced, from the RCS and ASGBI as well as other documents commenting upon the delivery of EGS, including NELA.

The large heterogeneity of cases (that cover multiple pathologies) seen in EGS meant that the search was very broad and led to a large number of articles to be reviewed. This was recognised early by the authors but deemed necessary to provide an overview of current EGS practice.

2.43 Content selection

Two authors (PC and EMB) independently screened titles followed by abstracts of the searched articles. Duplicates and those papers not meeting the inclusion criteria were excluded. Any discrepancies were discussed and reviewed by another author (SA). PC, EMB, and SA then screened full papers, selected papers were reviewed and data extracted. References of selected papers and the grey literature were checked for any further relevant studies. A final check of the selected papers was then performed by the senior study authors (AWD and ODF).

2.44 Data extraction

A data extraction form was created to ensure key information from each study was uniformly collected, (including title, author, year of publication, country of origin and hospital status).

Individual elements of the EGS structural model included in each study were then extracted including:

- Senior clinician (consultant surgeon) shift patterns
- On-site presence of senior clinicians
- Site of primary surgical assessment - ED or SAU
- Availability and access to radiology facilities
- Access to dedicated EGS operating theatres
- Availability of intensive care facilities

These structural elements were chosen as they were repeatedly described as key elements in EGS delivery in the RCS Unscheduled care document as well as the papers selected for this review.

The following end points were then assessed to see whether a link between them and the selected structural factors could be found:

- Morbidity/Complications
- Mortality
- Length of stay
- Cost-effectiveness
- Time to primary surgical review
- Time to theatre
- Opportunities for training

2.45 Quality assessment

The Newcastle-Ottawa Scale (NOS), a validated tool for assessing non-randomised studies was used to assess the quality of included studies, any low quality studies would be excluded from the study (Stang, 2010). NOS scoring were completed using a pre-prepared Pro Forma and scores were validated by a second assessor (EMB).

2.5 Results

2.51 Study characteristics

A total of 27 studies comprising 744,238 patients were included (Anantha, 2014; Boyle, 2012; Britt, 2010; Cubas, 2012; Dhupar, 2011; Diaz, 2010, 2011a, 2011b; Dultz, 2010; Earley, 2006; Elshove-Bolk, 2010; Faiz, 2010; Gandy, 2010; Holena, 2011; Kelz, 2009; Lau, 2011; Lehane, 2010; Parasyn, 2009; Pepingco, 2012; Poole, 2012; Schuster, 2011; Sorelli, 2008; Stupart, 2013; Suen, 2014; Symons, 2013; Ward, 2010; Wong, 2005).

Of the included studies:

- 12 were from the US
- 7 from Australia
- 4 from the UK
- 1 from each of: Ireland, New Zealand, Norway, and Canada

All 27 studies were retrospective.

Quality of included studies varied from 4 to 8 stars on the basis of the Newcastle-Ottawa Scale meaning that all studies were included.

Three studies assessed outcome specifically in emergency colorectal surgical patients. In the remaining studies, the surgical procedures analysed varied but mainly comprised of outcomes following appendectomy and cholecystectomy.

Sixteen studies compared outcomes from 2 different care models, whereas 11 studies described a single model of care.

Thirteen studies compared an ACS model with a traditional model. Of these, one (n = 1162) demonstrated a statistically significant reduction in mortality in ACS models (2%) compared to traditional practice (5%). Four studies also demonstrated a statistically significant reduction in postoperative complications in ACS models. Three studies showed a significant reduction in time to surgical review, median reduction of 3.1 hours with 6 reporting a median reduction of 7.1 hours in time to theatre and 5 showing a reduction in out of hours operating. Seven studies described a reduction in length of stay with a median reduction of 1.2 days demonstrated in ACS models. Overall, the ACS models were associated with reduced costs in 5 of the included studies.

Reference	Country	Year	Model of Care	Specialty	Pathology	Number of Patients	Quality
Schuster et al.	USA	1999-2006	Acute Care v Traditional Model	Colorectal	Benign and Cancer	283	*******
Britt et al.	USA	2006-2008	Acute Care v Traditional Model	EGS	Gallbladder	186	*******
Cubas et al.	USA	2009-2011	Acute Care v Traditional Model	EGS	Appendicitis Cholecystitis	288	****
Diaz et al. (A)	USA	2004-2009	Acute Care v Traditional Model	EGS	-	1162	******
Dultz et al.	USA	2006-2008	Acute Care v Traditional Model	EGS	Appendicitis Cholecystitis	555	*******
Earley et al.	USA	1999-2002	Acute Care v Traditional Model	EGS	Appendicitis	294	********
Gandy et al.	Australia	2004-2007	Acute Care v Traditional Model	EGS	Appendicitis	402	*******
Lau et al.	USA	2008-2010	Acute Care v Traditional Model	EGS	Cholecystitis	152	*******
Lehane et al.	Australia	2003-2007	Acute Care v Traditional Model	EGS	Cholecystitis	202	*******
Pepingco et al.	Australia	2004-2008	Acute Care v Traditional Model	EGS	Cholecystitis	271	******
Sorelli et al.	UK	2004-2005	Acute Care v Traditional Model	EGS	Appendicitis, Hernia	1622	********
Suen et al.	Australia	2008-2012	Acute Care v Traditional Model	EGS	Appendicitis	675	******
Anantha et al.	Canada	2009-2010	Acute Care v Traditional Model	EGS	Appendicitis, Cholecystitis	829	*****
Boyle et al.	Ireland	2009-2010	SAU v Traditional Model	EGS	-	2882	******
Diaz et al. (B)	USA	2003-2007	Faculty v Fellow	EGS	-	1769	******
Holena et al.	USA	2000-2006	TH v NTH	EGS	GI, HPB	311010	*******
Diaz et al. (C)	USA	2004-2008	Acute Care Model	EGS	-	3439	******
Parasyn et al.	Australia	2005	Acute Care Model	EGS	-	-	*****
Poole et al.	NZ	2009-2010	Acute Care Model	EGS	Cholecystitis	388	****
Elshove-Blok	Norway	2002-2003	Traditional Model	Colorectal	Benign and Cancer	196	****
Dhupar et al.	USA	2004-2009	Traditional Model	EGS	Appendicitis	453	*****
Kelz et al.	USA	2001-2004	Traditional Model	EGS	-	7370	*******
Ward et al.	UK	2006-2007	Traditional Model	EGS	Appendicitis	242	*****
Faiz et al.	UK	2001-2005	Emergency Colorectal	Colorectal	Benign and Cancer	37094	*****
Wong et al	Australia	2003	Transfer to Regional Care	EGS	-	2778	****
Symons et al.	UK	2000-2009	Hospital Resources	EGS	High-Risk EGS	367796	*****
Stupart et al.	Australia	2010-2011	Dedicated Acute Operating Room	EGS	Appendicitis, Cholecystitis	1950	******

Table - 2.1: Demographics of Included Studies

Key:

Pathology – Primary condition(s) being assessed with the study
Quality – Score based upon the Newcastle-Ottawa Scoring System
EGS – Emergency General Surgery
SAU – Surgical Assessment Unit
Benign and Cancer – Emergency surgery was performed for both benign and malignant colorectal conditions
Gallbladder – Patients underwent surgery for a number of emergency biliary conditions including: cholecystitis, choledocholithiasis and pancreatitis
- Pathology Not Described

Although 14 studies described ACS models, there was no consensus as to what constitutes an ideal ACS service. A majority (23) of the included studies were conducted in teaching hospitals. One study compared outcomes in teaching hospital with non-teaching hospitals. One study compared volume status of different hospitals and subsequent outcomes in emergency colorectal surgery and one study assessed the impact of access to radiology and ICU on mortality in the context of an EGS. Holena and colleagues suggested that the higher mortality rate demonstrated in teaching hospitals was due to the more complex caseload. Teaching hospitals did have a lower complication rate. Hospital caseload did not impact on outcomes following emergency colorectal surgery (Holena, 2011).

2.52 Structural factors affecting care

The working patterns for senior clinicians in EGS were reported in 10 studies; 2 studies described 24-hour on-site consultant cover whereas 8 described on-site cover during office hours. All 10 studies stated that consultants were cleared of elective duties while on-call. Five of these showed that the increased availability of experienced clinicians was associated with a reduction in time to review and time to theatre as well as reduced complication rates and length of stay.

Eight studies described the length of on-call shifts and the frequency of handovers of care between senior surgeons. This ranged from twice daily patient handovers to once weekly handovers.

Three studies described the introduction of an SAU as a primary site for surgical review, avoiding the need for stays in the ED. Such units resulted in the streamlining of emergency services and avoided delays. Boyle and colleagues suggested that the introduction of such a unit was associated with a reduction of an average of 4 hours in time to theatre. Sorelli et al showed that the implementation of a SAU model led to a reduction in out of hours operating with significant financial savings for their unit of £90,000 per annum. Wong et al described the use of an SAU for all EGS admissions in their unit, whereas Anantha et al displayed the highest cost saving of $343,680 over a year by introducing an ACS model with use of a SAU that ultimately reduced out of hours operating. Interestingly the use of SAU appears to be an English way of delivering care and was not seen in other countries. This is perhaps related to the four-hour waiting time initiative seen in UK ED's that lead to pressure to move patients onto a ward quickly.

Three studies reported on the presence of a dedicated emergency operating theatre with improved clinical outcomes. One study described the availability of radiology services and its effect on acute surgical admissions, with improved outcomes seen in centres with increased access to radiology services.

Reference	Attending Cover	Attending Work Pattern	Regional Centralisation	Access to Emergency Operating Room	Elective Commitments of On-call Surgeon	Site of Primary Surgical Assessment
Schuster et al.	-	-	-	-	-	-
Britt et al.	-	-	-	-	-	-
Cubas et al.	Onsite until 17:00	Twice daily	-	-	Cleared	ED
Diaz et al. (A)	-	-	Regional	-	-	-
Dultz et al.	Onsite 24/7	-	-	-	Cleared	-
Earley et al.	Onsite 24/7	Daily	-	-	-	-
Gandy et al.	Onsite until 17:00	Three per week	-	24 hour	Cleared	-
Lau et al.	Onsite until 18:00	-	-	-	Cleared	-
Lehane et al.	Onsite until 18:00	Three per week	-	-	Cleared	-
Pepingco et al.	Onsite until 19:00	-	-	-	Cleared	-
Sorelli et al.	Onsite until 17:00	-	-	-	Cleared	SAU
Suen et al	Onsite until 18:00	Weekly	-	Shared	Cleared	ED
Anantha et al	-	Two per week	-	24 hour	Cleared	-
Boyle et al.	-	Weekly	Regional	-	Cleared	SAU
Diaz et al. (B)	-	-	-	-	-	-
Holena et al.	-	-	-	-	-	-
Diaz et al. (C)	-	Weekly	-	-	-	-
Parasyn et al.	Onsite until 18:00	Three per week	-	24 hour	Cleared	-
Poole et al.	Onsite until 17:00	Daily	-	08:00-17:00	Cleared	-
Elshove-Blok	-	-	-	-	-	-
Dhupar et al.	-	-	-	-	-	-
Keltz et al.	-	-	-	-	-	-
Ward et al.	-	-	Two-site trust	-	-	Either hospital
Faiz et al.	-	-	-	-	-	-
Wong et al.	-	-	Regional	-	-	SAU
Symons et al	-	-	-	-	-	-
Stupart et al	-	-	-	-	-	-

Table - 2.2: A Summary Of Structural Factors Affecting The Delivery of EGS In Hospitals Included Within This Review

Key:
Attending Cover – Presence of attending whilst on-call, if not onsite taking calls from home
Attending Work Pattern – Frequency of attending level handovers
Regional Centralisation – Referrals to specialist centre from local hospitals
Two-site Trust – Hospital split across two sites, (one site had Emergency Room)
Shared – Emergency Operating Room shared between multiple specialties during daytime
ED – Emergency Department
SAU – Surgical Assessment Unit
- Not Described

2.53 The impact of EGS on outcome

2.53.1 Mortality

Sixteen studies reported upon mortality. Seven of these articles reported no deaths. These studies assessed outcomes following low-mortality procedures (appendectomy and cholecystectomy). Diaz et al (A) demonstrated a 3% reduction in mortality by developing a centralised ACS service for general surgical admissions compared to traditional practice (n = 1162 with P = 0.01). Schuster et al showed that ACS surgeons performed emergency colorectal resections with similar adjusted mortality outcomes as specialised colorectal surgeons. Diaz et al (B) did not demonstrate any difference in mortality between senior surgeons (n = 64/1543) and fellows (n = 10/226) when operating on EGS patients in an ACS model (4% in each group). Holena et al showed a significant increase in mortality in patients undergoing emergency surgery in teaching hospitals (3984 of 142,297) compared to nonteaching hospitals (3880 of 16,871) although the authors suggested that the teaching hospital was exposed to a more complex and high-risk caseload.

2.53.2 Morbidity/Complications

Nine studies reported on postoperative complications. Lau and Lehane in their articles demonstrated a significant reduction in postoperative complications among patients undergoing emergency cholecystectomy in an ACS model compared to traditional practice. Cubas et al demonstrated improved

outcomes after cholecystectomy. Both Cubas et al and Gandy et al observed significant reductions in complications after appendectomy in ACS models compared to traditional practice. Holena et al demonstrated that although mortality rates were increased in teaching hospitals, postoperative complications were lower when compared with those undergoing surgery in nonteaching hospitals.

2.53.3 Timing of management

Time-to-review was subdivided into time to surgical review from referral and time to the operating theatre from referral. Three studies reported upon time to surgical review in ACS models compared to traditional practice. These studies demonstrated a reduction in average time to review ranging from 0.2 to 5.8 hours, with a mean reduction on 3.05 hours to review. Time to the operating room was reported in 11 studies. Of those comparing 2 models of care, 5 of 7 studies showed a significant reduction in waiting times in ACS models. Reduction in waiting time ranged from 0.3 to 72 hours, with a mean reduction in waiting time to surgery of 14.2 hours seen in ACS models.

2.53.4 Length of stay

Fourteen studies assessed length of stay with 12 studies comparing ACS with traditional models of care. Of these 12 studies, 8 demonstrated a reduction in length of stay in ACS models, 2 did not show any difference and 2 showed an increased length of stay in ACS models.

2.53.5 Financial cost

Five studies reported on costs associated with EGS admissions. Four showed a reduction in costs associated with the introduction of an ACS model. Dhupar et al reported that on average delays to theatre in appendicitis led to increased cost of stay of $2696. Sorelli et al described the benefits of a consultant led ACS service leading to potential reductions of £90,000 per annum in a single institution. Anantha et al showed how an ACS model could reduce out of hours operating and showed subsequent savings of $343,680 over a year.

2.53.6 Timing of Surgery

Five studies showed that ACS models demonstrated a greater proportion of operating during daylight hours than traditional models. Three further non-comparative studies showed that this was linked to reduced morbidity in patients undergoing surgery in daylight hours. Stupart et al described dedicated operating theatres being associated with greater daytime operating and subsequent improved consultant satisfaction.

Study	Care Model (number of patients)	Mortality (%)			Complications (%)			Time to Review (Hours)		Time to Surgery (Hours)		Length of Stay (Days)		Cost Effectiveness (Money saved in ACS)		Out of Hours Operating		
		AC	*T*	*p*	*AC*	*T*	*p*	*AC*	*p*	*AC*	*p*	*AC*	*p*	*AC*	*p*	*AC*	*T*	p
Schuster et al.	AC (60) v T (233)	14 (23)	29 (12)	-	27 (45)	72 (31)	-	-	-	-1.2	-	+4.5	p=0.27	-	-	-	-	-
Britt et al.	AC (132) v T (54)	-	-	-	-	-	-	-	-	-8.8	p=0.45	-1.2	p=0.27	-	-	-	-	-
Cubas et al. (C)	AC (62) v T (51)	0 (0)	0 (0)	-	5 (8)	13 (25)	p=0.06	-5.8	p=0.030	-25.0	p<0.01	-1.9	-	-$3225	p=0.09	-	-	-
Cubas et al. (A)	AC (93) v T (82)	0 (0)	0 (0)	-	9 (10)	16 (20)	p=0.01	-2.2	p=0.001	-5.4	p=0.06	-0.9	-	-$1924	p=0.01	-	-	-
Diaz et al. (A)	AC (855) v T (307)	14 (2)	15 (5)	p=0.01	-	-	-	-	-	-	-	-1.0	p<0.01	-$3000	p<0.01	-	-	-
Dultz et al.	AC (291) v T (264)	-	-	-	-	-	-	-	-	-	-	-1.2	-	-$2935	-	-	-	-
Earley et al.	AC (167) v T (127)	-	-	-	-	-	-	-0.2	-	-4.0	p<0.05	-1.2	p<0.01	-	-	Inc	-	-
Gandy et al.	AC (226) v T (176)	0 (0)	0 (0)	-	21 (9)	30 (17)	p=0.02	-	-	-0.8	p=0.29	+1.0	p=0.92	-	-	Red	-	
Lau et al.	AC (71) v T (81)	-	-	-	5 (7)	15 (19)	p=0.03	-	-	-10.4	p=0.03	-0.6	p=0.11	-	-	-	-	-
Lehane et al.	AC (115) v T (87)	0 (0)	0 (0)	-	10 (9)	15 (17)	p<0.01	-	-	-24.0	p=0.01	-2	p<0.01	-	-	-	-	-
Pepingco et al.	AC (157) v T (114)	0 (0)	0 (0)	-	4 (3)	5 (4)	-	-4	p=0.008	-72.0	p<0.01	-	-	-	-	-	-	-
Sorelli et al.	AC (824) v T (798)	-	-	-	-	-	-	-	-	-	-	-	-	-£9000	-	Red	-	-
Suen et al.	AC (399) v T (276)	-	-	-	-	-	-	-	-	+3	p<0.01	0	p=0.42			Red		
Anantha et al.	AC (463) v T (366)	-	-	-	-	-	-	-	-	-1	p=0.03	0	p=1.3	-	-	Red		

Boyle et al.	SAU (1596) v T (1226)	0 (0)	0 (0)	-	-	-	-	-	-	-4.0	-	-	-	-	-	-	-	-
Diaz et al (B)	AC Fac (1543) Fel (226)	64 (4)	10 (4)	p=0.86	-	-	-	-	-	-	-	0	p=0.93	-	-	-	-	-
Holena et al.	TH (142297) v NTH (168713)	3984 (3)	3880 (2)	p<0.01	26752 (19)	32393 (19)	p<0.01	-	-	-	-	-	-	-	-	-	-	-
Stupart et al.	DEOR (984) v T (966)	-	-	-	-	-	-	-	-	-	-	-	-	-$343680	p<0.01	Red		p<0.01

Table - 2.3: Outcomes reported in studies comparing models of care in emergency general surgery

Key:

AC – Acute Care Model
T – Traditional Model
P – P-Value (all figures are rounded to two decimal places)
TH – Teaching Hospital
NTC – Non-Teaching Hospital
Fac – Faculty Staff – Certified Surgeon
Fel – Fellow
SAU – Surgical Admissions Unit
DEOR – Dedicated Emergency Operating Room
Cubas et al. (C) – Cholecystectomy Group
Cubas et al. A) – Appendectomy Group
Out of Hours Operating - Inc – Increased in ACS
Out of Hours Operating - Red – Reduced in ACS
- Not Reported

Reference	Number	Deaths (%)	Complications (%)	Time to Review (Hours)	Time to Surgery (Hours)	Length of Stay (Days)	Cost Effectiveness	Out of Hours Operating
Diaz et al. (C)	3439	94 (3)	-	-	-	-	-	-
Parasyn et al.	-	-	-	-	-	-	-	Present
Poole et al.	388	0	3 (1)	-	72.0	5.0	-	-
Elshove-Bolk et al.	196	46 (23)	77 (39)	-	-	-	-	Present
Dhupar et al.	453	0	-	-	-	1.4	+$2696	-
Kelz et al.	7370	-	-	-	-	-	-	Present
Ward et al.	242	-	-	-	19.3	-	-	-
Faiz et al.	37094	10757 (29)	-	-	-	-	-	-
Wong et al.	2778	81 (3)	-	-	-	-	-	-
Symons et al.	367796	57376 (15.6)	-	-	-	-	-	-

Table – 2.4: Outcomes reported in studies describing single models of care in EGS

2.6 Discussion

2.61 Conclusions from chapter

This systematic review has demonstrated that the utilisation of ACS models within the included studies was associated with improved outcomes in the delivery of EGS, often at a reduced cost. Although there was no consensus on the optimal ACS model

This model may be a potential template for future planning and delivery of EGS services across the world and provides an invaluable starting point for understanding the structural factors of note for this thesis.

2.62 Translation of findings to clinical care

The importance of delivering high-quality EGS services cannot be underestimated. Reports such as the recent Francis Inquiry into the Mid-Staffordshire NHS Foundation Trust and 'Crossing the Quality Chiasm' in the US have reiterated the importance of quality in clinical care. Providing high-quality care to emergency patients is particularly challenging given the unpredictable nature of the workload coupled with the need for rapid and efficient access to definitive care with decision-making undertaken by experienced clinicians. Surgeons across the world face the same challenges in providing safe emergency care and therefore sharing information as to how best to structure service delivery and establish best practice is of vital importance to both clinicians and policy makers.

2.63 Strengths of this review

This review builds upon recommendations from previously published consensus statements assessing the delivery of EGS (ASGBI, 2013; Parks, 2017; Royal College of Surgeons, 2011). It is unique as the first systematic review, which highlights the need for improving structural factors by focusing upon different models of care and their effect on clinical outcomes. A recent meta-analysis by Nagaraja et al compared outcomes in the context of ACS to traditional models of care, showing favourable outcomes in ACS (Nagaraja, 2014). Nagaraja and colleagues did not, however, unpick the important constituent elements of the ACS models within their analysis. This review was different as it deliberately aimed to assess a wide range of outcomes from a broad case mix to give a greater overview of factors contributing to high-quality EGS delivery. These factors included the impact of teaching hospital status, volume outcome relationships, and access to support facilities such as radiology and ICU. Modifying the delivery of services not only improves patient outcomes but also is an achievable target that can result in financial savings for hospitals in different countries as demonstrated in this review.

However, by demonstrating very favourable outcomes toward ACS, the results seen in this review and the meta analysis by Nagaraja may reflect an element of reporting bias in the included studies to justify the adoption of ACS models in their hospitals.

Although steps are being taken to implement change and hone practice, much needs to be done to ensure standards continue to improve. Morbidity and mortality figures described remain high highlighting the need for further improvements to reduce the burden associated with EGS.

Previously published work has established that increased senior clinician availability improves patient outcome. How this should be achieved effectively in the delivery of EGS is not fully understood and the implementation of these findings into NHS practice will be discussed in later chapters. A recurring question that will run through each of the chapters in this thesis is whether the introduction of dedicated emergency general surgeons as a recognised subspecialist has/will act as a catalyst for changing attitudes and allocating resources toward emergency surgical care in the UK. A key factor for this is the variability in the working pattern and length of surgeons' on-call shifts in EGS that was highlighted in this review.

2.64 Limitations of this review

Little is known about the optimal working pattern for clinicians to provide high quality, safe emergency surgical care as discussed and this requires further attention.

Issues surrounding handover of patient care between shifts were poorly described. The safety risks associated with inadequate handovers have already been highlighted previously and will be explored in more detail later.

This is particularly important in the emergency setting where handovers are frequent and a patient's clinical condition can rapidly change. The quality of handover was poorly reported in the included studies. Studies by Gandy et al and Poole et al were the only papers to clearly describe a formal handover system for patients who had not been resolved by the end of a shift. Each demonstrated improved outcomes after the implementation of ACS models with systems for formal handover.

This review was limited by a relative scarcity of published comparative high-quality studies in this area. All of the data included were retrospective and none of the studies described the use and impact of all of the structural factors being assessed. Studies included were from the developed world, therefore limiting more global recommendations. Assessing outcomes from a number of countries may also limit this review, as different health care systems may not have comparable resource allocation toward EGS delivery. This may make a meaningful comparison of outcomes difficult particularly when assessing the financial implications of modifying EGS services. Therefore, as well as assessing the cost of dedicated EGS pathways, this review also examined length of stay as a more comparable proxy outcome measure across health care systems.

The review focused on the delivery of EGS, therefore trauma vascular surgery and urology were excluded. In most of the developed world, vascular surgery and urology are recognised independent specialties and therefore provide separate emergency cover from general surgery. Trauma was also excluded

from this review, EGS is increasingly being delivered by ACS teams in the United States, and surgeons will therefore maintain a significant trauma interest (as ACS consists of EGS, trauma, and surgical critical care). The concern as to whether the broad nature of ACS may affect outcomes in EGS when compared to outcomes from specialist gastrointestinal surgeons who deliver EGS services in the United Kingdom and Europe was addressed by Schuster et al, who demonstrated that ACS surgeons had similar risk-adjusted mortality for emergency colorectal procedures as colorectal surgeons. The higher crude mortality was attributed to ACS surgeons seeing a more complex caseload of emergency presentations.

The review also focused upon patients who underwent surgical procedures. Surgeons assume responsibility for a number of clinical conditions, many of which can be complex and do not always require surgical intervention, an example being acute pancreatitis. Therefore, this review may not provide an accurate reflection of a surgeon's true workload.

A further limitation is that the universal translation of the ACS model into different health care environments was not addressed by the studies included within the review. ACS requires investment both in terms of hospital structure as well as human resources (e.g., providing dedicated emergency operating rooms and employing enough senior surgeons to be cleared of elective commitments when on-call). This investment may be suitable in densely populated metropolitan areas, where the demand for acute care services makes increased resource allocation economically viable; however, in

remotely populated rural areas, ACS may not be financially sustainable and may rely on centralising services.

A broad heterogeneity in conditions seen in EGS was identified; clinical conditions such as appendicitis and cholecystitis are not often associated with poor outcomes and therefore it was unsurprising to see low mortality in these studies. However, this review also commented upon complex colorectal emergencies, which are often associated with poor outcomes and mortality rates of more than 20% were described. Although such variation in caseload and associated outcomes may be seen as a limitation of the review, reporting this heterogeneity was deemed necessary to provide an accurate overview of current practice in EGS. However in order for this thesis to gain maximum impact it is clear that focus when examining outcomes such as mortality should remain on high-risk EGS cases. EGS cases such as appendicitis are extremely common; however mortality rates are so low that it would be difficult to gain meaningful data on how services can be modified to improve outcomes. However in high-risk EGS where mortality can be as high as 25% by adapting hospital structure it is hoped that improvements in outcome can be seen. This thesis will look at outcomes in low-risk cases, related to gallstone pathology when it examines efficiency as a marker of quality in later chapters.

Although many of the included studies commented upon and compared outcomes between the described health care models, various confounders that influence outcome were not always explored. An example being mortality,

to fully understand mortality numerous factors need to be considered, including: patient demographics, complexity of cases, and institutional factors such as nursing ratios and access to radiology and ICU. Similar assessment of potential confounders is required when analysing the other outcomes included in this review. For studies to accurately compare outcomes between 2 cohorts (ACS and traditional practice), they should be case matched and risk adjusted. Holena et al concluded that teaching hospitals have a greater mortality than nonteaching hospitals. This statement is not in keeping with established literature and practice; however, on closer inspection of the results, it is clear that the teaching hospitals included in the study were seeing a more complex caseload. The authors also described a greater involvement of trainees in the care of emergency patients in teaching hospitals, which differed from nonteaching hospitals where care tended to be senior led. A combination of these factors was used to explain the higher mortality rates seen in the study; were the patients from each cohort more accurately matched in a prospective study the results may have differed.

Overall, the introduction of ACS models seems to have had a positive effect on the delivery of EGS within the studies included in this review; however, which elements of ACS models contribute most to improving outcomes is not fully understood. A similar picture has been seen with the introduction of enhanced recovery programs after major gastrointestinal surgery (ERAS). ERAS have been associated with improved outcomes but which components of the pathway have the greatest impact upon outcome is not known. An understanding of this is important as resources can be directed to the

elements with the greatest potential for improving outcomes. It may, however, be that innovations such as ACS and ERAS are not solely responsible for the improved outcomes seen but hospitals adopting these models place greater emphasis on QI and the delivery of effective care by greater financial investment in these services therefore leading to a generalised improvement in overall standards and subsequent outcomes.

2.7 How can we take these results forward?

This systematic review has provided a key list of commonly occurring structural factors that are used to examine outcomes and therefore quality in the delivery of EGS across the world. These factors will now be used to form the basis of all structural modelling in future chapters.

This review has also helped to focus the thesis by highlighting the importance of focusing upon high-risk EGS, for example patients undergoing a laparotomy. It is clear that a large proportion of EGS workload comes from appendicitis and other low-risk cases, however it will be very difficult to correlate structural influences to outcomes in cases were mortality is already less that one percent and therefore to aim for maximum impact for this thesis the outcomes examined in the following chapter will focus upon high-risk cases. However the examination of the EGS pathway which will be conducted in later chapters will look at all aspects of EGS care including low-risk cases as it is important to fully understand burden of EGS workload to a system to identify quality and areas for improvement within pathways of care.

This review generated questions that provide significant implications for the delivery of EGS affecting clinicians and policymakers. It highlights the need for improvements and standardisation of care looking at not only work force planning but also the structures and processes available in hospitals to ensure the safe and efficient transition of patients during each stage of their admission. Before change is implemented into clinical practice, further work needs to be conducted in finding an optimal model of ACS and its impact on clinical outcome.

Understanding the Problems of Service Delivery in Emergency General Surgery

Chapter Three

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3.1 Introduction

This chapter will explore the quantitative methodologies that will be used to identify quality in the delivery of EGS. It will explain the rationale for outcome data collection and analysis. It will introduce the role for administrative data in healthcare and examining outcomes as well as how larger global datasets can be used to share outcome data as a means of identifying best practice. The example used in this thesis will be the Dr Foster Global Comparators Project (GC). The main body of this chapter will then examine outcomes in the delivery of EGS by using the GC dataset in order to cement to the theory that a knowledge of how different healthcare models and their structures influence service delivery and ultimately outcome are essential in developing an understanding of best practice and identification of high-quality care.

3.2 Quantitative Data

3.21 Definition

Quantitative data can be defined as: the collection and interpretation of numerical data that are amenable to statistical manipulation (Mark, 2001).

This analysis of quantitative data is often used in healthcare research to define a problem rather than describe it as its examination allows for academics to test hypotheses in order to answer research questions.

3.22 Role in healthcare

The testing of hypotheses when evaluating outcomes in healthcare, especially quality, is particularly challenging, as there are so many variables that contribute to it as was discussed in the introductory chapter. These variables must be included in any quantitative analysis to ensure that the results presented paint an accurate picture of the care provided and therefore large numbers of patients need to be included in any analysis to ensure meaningful conclusions, that take all variables into account are made. In order to achieve this statistical modelling is required to gain accurate results.

For the purposes of this thesis both patient and hospital level variables will be included in any quantitative data modelling for completeness.

3.23 History of outcome data collection

There is a perceived belief that the collection of outcome data in healthcare is a relatively new phenomenon that has developed alongside advances in information technology. The truth however is that clinicians have been collecting their outcome data for many years in order to improve standards

and quality. Two key historical figures that pioneered this idea were Ernest Codman and Florence Nightingale.

Ernest Amory Codman 1869 – 1940

Figure – 3.1: Ernest Codman

Ernest Codman was a Harvard Educated Surgeon who spent his career championing his theory of the “End Result Idea”. Codman believed that a hospital should follow up a patient’s journey after an intervention for a sufficient period of time to allow them to determine if the treatment had been a success or had resulted in any complications. This was so the medical fraternity could learn from both the successes and failures in order to advance standards in care (Neuhauser, 2002).

End Result Idea required the collection and interpretation of outcome data and resulted in two of Codman’s most significant contributions to Medicine. The world’s first Morbidity and Mortality meeting was led by Codman at The

Massachusetts General Hospital and he also developed the first national registry in the US to follow patients with bone tumours (Kaska, 1998).

Although both of these innovations are now routine in medical practice, they were revolutionary in Codman's time. As a result, he was forced out of the Massachusetts General by his peers who rejected his plans to 'evaluate surgeon competence'.

He latter set up his own hospital called the End Result Hospital and he published 'A Study in Hospital Efficiency' where he outlined 123 errors seen in medical care given to his patients. Codman classified the errors by type:

- Errors due to lack of knowledge or skill
- Surgical judgment
- Lack of care or equipment
- Lack of diagnostic skill
- Calamities of surgery – accidents and complications over which we have no known control

This classification can be seen as hugely insightful given that it covers all aspects of the Donabedian model of quality almost 50 years before it was described (Donabedian, 1989).

An example of Codman's approach from 'A Study in Hospital Efficiency"

“Case #90. Jan27 1913. Stout female – 36. Abdom. pain of 12 hours duration; Pre-op diag. subacute appendicitis. Op. (EAC and GWM) – Appendectomy. Appendix shows evidence of a previous attack but no sign of acute inflammation. Comp. none. (Error in diagnosis – Ed). Result August 1913 well. August 18 1915. Now has symptoms of gallstones. Op. advised, scar solid.” (Neuhauser, 2002)

The findings described from this extract showed that there was a misdiagnosis, which still occurs today. The patient continues to be followed up for years after the surgery demonstrating “end result”. This patient was found to have a new pathology not related to the original surgery. A demonstration of how Codman strived for quality by understanding his patient’s outcomes.

Interestingly Codman was disowned by the medical community and was a seen as disgrace to his family name for his pursuit of the “End Result Idea” which was not accepted by his peers. Codman felt that doctors refused to publish their outcomes, as it would affect their incomes. It was not until after his death that his achievements were acknowledged and he is now described as a founding father of the American College of Surgeons. His work has now also been recognised by the Massachusetts General Hospital and Harvard Medical School who have created the Codman Centre for Clinical Effectiveness in Surgery. I am proud that Professor David Chang, Director of Healthcare Research and Policy Development at The Codman Centre has collaborated on the work in this chapter providing an association between this

thesis and one of history's most influential figures in the field of patient safety in surgery.

The American College of Surgeons describe Codman as "a crusader whose ideas were not entirely appreciated during his lifetime, but whose ideas have become the basis of patient-centred quality based surgery in the College standards and in that of current day medical practice (Noble, 2006).

Florence Nightingale 1820 – 1910

Figure - 3.2: Florence Nightingale

Florence Nightingale is widely recognised as the founder of modern nursing; however her contribution to medical statistics and the collection/sharing of outcome data, (in particular to the effect of hospital structure) to improve clinical outcomes deserves equal credit (Shell, 2008). Her meticulous recordings of outcomes of injured soldiers during the Crimean War led to the understanding of the link between hygiene and infection. She noted that ten times as many soldiers died from infections such as typhoid, cholera and

dysentery than they did of battle wounds. With the flushing of sewers and introduction of 'Nightingale Wards' with less crowding and improved ventilation and crucially the introduction of hand washing, Nightingale reduced death rates in her hospital from 42% - 2% (Fee, 2010). History has questioned Nightingale's role in such radical reforms with some commentators arguing that her role in improving quality and standards was driven by the media's need to find a national hero at a time of great social change. However her name will always be associated with describing the link between hospital structure and outcomes (Mcdonald, 2014).

Referring back to the introductory chapter and the definition of QI and quality in healthcare, both Codman and Nightingale used outcome data to drive institutional change in order to improve outcomes for their patients.

3.3 Administrative Data

The importance of data collection in driving QI and improving standards in healthcare has been described. There are several ways to collect the required data to identify quality in the delivery of EGS.

One option would be to collect real-time patient outcome data during hospital admissions. The key problem with this form of data collection is that it is extremely time consuming and may not provide the required results due to the unpredictability of EGS admissions and variations in pathology and patient factors as discussed in the introduction.

An alternative to this is the use of administrative data; this is a highly effective way of analysing large volumes of outcome data and overcoming the arduous burden of real time data collection. Hospital Episode Statistics (HES) is a data warehouse that contains information on all emergency department attendances, hospital admissions and outpatient encounters at English NHS hospitals. This equates to over 125 million records a year being collected and inputted to HES (Aylin, 2004; Symons et al., 2013).

HES also contains essential patient demographic data allowing for the creation of complex statistical models to examine patient outcomes. Examples of available patient demographics are: age, gender, ethnicity and postcode. HES allows for the collection and analysis of diagnostic data by the using the International Classification of Diseases 10th Revision (ICD-10), this is used to formulate a primary diagnostic code and up to thirteen secondary codes that account for pre-existing morbidity as well as those found during the most recent admission.

The use of HES data is an accurate way of gathering data for large numbers of patients, making it particularly useful for examining national trends and influencing healthcare policy. However HES data cannot be completely accurate due to the errors in inputting data. Data is inputted by hospital locally using clinical coders who convert hospital notes into ICD-10 codes, the quality of note keeping within hospitals remains highly variable and therefore coders may make errors or miss important information due to this and therefore HES

has previously been criticised for its accuracy. However a review in 2014 found that the average number of errors made by coders was 7% (NHS England, 2014). This figure is significantly lower for in-hospital mortality which is now coded correctly 99% of the time and diagnostic coding has been deemed 96% accurate since the introduction of 'payment by results' by the Department of Health. It is widely agreed that the quality of clinical coding will further improve with the introduction of electronic patient records in hospitals that can allow for a more uniform and accurate form of note keeping and the real-time conversion of these notes to appropriate clinical codes.

3.4 Data Registries

Despite HES being the most wide-ranging and comprehensive database available for medical research in England it cannot always capture specific outcomes/endpoints that clinicians look for to improve their practice and therefore smaller data registries may be created in order to capture data for specific purposes. Examples of this in surgery within the UK include the National Joint Registry, the National Vascular Registry and the National Bowel Cancer Audit (National Joint Registry, 2014; Thompson, 2010). As discussed in the introduction the NELA aims to collect data specific to patients presenting with EGS pathology. Data registries are thought to contain fewer errors than HES as data inputted is by professionals with a specialist interest in the area and therefore a greater understanding of what information is required for accurate data collection. Their main limitation is that the information collected will be specific to the specialty that the registry belongs

to and therefore general demographic information may be missing, as will cases that are not directly relevant to the registry.

3.5 Why compare global outcomes when examining quality?

It is clear from the previous chapters of this thesis that there remains huge differences in the way that EGS services are delivered around the world and therefore an understanding of these differences and their effect on outcome are essential to identify quality.

A common criticism of comparing outcomes from different healthcare models is that drawing comparisons between services that have differing models of care and resource allocation is like comparing ‘apples and pears’ and meaningful comparisons cannot be made. However when examining outcomes and quality, understanding the subtle differences in structure between a variety of models is essential to determine which factors truly contribute towards high-quality care.

The Organisation for Economic Co-operation and Development (OECD), states that countries within their group spend on average of 9.3% of their gross domestic product (GDP) on healthcare (OECD, 2015). However there is huge variation in healthcare spending within this group with the US spending most (16.9% of GDP) compared to the UK and Australia who spend 9.3% and 9.1% respectively. A comparison of outcomes between the different healthcare models seen in these countries will provide an insight into whether

the additional money spent is translated into better outcomes for patients. It also allows for greater understanding of the processes seen in different countries, for example are similar populations being treated? Is the incidence of conditions such as diverticulitis similar between different countries and if so are patients managed in a similar way? This approach allows for the sharing of best practice in an ever-tighter knit global community.

3.6 The Doctor Foster Global Comparators Project

Dr Foster Intelligence is a healthcare analytics company that was formed in 2000 and subsequently purchased-in-part by the UK government with the aim to work with healthcare organisations to achieve sustainable improvements in performance through better use of data. A key principle behind the work conducted by Dr Foster is the importance of benchmarking by using outcome data and using this information to understand variation in healthcare delivery. The company believes that by reducing variation between hospitals overall performance in healthcare delivery will improve and therefore better care can be provided to patients. In order to maintain its quality and ensure all work produced underwent rigorous academic review, Dr Foster formed a partnership with Imperial College London. It has subsequently been purchased by Telstra Health and the Global Comparators (GC) arm of the organisation is now run as a not-for-profit collaboration which aims to benchmark data from centres across the world (Bottle, 2013).

The Dr Foster concept was originally applied to UK hospitals alone; however they soon realised that a similar methodology could be applied to international hospitals and GC was launched in 2010.

GC has steadily grown to now include over 45 hospitals across ten countries and examines outcomes across six domains:

- Gastrointestinal Surgery
- Health Economics
- Heart Failure
- Orthopaedic Surgery
- Sepsis
- Stroke

3.61 My role in Global Comparators

The following work described was completed as part of GC. I was invited to join GC in order to look at outcomes following high-risk EGS admissions in the participating centres.

The studies used a combination of HES and GC Registry data and aimed to examine whether global differences in outcome exist in the delivery of EGS and also whether any global differences can be explained by structural differences in hospitals across the project. It is hoped that an understanding of this will help inform us of what constitutes high-quality care in the delivery of EGS across the world and the findings of this work can be used to inform

policy makers and service providers in the UK as to how services may be shaped in the future to achieve optimal outcomes.

3.62 Validating Global Comparators

A number of projects have been completed by the GC Project that aims to validate the methodology for using administrative data. I have been involved in two of these studies. One compared administrative data findings to an Australian bowel cancer registry in Victoria and the other compared outcomes to established RCT data in carotid interventions. Both studies demonstrated excellent cross-correlation of results and are awaiting publication at this time, they have shown that the GC dataset provides excellent high-quality data when examining surgical outcomes.

3.63 Acknowledgements at Global Comparators

The remainder of this chapter contains data results and statistical analysis. This was completed with the help of Dr Neil Casey PhD (NC) and Dr Mark Joy (MJ) PhD, Senior Analysts at GC.

Further acknowledgement must be made to Dr David Chang, Massachusetts General Hospital (DC) and Professor Carol Peden (CP) from The University of Southern California who provided methodological advice and support through the process.

A final special thank you to Ellen Klaus, Director of GC for her on-going guidance and support for the duration of this work.

3.7 Do global differences in emergency surgical outcomes exist?

As discussed, the unpredictability and variety of workload seen in EGS makes prospective data collection difficult and time consuming. This problem is amplified when trying to collect large volumes of patient data and therefore using administrative outcome data can add valuable information on patient demographics and treatment for large numbers of patients. The use of international datasets allows for further analysis and comparison between different healthcare systems and may provide valuable information and insight to policy makers and clinicians to develop and improve patient care.

3.71 Aims

The primary aim of this work is to determine whether global differences in outcomes following emergency general surgical (EGS) admissions exist between hospitals in the GC Project.

The second aim is to explore the relationship between hospital structure and outcomes in the delivery of EGS in GC hospitals. This will be achieved by a combination of administrative data analysis and a survey.

3.8 Methods

3.81 Ethical approval

This study was run as a QI project and therefore formal ethical approval was not required by any of the participating academic institutions. The study was discussed and approved by the Dr Foster Science and Research Committee at the Annual GC Meeting in Chicago, November 2013.

3.82 Participants

Retrospective discharge data were obtained from 23 academic medical centres across three countries (Australia, England and US). Each participating unit is a member of GC. Data for English hospitals were obtained from the Hospital Episodes Statistics (HES) database (covering all admissions to NHS hospitals). For other countries, electronic inpatient records were obtained directly from each participating hospital's administrative database. These hospitals were selected from within GC as they provided access to complete datasets covering the period of analysis from 2007 - 2015.

3.83 Inclusion criteria

This study focused upon high-risk EGS diagnoses. High-risk diagnoses were defined as those with a crude mortality rate of greater than 5% as previously described by Symons et al. (see appendices for diagnosis codes) (Symons,

2013). The included diagnosis codes were mapped into seven clinical conditions:

- Bowel ischemia
- Diverticulitis
- Liver and biliary
- Gastrointestinal ulcers
- Hernias
- Peritonitis
- Miscellaneous

The rationale for focusing upon high-risk pathology was identified within the systematic review chapter where an overview of current EGS practice was observed.

Although clinical presentations such as acute appendicitis and cholecystitis make up a large proportion of EGS admissions, their management is associated with low levels of mortality (less than 1%) and complications and therefore modifying EGS services may not result in improved outcomes unlike those that may be seen in high-risk conditions (Cubas, 2012).

All adult patients discharged from the included hospitals between 1st January 2007 and 31st December 2012 who were admitted with a primary diagnosis meeting the inclusion criterion were included in this study.

3.84 Exclusion criteria

Centres were excluded if the authors did not have access to complete data for the period of analysis. Patients admitted with a non-gastrointestinal primary diagnosis and paediatric patients (those under the age of sixteen) were excluded. Patients who were classed as short stay with an in-patient admission of less than 24-hours were also excluded.

3.85 Study procedure

3.851 Survey

A survey (see appendices) covering key structural aspects of an EGS admission was created and distributed to senior clinicians within the hospitals included in the study.

The questions included in this survey were developed based upon key findings from the systematic review in the previous chapter and from key policy documents including those produced by NELA and the RCS as described in the introductory chapter.

The survey was tested for accuracy by randomly selecting five centres within the cohort and sending it out to a second clinician within these hospitals to ensure each clinician reported comparative responses.

The results of this survey was then translated to appropriate binary code and included in statistical analysis to determine the effect of hospital structure on outcome.

3.852 Administrative data collection

The dataset used was based upon the primary diagnostic code assigned to each hospital admission.

This is calculated using the international classification of diseases (ICD), which is recognised by the World Health Organisation (WHO) as the standard diagnostic tool for epidemiology, health management and clinical purposes across the world (World Health Organisation, 2016). It is used to standardise disease classification in medical records, to collect epidemiological data and reimbursement/resource allocation for healthcare providers.

There have to date been ten revisions to the ICD classification and both England and Australia use ICD-10 in their respective national administrative datasets whereas at the time of this study, the US was using ICD-9. Therefore for this study, using appropriate and matched ICD-9 and ICD-10 codes from the participating countries datasets, data were collated analysed, in-house using the statistical software package R©.

3.853 Outcome measures

The following four-outcome measures were selected, as they were available with the GC dataset.

- Mortality was defined as any in-hospital death within seven or thirty days of hospitalisation.

- Readmission was defined as any unplanned admissions to an inpatient unit at the same hospital within 30-days of discharge.

- Long length of stay was defined as a length of stay greater than that of the 75th percentile patient in the participant groups for the primary diagnosis as described.

3.854 Statistical analysis

Patient level data used for risk adjustment were: diagnosis group, age, sex, country, year of discharge, co-morbidity and admission source/transfers.

- Age was divided into four groups (>60, 60-69, 70-79, >80)

- The comorbidity index score was constructed from the 31 Elixhauser comorbidities, plus dementia that were recorded against each patient on admission to hospital. Elixhauser is a validated method of

determining co-morbidity and is routinely used by Dr Foster. The Charleston co-morbidity index provides an alternate method recording co-morbidity however was not used in this study (Lieffers, 2011).

- Based upon the pathology being examined all admissions were deemed as emergencies, transfers were defined as patients being transferred from another acute hospital setting in order to receive emergency care.

3.855 Geographical differences

A multivariate logistic regression model was created using the patient level predictors to assess 7 and 30-day in hospital mortality, 30-day emergency readmission to hospital and long length of stay.

This allowed the authors to determine whether geographical differences in outcome exist.

A clear geographical difference in outcome was demonstrated with associated clustering of units from each country as demonstrated in the funnel plots below (Spiegelhalter, 2005). Therefore a random intercept hierarchical regression model was then created containing structural factors identified from the survey in order to determine which structural factors contributed to outcome. This multi-level modelling technique removed the geographical

influence on results allowing for an accurate measure of structural factors within their own right.

3.9 Results

3.91 Demographics

A total of 69,490 patients were included in this study.

- 14,881 from Australia
- 29,152 from England
- 25,457 from the USA

Five centres were in Australia, Ten were in England and eight were in the USA.

Patient demographics, including age, sex and co-morbidity were similar between countries (See Table 3.1).

A total of 27% of patients admitted underwent a surgical procedure related to their primary admission code. Ratios of admissions/surgery were similar in all three countries, (23% Australia, 28% England, 27% USA $p<0.001$).

	Australia	England	US	Total	
Admissions (%)	14,881 (21)	29,152 (42)	25,457 (37)	69,490	
Operated (%)	3,422 (23)	8,293 (28)	7,367 (27)	19,082	p<0.01*
Average Age	63	63	57	61	p<0.01**
Female (%)	50	54	57	54	p<0.01*

*Table – 3.1 – Demographics of all patients within study *=Chi Squared **=Kruksal Wallis*

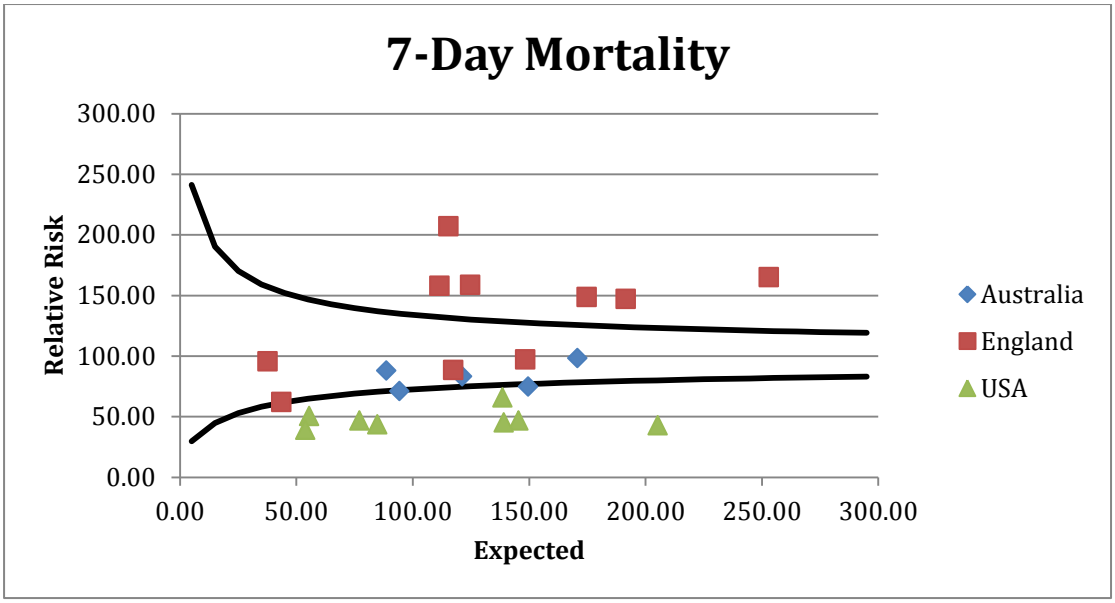
3.92 Geographical differences in outcome:

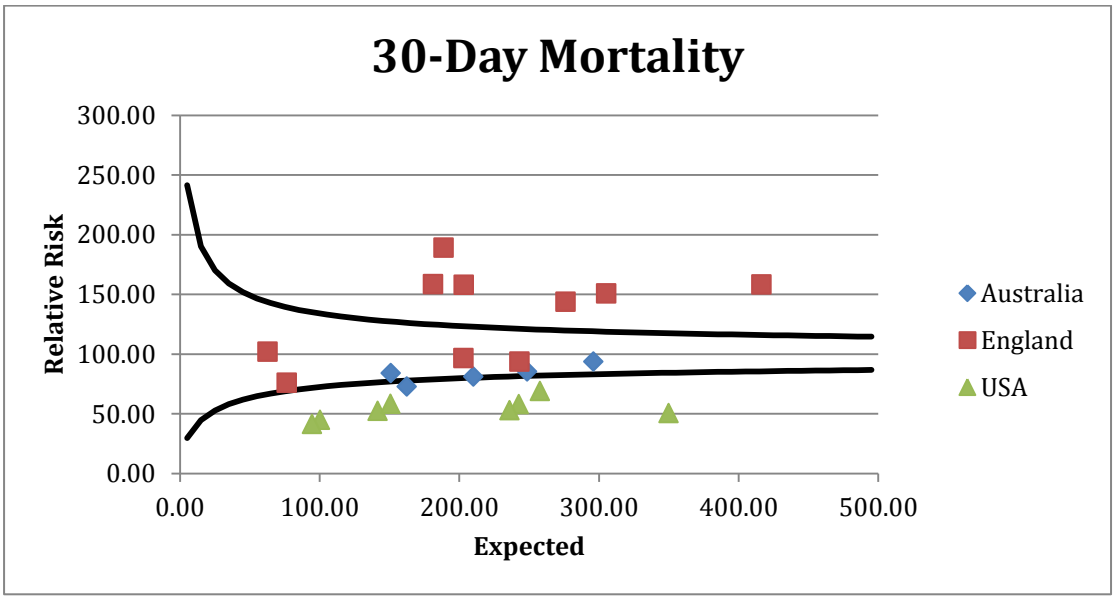
The tables and funnel plots below demonstrate that geographical differences in outcome were seen across the high-risk EGS cohort.

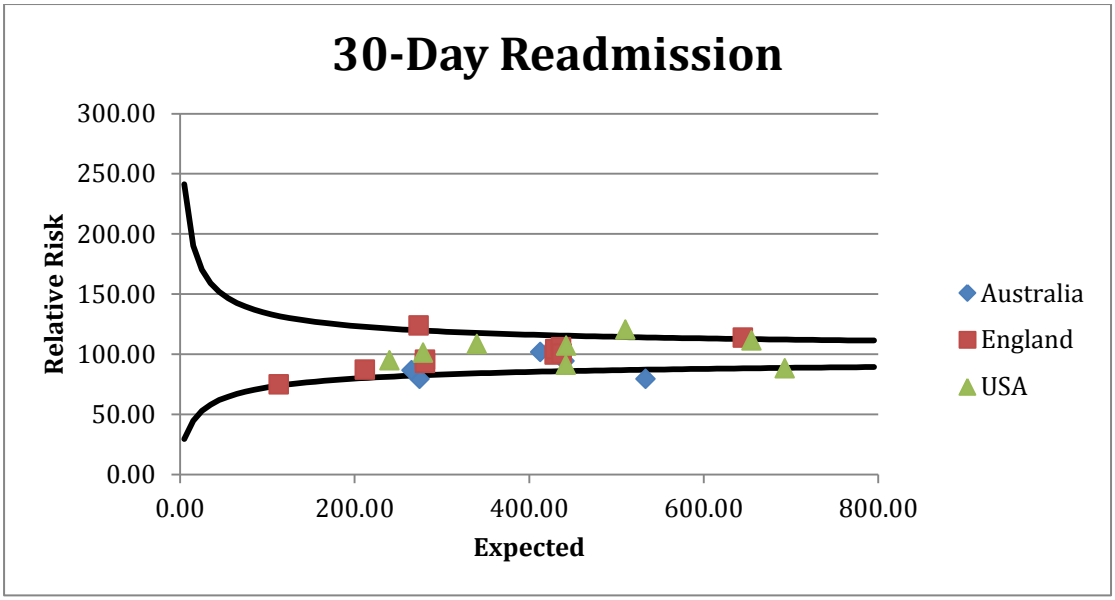
Clustering of centres from each country was seen. There was wide-distribution of centres particularly when examining mortality however these centres fitted within 3 standard deviation limits.

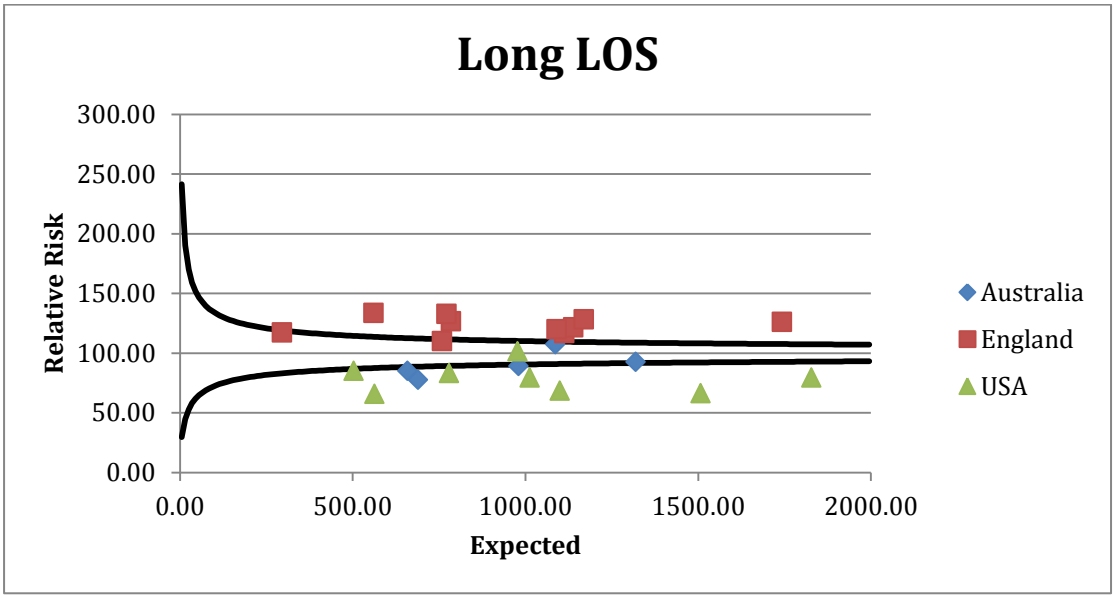
The four funnel plots below (figures 3.3, 3.4, 3.5, 3.6) were created by using patient level variables in a multivariate logistic regression model and demonstrate differences in geographical trends and outcome between the 23 GC centres included in this study. (n=69,490 in all funnel plots)

***----** = 99.8% Control Limits*


7-Day Mortality
Relative Risk
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Expected
Australia
England
USA


30-Day Mortality
Relative Risk
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
100.00
200.00
300.00
400.00
500.00
Expected
Australia
England
USA





Overall mortality in this cohort was 8%. Mortality analysis was sub-divided to look at both 7 and 30-day outcomes, and separated into two cohorts, all-comer those who underwent surgery.

All-comer mortality at 7-days within this cohort demonstrated odds ratios (OR) of 0.95 in Australia, 1.70 in England and 0.62 in the USA (Reference 1.00).

At 30-days a similar picture was seen with Australia 0.90, England 1.91 and the USA 0.58 (Reference 1.00).

Within the post-operative subgroup 7-day mortality odds ratios were the same across the cohort with OR 1.00.

However after 30-days these results had changed to 0.74 in Australia, 1.47 in England and 0.92 in the USA.

30-day readmission rates showed OR of 0.92 in Australia, 1.42 in England and 0.76 in the USA (Reference 1.00). In the post-operative subgroup readmissions were 1.32 in Australia, 1.42 in England and 0.79 in USA (Reference 1.00).

Long length of stay OR were: 0.88 in Australia, 1.98 in England and 0.58 in the USA (Reference 1.00). In the post-operative subgroup these were 0.82 in Australia, 1.56 in England and 0.78 in the USA.

*Table – 3.2: Patient level variables used in the primary logistic regression modelling to determine geographical differences in outcome between the included centres. The data presented are for all EGS admissions (Cohort of 69,490 patients) * = p<0.01*

		7-day Mortality OR (95% CI)	**30-day Mortality** OR (95% CI)	**30-day Readmission** OR (95% CI)	**Long Length of Stay** OR (95% CI)
Year (Ref 2012)	2007	1.23 (1.06 – 1.42)*	1.37 (1.22 – 1.53)*	1.07 (1.00 – 1.15)	1.24 (1.17 – 1.32)*
	2008	1.10 (0.96 – 1.26)	1.24 (1.11 – 1.39)*	1.11 (1.04 – 1.18)*	1.17 (1.10 – 1.24)*
	2009	1.13 (0.99 – 1.30)	1.25 (1.12 – 1.39)*	1.10 (1.03 – 1.17)*	1.13 (1.07 – 1.20)*
	2010	1.09 (0.95 – 1.25)	1.13 (1.01 – 1.26)	1.03 (0.96 – 1.09)	1.09 (1.03 – 1.15)*
	2011	1.01 (0.88 – 1.16)	1.08 (0.97 – 1.20)	1.01 (0.95 – 1.08)	1.10 (1.04 – 1.16)*
Sex (Ref Female)	Male	0.92 (0.85 – 1.00)	0.96 (0.90 – 1.03)	1.03 (0.99 – 1.07)	0.90 (0.87 – 0.93)*
Age (Ref <60)	60-69	1.81 (1.54 – 2.13)*	1.73 (1.54 – 1.95)*	1.09 (1.03 – 1.15)*	1.19 (1.14 – 1.25)*
	70-79	3.20 (2.77 – 3.69)*	2.85 (2.56 – 3.17)*	1.24 (1.17 – 1.30)*	1.37 (1.30 – 1.48)*
	80+	7.01 (6.83 – 8.01)*	6.11 (5.53 – 6.76)*	1.80 (1.71 – 1.90)*	1.43 (1.36 – 1.50)*
Comorbidity (Ref <10)	>10	2.52 (2.30 – 2.76)*	3.83 (3.55 – 4.13)*	2.09 (2.00 – 2.18)*	2.69 (2.59 – 2.79)*
Pathology (Ref HPB)	Bowel Ischemia	8.11 (6.97 – 9.49)*	4.85 (4.32 – 5.44)*	1.70 (1.58 – 1.84)*	0.49 (0.45 – 0.52)*
	Bowel obstruction	1.13 (0.97 – 1.32)	0.93 (0.83 – 1.03)	1.02 (0.97 – 1.08)	0.64 (0.61 – 0.67)*
	Peritonitis	5.23 (4.36 – 6.26)*	3.11 (2.70 – 3.57)*	1.59 (1.46 – 1.79)*	0.63 (0.58 – 0.68)*
	Diverticulitis	1.90 (1.54 – 2.35)*	1.52 (1.30 – 1.78)*	1.04 (0.95 – 1.14)	2.17 (2.02 – 2.34)*
	GI Ulcers	3.03 (2.43 – 3.78)*	2.72 (2.31 – 3.20)*	1.14 (1.02 – 1.26)	1.65 (1.51 – 1.81)*

	Hernias	1.04 (0.82 – 1.32)	0.83 (0.70 – 0.99)	0.75 (0.68 – 0.82)*	1.62 (1.51 – 1.73)*
	Miscellaneous	5.13 (4.35 – 6.04)*	3.32 (2.94 – 3.76)	1.69 (1.57 – 1.83)*	1.41 (1.31 – 1.51)*

*Table – 3.3: Patient level variables used in the primary logistic regression modelling to determine geographical differences in outcome between the included centres. The data presented are for the subgroup of patients who underwent surgery (Cohort of 19,082 patients) * = p<0.01*

		7-day Mortality OR (95% CI)	**30-day Mortality** OR (95% CI)	**30-day Readmission** OR (95% CI)	**Long Length of Stay** OR (95% CI)
Year (Ref 2012)	2007	1.17 (0.84 – 1.63)	1.23 (0.97 – 1.55)	1.10 (0.97 – 1.26)	1.17 (1.05 – 1.30)
	2008	1.03 (0.75 – 1.42)	1.30 (1.05 – 1.62)	1.14 (1.00 – 1.29)	1.18 (1.06 – 1.31)*
	2009	0.99 (0.71 – 1.36)	1.13 (0.90 – 1.42)	1.08 (0.95 – 1.23)	1.13 (1.02 – 1.25)*
	2010	1.10 (0.81 – 1.50)	1.06 (0.85 – 1.32)	1.04 (0.92 – 1.18)	1.01 (0.92 – 1.12)
	2011	0.96 (0.70 – 1.31)	0.98 (0.79 – 1.23)	1.04 (0.92 – 1.18)	1.15 (1.04 – 1.27)*
Sex (Ref Female)	Male	0.86 (0.71 – 1.04)	0.95 (0.83 – 1.08)	1.07 (0.99 – 1.15)	0.93 (0.88 – 0.99)*
Age (Ref <60)	60-69	2.08 (1.52 – 2.85)*	1.94 (1.57 – 2.41)*	1.11 (1.00 – 1.23)	1.38 (1.28 – 1.50)*
	70-79	2.84 (2.12 – 3.81)*	2.66 (2.17 – 3.25)*	1.21 (1.09 – 1.34)*	1.68 (1.54 – 1.83)*
	80+	4.57 (3.44 – 6.05)*	4.52 (3.72 – 5.48)*	1.62 (1.45 – 1.80)*	1.90 (1.74 – 2.09)*
Comorbidity (Ref <10)	>10	2.58 (2.07 – 3.21)*	3.79 (3.23 – 4.45)*	2.19 (2.01 – 2.38)*	2.83 (2.65 – 3.08)*
Pathology (Ref HPB)	Bowel Ischemia	7.62 (4.48 – 12.96)*	4.59 (3.26 – 6.45)*	1.82 (1.51 – 2.19)*	0.47 (0.40 – 0.56)*
	Bowel obstruction	0.45 (0.26 – 0.78)*	0.62 (0.44 – 0.87)	0.73 (0.63 – 0.86)*	0.72 (0.63 – 0.81)*
	Peritonitis	3.16 (1.78 – 5.63)*	2.00 (1.37 – 2.93)*	1.16 (0.95 – 1.42)	0.41 (0.34 – 0.48)*
	Diverticulitis	1.06 (0.47 – 2.40)	1.18 (0.70 – 1.99)	0.99 (0.74 – 1.32)	1.71 (1.32 – 2.20)*
	GI Ulcers	1.19 (0.66 – 2.16)	1.56 (1.09 – 2.24)	0.73 (0.61 – 0.89)	0.81 (0.69 – 0.94)*

	Hernias	0.65 (0.37 – 1.15)	0.54 (0.37 – 0.78)*	0.54 (0.46 – 0.64)	0.70 (0.61 – 0.80)*
	Miscellaneous	2.27 (1.26 – 4.08)*	1.69 (1.15 – 2.47)*	1.14 (0.94 – 1.39)	1.20 (1.01 – 1.42)

3.93 Patient level factors (see tables 3.2 - 3.5):

Mortality improved with time as 2012 mortality was significantly improved when compared to 2007 ($p<0.01$ for 7 and 30-day mortality, readmission and long length of stay in both all-comer and post-operative groups).

Increasing age and co-morbidity were associated with worse outcomes across the board ($p<0.01$ in all outcome analyses).

Presenting pathology was also associated with outcomes with bowel ischemia and peritonitis being associated with the highest levels of mortality in the all-comer and post-operative groups ($p<0.01$)

Being transferred from another unit was also associated with worse outcomes ($p<0.01$ in all analyses).

3.94 Hospital level factors

3.941 Intensive Care

ICU availability was associated with significantly improved outcomes. For every additional ICU bed per 100 hospital beds (range 2-14) a 5% improvement in 7 and 30-day mortality was seen in the all-comer group ($p<0.01$).

Within the post-operative subgroup a 6% improvement in mortality was seen at 7 and 30-days ($p<0.01$). Increased ICU availability did not influence readmission rates or length of stay.

3.942 Volume

Volume was categorised into low, middle and high volume units based on EGS admissions during the study period.

Low volume centres saw less than 3000 EGS admissions, middle volume had 3000-4000 EGS admissions and high volume centres saw greater than 4000 EGS admissions.

Middle volume units were associated with the best outcomes with a 16% improvement in 7-day all-comer mortality ($p<0.01$) and 11% improvement in 30-day mortality ($p=0.02$) when compared to low and high volume centres.

In the post-operative subgroup middle volume units were associated with 18% improvement in 7-day mortality compared to low volume centres ($p=0.03$).

There was no significant association between hospital volume and readmission rates and long length of stay.

3.943 Consultant workload

The working pattern of consultant-level (attending) surgeons on-call for EGS was examined.

Having a consultant based on-site 24-hours a day whilst on duty was associated with a 33% improvement in 30-day mortality rates in the post-operative subgroup ($p=0.04$). However there was no significant improvement in outcome for all other measures of mortality in this area.

A registrar making the primary surgical assessment over an attending was not associated with any difference in mortality across all cohorts.

Clearing consultant surgeons of elective commitments whilst on duty for EGS was associated with a significant improvement in 7-day mortality in the procedure subgroup, odds ratio 0.65 ($p<0.01$).

Having surgeons free of elective commitments was also associated with a 22% improvement in long length of stay for EGS patients ($p<0.01$).

3.944 Handovers

Handovers of EGS patients were not associated with improvements in outcomes.

		7-day Mortality OR (95% CI))	**30-day Mortality** OR (95% CI)	**30-day Readmission** OR (95% CI)	**Long Length of Stay** OR (95% CI)
Transfer (Ref No)	Transfer In	2.06 (1.53 – 2.77)*	1.93 (1.53 – 2.44)*	1.16 (1.01 – 1.34)	1.44 (1.27 – 1.64)*
Volume (Ref <3000)	3000-4000	0.84 (0.75 – 0.95)*	0.89 (0.81 – 0.98)	1.04 (0.98 – 1.09)	1.05 (1.00 – 1.11)
	>4000	1.08 (0.97 – 1.17)	1.06 (0.98 – 1.16)	0.99 (0.94 – 1.05)	1.01 (0.96 – 1.05)
Consultant on-site 24 hours (Ref Not)	Onsite	1.01 (0.74 – 1.36)	1.00 (0.80 – 1.25)	1.28 (1.14 – 1.42)*	0.98 (0.89 – 1.08)
Consultant cleared of elective commitments (Ref No)	Cleared	1.04 (0.91 – 1.20)	0.95 (0.85 – 1.06)	0.94 (0.88 – 1.01)	0.78 (0.74 – 0.83)*
Primary assessment (Ref Trainee)	Assessment by Consultant	1.01 (0.83 – 1.22)	1.19 (1.03 – 1.38)	1.04 (0.95 – 1.13)	1.24 (1.15 – 1.34)*
Handovers (Ref No)	Handovers	0.94 (0.80 – 1.11)	1.01 (0.89 – 1.14)	0.98 (0.92 – 1.06)	1.07 (1.01 – 1.14)
Dedicated EGS Operating Theatre (Ref No)	Dedicated EGS Operating Theatre	0.94 (0.83 – 1.06)	0.91 (0.82 – 1.00)	1.00 (0.94 – 1.06)	0.96 (0.91 – 1.02)
Surgical Assessment Unit Present (Ref No)	Surgical Assessment Unit Present	1.25 (1.12 – 1.39)*	1.32 (1.21 – 1.43)*	1.08 (1.03- 1.14)*	1.07 (1.02 – 1.11)
ICU beds	ICU beds per 100 hospital beds	0.93 (0.91 – 0.95)*	0.95 (0.93 – 0.96)*	0.99 (0.98 – 1.00)	1.01 (1.01 – 1.02)*

*Table – 3.4: Hospital level variables used in the hierarchical regression model to determine which structural factors affect outcomes. The data presented for all EGS admissions in the study (Cohort of 69,490 patients) * = p<0.01*

		7-day Mortality OR (95% CI)	**30-day Mortality** OR (95% CI)	**30-day Readmission** OR (95% CI)	**Long Length of Stay** OR (95% CI)
Transfer (Ref No)	Transfer In	1.62 (0.82 – 3.22)	1.49 (0.94 – 2.38)	1.08 (0.82 – 1.41)	1.42 (1.25 – 1.61)*
Volume (Ref <3000)	3000-4000	0.87 (0.66 – 1.13)	0.82 (0.68 – 0.99)	0.98 (0.88 – 1.09)	1.04 (0.95 – 1.14)
	>4000	1.07 (0.85 – 1.35)	0.87 (0.74 – 1.04)	0.96 (0.87 – 1.07)	0.96 (0.89 – 1.05)
Consultant on-site 24 hours (Ref Not)	Onsite	0.74 (0.48 – 1.12)	0.67 (0.47 – 0.98)	0.94 (0.77 – 1.15)	0.91 (0.78 – 1.07)
Consultant cleared of elective commitments (Ref No)	Cleared	1.35 (1.09 – 1.67)*	1.04 (0.83 – 1.31)	1.01 (0.88 – 1.16)	0.80 (0.72 – 0.89)*
Primary assessment (Ref Trainee)	Assessment by Consultant	0.89 (0.65 – 1.72)	1.08 (0.80 – 1.45)	1.11 (0.93 – 1.32)	1.11 (0.96 – 1.27)
Handovers (Ref No)	Handovers	0.79 (0.57 – 1.10)	1.01 (0.78 – 1.31)	0.99 (0.86 – 1.15)	1.19 (1.06 – 1.34)*
Dedicated EGS Operating Theatre (Ref No)	Dedicated EGS Operating Theatre	0.92 (0.70 – 1.22)	0.95 (0.78 – 1.17)	1.05 (0.93 – 1.19)	0.89 (0.80 – 0.98)
Surgical Assessment Unit (Ref No)	Surgical Assessment Unit	1.26 (0.99 – 1.62)	1.29 (1.09 – 1.54)*	1.09 (1.00 – 1.20)	1.02 (0.95 – 1.10)
ICU beds		0.94 (0.91 – 0.98)*	0.98 (0.95 – 1.02)	1.00 (0.99 – 1.02)	1.01 (1.00 – 1.02)

*Table – 3.5: Hospital level variables used in the hierarchical regression model to determine which structural factors affect outcomes. The data presented are for the subgroup of patients who underwent surgery (Cohort of 19,082 patients) * = p<0.01*

3.10 Discussion

This chapter has identified a unique set of results, as it is has examined a combination of geographical differences in outcomes in EGS admissions and how they may be affected by structural factors within hospitals.

3.101 Translation to clinical care

The use of administrative data to inform clinicians of outcomes has been successfully implemented across many areas of surgery however this is the first study to examine global outcomes in high-risk EGS.

The GC project has been at the forefront of utilising the power of administrative data to examine global outcomes so that different healthcare systems can learn from each other and identify best practice from the sharing of outcome data (Munasinghe et al., 2015).

Although many steps are being taken to implement improvement in the delivery of EGS the findings from this study show that much needs to be done to provide safe and effective care for our EGS patients in particular with regards to resource allocation and defining appropriate surgeon working patterns.

Improvements in practice have been demonstrated with mortality rates reducing over the time of the study from 2007 – 2012, however overall

mortality remains at 8% which is much higher than in elective practice where predicted mortality is less than 2% following an elective laparotomy (NELA, 2015).

The geographical differences seen in outcomes were significant and show that greater resource allocation towards EGS may be required to improve mortality rates. The US hospitals within this cohort had the highest number of ICU beds available within their hospitals and therefore may explain their improved outcomes.

Previously published work has showed that senior clinician involvement is associated with improved outcomes in surgery and this study supports this (Earley et al., 2006). However the most notable finding from this study is the impact of ICU support in improving mortality for EGS patients. A six percent improvement in mortality was seen for every additional ICU bed per 100 hospital beds was described ($p<0.01$). This may go some way to explain the geographical differences in outcome as US hospitals had a greater proportion of ICU beds compared to those in Australia and the UK. A similar picture was seen in a recent UK study with examined EGS outcomes in UK hospitals (Symons et al., 2013). It is important for those involved in the delivery of EGS to recognise that it is a multi-disciplinary specialty and appropriate support services such as: ICU, radiology and pathology are essential to providing high-quality care.

A commonly occurring theme in 21st century healthcare is the centralisation of services to specialist units. This has been seen in elective cardiac, esophago-gastric and vascular surgery with successful results (Rouvelas, 2010). The US is also in the process of centralising EGS services as part of the acute care surgery (ACS) model, which encompasses EGS, trauma and surgical critical care in large specialist units. It is thought that improved outcomes seen in large units are due to a high-volume of workload and concentrations of expertise and resources allowing for patients to receive optimal care. This study shows that centralisation may not be appropriate for EGS as patients being transferred from other units as well as high-volume centres were associated with poor outcomes and increased mortality. This may be due to the acute nature of EGS meaning that delays caused by transfers or having to wait for treatment in busy high-volume centres may lead to adverse outcomes making centralisation inappropriate unlike in the aforementioned elective specialties. Further work needs to be done to explore this as it may be that the patients in these hospitals had more complex pathology and therefore may have had a greater risk of mortality as the largest centres had the most complex workload with sick patients being transferred in from smaller units (Holena, 2011).

A further strength of this work is that it did not focus purely on patients that underwent an operation. It is well recognised that some patients being admitted to hospital with high-risk pathology may not be suitable for intervention and supportive or palliative care may be the most appropriate treatment. This should not be seen as a failure as it is essential that surgeons maintain a holistic approach when managing their patients. Therefore the

results of all-comer mortality seen in this work may be interpreted in several ways and may reflect differences in geographical practice and decision-making. However it can be assumed that given the invasive nature of a laparotomy that any patient who was taken to theatre was so with curative intent.

3.102 Limitations of this study

The limitations of presenting administrative data findings are well recognised, as results are dependent on the quality of coding which can result in cases being inappropriately included or omitted from the dataset. However this is hopefully countered by the large number of patients included in this cohort. Having outcome data for almost 70,000 patients coupled with the degree of statistical significance seen in the results shows that the trends observed are of clinical importance.

It is important to highlight that the findings from this study are only based on a limited number of centres (23) within the countries being examined therefore may not be representative of outcomes across countries as a whole. As each centre was a large academic medical centre, outcomes in other units in the selected countries may differ and the overall mortality figure of 8% seen in this study is lower than findings from the UK and US. The recent publication of data from the UK National Emergency Laparotomy Audit showed an overall mortality rate of 11% after emergency laparotomy in the UK (NELA project team, 2015). Therefore the centres included within this study may be high

performing outliers within their respective countries. This may be explained by the fact the included hospitals engage in quality improvement projects such as GC and therefore have a greater institutional focus towards providing high-quality care.

The outcomes examined were limited by the availability of data. Therefore mortality examination was confined to in-hospital mortality within thirty days. This may mean that patients dying in the community following discharge or having been transferred to another healthcare facility would be missed. This is particularly important when considering US data as the systematic review in chapter two described that the US routinely now uses an ACS model of care where services are centralised (Chana, 2016). This means that patients may be transferred to an ACS facility for their operation and then returned back to their local hospital for on-going care and convalescence, the findings of this study would not reflect the outcomes for these patients.

Examining mortality for a longer period of time (60-90 days) may also demonstrate a change in outcomes. Thirty days is a relatively short period of time to follow up patients and they may remain in a high-dependency environment during this time. A similar picture in thirty-day mortality between the UK hospitals was seen in elective colorectal resections however when follow up was extended to 90-days mortality rates began to converge (Byrne, 2013). This was attributed to longer ICU stays for US patients who were dying at a later stage. Patterns in EGS may be similar if longer follow-up data was available.

This study did not explore the economic impact of delivering EGS services within GC hospitals. The Organisation for Economic Co-operation and Development (OECD) has produced data that shows that the US has the greatest expenditure of GDP (16.9%) on healthcare in the world with the UK and Australia spending similar proportions of their GDP (9.3% and 9.1% respectively) (OECD, 2015). It is not known whether the UK and Australia can provide similar resources to EGS delivery as the US and whether this additional expenditure will result in overall savings both economically but also in improved quality of life, with reduced mortality, length of stay and readmissions being seen. Further work in collaboration with healthcare economists and policy makers is required to explore this further.

3.103 Conclusion

This work has generated questions that will impact significantly upon the delivery of EGS across the world. A combination of these findings with those seen in the previous chapter now provide evidence for a number of structural factors that are associated with improved outcomes in EGS delivery. The question now remains how can these findings be successfully implemented into clinical practice to improve care for our patients.

Examining the Emergency Surgical Pathway

Chapter Four

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4.1 Background

The previous chapter explored how quantitative methodologies can effectively be used to examine outcomes in health care by providing large numbers of results and demonstrating trends in outcome data. The results from the previous chapter show that structural factors may play a key role in determining outcome and identifying quality in the delivery of EGS. Despite its strengths, quantitative research does not account for day-to-day problems that are encountered by frontline staff delivering healthcare and how these issues may affect outcomes.

Therefore in order to truly understand high-quality care, the delivery of EGS needs to be explored in more detail and we will therefore look at qualitative methodologies.

4.2 The role of qualitative research in identifying quality in healthcare

Qualitative research encompasses a number of methodologies. Its strength in healthcare is that it provides an in-depth analysis into human behaviours and how the environment in which the subject practices influences these behaviours (Fossey, 2002). The understanding of this is a key component to

QI as described in the introductory chapter.

A number of the potential methodological flaws encountered by quantitative research, described in the previous chapter, can be explored and explained in detail by qualitative studies (Vincent, 2010). When critiquing outcome data in surgery, academics, clinicians and healthcare providers often state that it is difficult to interpret results as binary outcomes in the form of numbers and statistics as there are so many complex factors and interactions that determine an outcome. Every patient is unique and the huge variation seen in anatomy, physiology, pathology and care delivery based on an individual clinician preference means that no two patients ever have the same outcome when admitted to hospital. These intricacies are often not accounted for in data analysis and therefore using this as the sole tool for identifying quality is a flawed methodology. This complexity is also an argument for not comparing healthcare to other high-risk industries such as aviation, (which relies on much more predictable machinery) as previously described in chapter one.

4.21 Case example of the benefits of qualitative research in exploring outcomes

Registry data is routinely collected from a number of clinical specialties in the UK and across the world. Registries provide a rich, detailed data set for healthcare providers to plan service delivery and examine outcomes (Stey, 2015).

A by-product of this ability is to provide both unit and surgeon level outcomes to fellow professionals and, more importantly, the general public. In the UK the publication of this data is routine in the fields of: cardiac surgery, vascular surgery and colorectal surgery (Hickey, 2014).

The concept of publicising these data was initially met with ferocious criticism from surgeons as despite providing transparency to patients on mortality they felt it was not a fair reflection of their practice and a means to be judged. Surgeons working in specialist tertiary referral centres stated that their practice could not possibly be judged against that of their peers in smaller units as their caseload was completely different and the nature of dealing with complex patients meant that their practice would always be associated with high levels of mortality, morbidity and long lengths of stay (Boseley, 2015).

It was also seen as a negative deterrent to those clinicians who wish to push the boundaries of practice by innovating in experimental procedures and technology in order to advance standard and improve care for the population in the long term. Novel treatments and procedures may be associated with increased morbidity and mortality in the early stages, as with any learning curve. The publication of outcome data may deter providers from authorising novel services and from patients wishing to be treated by those surgeons and hospitals with poor results in the published data.

However, if the publication of outcome data were supplemented by a descriptive narrative that takes factors such as case mix and unit level

structure into account, it would provide a greater depth and richness to the numbers and would help put both clinicians' and patients' minds at ease.

4.3 A brief history of qualitative research

Qualitative research methodologies have traditionally evolved from the domains of social science and anthropology. Therefore much of the work in this field has been performed by: behavioural, experimental and clinical psychologists.

The focus of qualitative research is not to determine numerical results such as "How many?" but to ask the questions of "Why?" and "How?" and its real strength is in the investigation of complex interactions between subjects that determine their behaviours and decision-making (Vincent, 2010).

4.32 Fields of qualitative research and their association with healthcare research

- Grounded theory – this is a methodology in which data are collected without a pre-set and specific research question in mind, as data are collected and trends develop data can be coded into categories (Strauss, 1994). These categories can be analysed to form the basis for theory. It is very different from traditional medical research, which often begins with a hypothesis and the data collection is focused

towards answering a specific question.

  - A grounded theory study would collect a series of codes based on the observations in the study; these would be grouped together to form broader concepts. These concepts are then further grouped together more broadly into categories, which generate a theory, and this is the ultimate end goal of grounded theory.
  - An example of grounded theory being used in medicine is looking at adjuvant holistic therapies in cancer patients and how the patient's pre-conceived beliefs influence their attitude towards treatment.

- Organisation storytelling – this is often used in the study of management, the interactions between individuals and their environment and organisational design (Duffield, 2016).

- Ethnography – ethnography is the systematic study of people and cultures and it is where a researcher observes a society from the point of view of the subjects of the study. This is classically seen in anthropology where a researcher will immerse themselves in the environment of their subjects and by the process of observation and detailed record-keeping can develop an in-depth knowledge about the subjects, in particular their social interactions and behaviours (Draper, 2015; Neyland, 2007).

All of the methodologies listed above are applicable to looking at the delivery of healthcare and identifying quality; systems in healthcare have a profound influence on service delivery, not only to the patient receiving care but also those healthcare professionals who are delivering the care.

A particular use of qualitative studies is to form the basis of future study design by increasing our understanding of problems. For the purposes of this thesis, qualitative methods will allow us to delve deeply into factors that affect the delivery of high-quality healthcare and in using the Donabedian and Institute of Medicine models as our guide for quality in healthcare we will explore the effect of the hospital system upon outcomes and service delivery.

The pitfalls of using these methodologies, in particular ethnographic studies in healthcare are that they are incredibly resource-heavy, given the nature of direct observation required. It is almost impossible to observe healthcare interactions on a 24/7 basis as not only is it difficult for the researcher, but it is also potentially intrusive for the subject (both the patient and those being observed at work).

Therefore as a means of compromise, the study design for this work will incorporate the use of clinical notes review as well as direct patient observation. This is a methodology that has been utilised in previous healthcare studies looking at the patient journey.

4.4 Rationale for the study

The idea for exploring individuals during their hospital stay in depth came from a seminal paper written by Charles Vincent in the *BMJ* in 2001 titled *Adverse events in British hospitals: preliminary retrospective record review* (Vincent, 2001). In this study Professor Vincent reviewed over a thousand medical/nursing records of patient admissions in two acute hospitals in London and the aim of this study was to record the number of adverse events occurring during an inpatient stay. These were in elective admissions rather than emergency admissions as to differing from this work, however the findings were startling in that one in ten patients experience an adverse event during a planned hospital admission demonstrating the potential harm that we as healthcare providers can inflict upon our patients.

It is this level of scrutiny of patient-level data offered by qualitative methodologies that adds to the richness of this thesis in determining structural factors that contribute to high quality care in the delivery of EGS.

4.5 Key definitions for this study

- Non-routine event – Any event that is perceived to be unusual or atypical. Medical management may have been optimal.

- Adverse event – Medical mismanagement occurred. This does not necessarily result in harm or injury occurring but care was deemed to

be negligent or sub-standard and not related to the disease process.

The definition of adverse events is subjective and differs in the literature. The definition given above is based upon The Harvard Medical Practice Study and matches that used in the Vincent paper.

Given the acute nature of EGS, there will be certain patients who will have poor outcomes associated with their admissions and these are purely due to the nature and severity of their disease. In these situations both non-routine events and adverse events may still occur, however may not influence the outcome for that patient and in these situations the outcome is deemed not preventable.

4.6 Study design and method

This study was a prospective observational study incorporating aspects from a number of qualitative methodologies, predominately ethnography but also grounded theory and organisational storytelling.

The study followed the inpatient journey of twenty patients admitted as general surgical emergencies to two large English acute NHS trusts.

4.61 Ethics

The study was presented and discussed at local research and audit meetings in both hospitals as well as at Imperial College London. It was approved as a quality improvement project and therefore formal ethical approval was not sought.

4.62 Hospital structure

North Bristol NHS Hospitals Trust is a large English teaching hospital admitting general surgical emergencies from a population of approximately 500,000.

The hospital has an on-site ED, which has been designated as a regional trauma centre with 24-hour on-site consultant cover.

Emergency surgical admissions are referred either directly from the community via GPs to a dedicated SAU or from the ED.

The EGS service is made up of eleven consultant gastrointestinal surgeons. Five are upper gastrointestinal specialists and six are colorectal surgeons. Urology and vascular surgery have separate on-call teams.

There is an on-site registrar 24 hours a day with support from two junior doctors. There is a second emergency registrar who is responsible for the day's operating.

There is 24-hour access to interventional radiology and ICU.

The SAU nurse to patient ratio is 1 to 6 and referrals to the SAU are taken directly from the nursing staff in the department. Referrals from the emergency department are taken by the senior house officer/core trainee on-call.

North West London Healthcare NHS Trust is made up of two large English district general hospitals, with one of the largest ED's in Europe. It also has 24-hour on-site consultant cover and also houses a national quaternary referral complex colorectal hospital.

The EGS service is predominantly run by emergency surgeons with the support of 24-hour resident registrar cover with junior support. It also has separate urology and vascular surgery on-call services on-site.

Patients have access to 24-hour interventional radiology and ICU facilities and the surgical admissions unit differs to Bristol in that it closes at 18:00 and any referrals after this time will be admitted to general surgical wards.

The specialist colorectal hospital has its own dedicated team of doctors from consultant level down and does not routinely accept emergencies, as these will be required to come through the emergency department of the hospital.

4.63 Participants

Twenty adult patients (over the age of 16 years) were included in this study. Ten from each hospital were observed from time of admission to discharge.
As this study is focusing on the delivery of EGS inpatient services the following cases were excluded: breast, endocrine, gynaecology, paediatrics, trauma, urology and vascular. This is because each one of these specialties had their own recognised emergency pathways of care.

Patients who were discharged from the ED following a primary assessment were also excluded from this study as it focused upon the identification of process failures throughout the entire inpatient pathway.

Patients observed were not preselected. EGS patients meeting the inclusion criteria during the study period were included up until the point where twenty patients were identified and observed.

4.64 Ethnographic observation

An observer (PC) was trained in ethnographic methodology and field note keeping by an experienced academic surgeon and clinical psychologist (SA and LH).

This training was in the form of a pilot where three patients were observed during the hospital stay by the observer and trainers independently. Field

notes were then correlated to ensure that appropriate observations were recorded and the study protocol would be followed.

As previously mentioned it is not possible for a single observer to follow such a large number of patients throughout the entirety of their hospital stay. Therefore at times where the observer was not present in hospital, retrospective case note reviews were performed as well as short interviews with the medical and nursing staff involved in the care of the patients whilst the observer was away.

The observer followed the patients during the entirety of their emergency admission. Upon the first encounter with the patient, consent was taken to ensure the patient was fully aware that they were participating in a QI project.

The observer was not involved in the care of the patient being followed, however was allowed to raise concerns with the clinical team should he feel the patient may be at risk of significant and immediate harm.

The observer followed EGS patients from their first clinical encounter either in the ED or the SAU and was therefore assigned to the clinician responsible for the primary assessment (this was normally a surgical registrar or senior house officer).

Observations took place through all stages of the patient's journey including: interdepartmental transfers, investigations, operative interventions and ward-

based care. Observations ceased when the patient was discharged from hospital and left the hospital building.

A pre-validated pro forma was created between the trainer and observer based upon factors deemed key to the delivery of effective emergency care delivery. This will be discussed in detail later. Detailed ethnographic field notes were kept in real time to record: management, clinical decisions, inter-professional communication, communication with the patient and the effect on the working environment on care delivered such as external interruptions to clinical staff providing care and human factors (a clinician's ability to cope in managing the patient's care).

The observer would note both positive and negative findings within the pro forma and record key conversations and opinions of staff in order to gain an in-depth understanding into behaviours and organisational factors that affect clinical care.

The same pro forma was used in all locations to ensure no bias in information gathering.

Following the patient's discharge from hospital case notes were retrospectively reviewed in detail by the observer and the trainers to identify any deviation from the ideal standard of care that may have been missed during live observations.

The recorded field notes were retrospectively reviewed and moderated by the trainers, who have a specialist interest in this field of study. The senior supervisors (ODF and AWD) were available to moderate any questions raised during the data-collection and analysis.

4.65 Areas to be observed

Using the a combination of the following principles discussed and referenced so far in this thesis:

- The Institute of Medicine definition of quality in healthcare
- The Health Foundation definition of QI
- The Donabedian Model
- The Codman “End Result Idea”
- Grounded Theory
- Organisational Storytelling
- Ethnography

A discussion was had between a series of surgeons (PC, SA, EMB, ODF, AWD, AMP) looking at which structural factors on an individual level are key in the delivery of high-quality surgical care and how they could be assessed/examined. These factors were broadly grouped together into the following:

- Assessment

- Management
- Communication
- Documentation
- Environment
- Infection control
- Investigations
- Medications
- Staffing
- Timing

If we take the key policy documents from the Royal College of Surgeons of England and the Association of Surgeons of Great Britain and Ireland looking at issues affecting the delivery of EGS, all of these areas are covered in these documents and therefore were included in the ethnographic observations.

For every patient the observer witnessed each of these stages of healthcare delivery in each of the different hospital environments.

- The ED
- The SAU
- The general surgical ward
- The operating theatre

4.7 Results

4.71 Patient cohort

A total of twenty patients were observed from admission to discharge:

- 4 patients admitted with acute appendicitis
- 2 patients admitted with acute cholecystitis
- 2 patients admitted with biliary colic
- 2 patients admitted with acute ano-rectal abscesses
- 1 patient admitted with gastroenteritis
- 1patient admitted with an enterocutaneous fistula
- 1 patient admitted with a fistula-in-ano
- 1 patient admitted with pouchitis
- 1 patient admitted with small bowel obstruction
- 1 patient admitted with an acute groin hernia
- 1 patient admitted with constipation
- 1 patient admitted with a perforated duodenal ulcer
- 1 patient admitted with ovarian pathology
- 1 patient admitted with hepatic jaundice

The mean age of the cohort was 38 (range 19 to 72). Of the patients admitted, eight patients (40%) went to theatre. Two patients were transferred to another team during their hospital admission. There were no deaths seen in this cohort of patients. Comorbidity ranged from ASA Grade 1 to 3. Six patients were female with fourteen male patients included in the study.

4.72 Non-routine and adverse events

Of the patients admitted, a total of 92 non-routine events were recorded with 89 adverse events seen in 17 patients (85% patients experienced an adverse event during their EGS admission). A majority of these events occurred either in the ED or in the SAU. No adverse events were seen in the operating theatre and one patient required an ICU admission.

4.73 Findings from the study

Given the nature of ethnographic studies, many of the observations made are described in free text and are now listed below.

They will be separated into non-routine events, process failures and adverse events and are based upon the structural factors being examined in this study.

Non-routine events based on assessment:

There were two events where the duty SHO did not formally assess or examine patients, as they were unsure of what to do.

“I do not know what is going on, we will have to wait for the registrar”

“I do not see the point in examining the patient as I am unsure of what I am looking for and the registrar will repeat the examination soon”

There were two further episodes where the F1 on duty did not make a presumed diagnoses or create a differential diagnosis lists as they were unsure of what to do.

These episodes are seen as non-routine events as the expectation of an acute surgical review is that a history and examination would be undertaken by the assessing doctor to establish pathology and differential diagnoses would inform an appropriate management plan.

The above can be described as process failures with no associated harm but were preventable.

Adverse events based on assessment:

A pregnant patient was seen with a peri-anal abscess. She was in her first trimester and was taking medication that was potentially teratogenic (infliximab and mercapatapurin). She was not discussed with the obstetric team or midwives, she was booked for surgery and miscarriage was not discussed as a risk.

The clerking SHO did not recognise the risks of medications, surgery and sepsis to a new pregnancy. The registrar resolved the issue.

Another patient with an acute abdominal infection was seen in the ED, the triage nurse or ED doctors recorded no observations or objective measures of physiological derangement.

Both of these events can be seen as adverse events that were preventable. The patient's stays were prolonged, as issues related to the events required addressing.

Non-routine events based on management:

Two non-routine events occurred in the management of patients in this study. One patient was reviewed and bloods were requested as part of their investigations. These were not performed in the urgent care centre where the patient was seen.

Another patient was transferred to the ward from the ED without an ID band being placed on them. Their ID was verbally checked.

Neither of these events were related to medical error and can be seen as non-routine events.

Adverse events based on management:

Several adverse events occurred in this area of the study examples included. A patient with a perforated duodenal ulcer was seen in the ED. A chest x-ray was performed and showed a pneumoperitoneum. However it was not checked by the ED team and therefore not handed over to the surgical team. This was because the patient was reaching their four-hour “breach” time in the ED and therefore was sent straight to SAU from radiology. This led to a delay in review from the surgical registrar who did not know the patient had perforated. When he saw the patient it was clear that the patient had not had antibiotics or a proton pump inhibitor. He said, “This is really bad management”.

The pregnant patient who was discussed earlier was booked for surgery and kept starved in hospital. Due to delays in the EGs theatre she waited 18 hours from booking to surgery. She was not prioritised as a pregnant patient.

Both of these events can be seen as adverse events as they led to unnecessarily prolonged hospital stays for these patients.

Non-routine events based upon communication:

Communication proved to be a real issue in this study and a majority of non-routine events were based upon this area. During one clerking an F1 was called and bleeped ten times, these disruptions increased the time taken for the clerking and may have led to lapses in concentration and error occurring

For another patient the SHO stopped midway during a rectal examination to take a phone call. This left the patient in an embarrassing and uncomfortable situation for a prolonged period of time.

An SHO could not get hold of the registrar as she was attempting to call his personal mobile phone that had no signal in the hospital.

An associate specialist who was covering the consultant on-call shift did not consent a patient for surgery as he felt “it was not his job” to do this. This led to a delay in the consent process.

Four patients experienced language barriers between themselves and members of the on-call team responsible for their care.

Non of these events led to harm but can be seen as non-routine events and process failures

Adverse events based upon communication:

The patient who was discussed in the previous section who had a perforated duodenal ulcer came to the SAU. Upon discovery of the diagnosis the ward sister called the ED and asked why an unstable patient had been sent to the ward without being appropriately managed. This lead to an argument over the phone. The ward sister said during the conversation, “This outcome is a result

of breach targets rather than focusing on the clinical picture and needs of the patient."

This patient also did not speak much English as he was Polish and when the registrar reviewed him, he struggled to obtain a history. During the consultation another patient in the bay informed the team that he was Polish and preceded to translate on behalf of the patient. This was done through the curtains of the bed.

Both of these examples are deemed adverse events as they go against the principles of good medical practice and may have resulted in patient harm.

Adverse events based upon documentation:

A number of adverse events that affected patient care and may have resulted in patient harm during this study.

Of the 20 patients seen in this study. Six (33%) did not have drug charts written after their first surgical review. This led to delays in the administration of medications and fluids.

Two (10%) did not have a venous thromboembolism risk assessment completed.

For one patient, notes were misplaced and therefore the SHO started a new clerking pro-forma after the registrar review. This meant the patient had duplicate notes, both incomplete.

Three patients had incorrect nutritional status documented. One patient registrar recommended clear fluids, SHO documented nil by mouth, one patient was told they could eat after their scan but this was not documented so patient was kept nil by mouth. Another patient was kept starved for nine hours, as the SHO did not record the result of a scan in the notes.

One patient was consented for the wrong operation. The registrar decided to perform an open appendicectomy on a slim male patient. The SHO misunderstood this and consented him for a laparoscopic appendicetomy.

One radiology request was incorrectly completed meaning that a scan was not performed.

One patient was discharged home after the registrar reviewed him. This review was not documented so the last documentation in the notes was from the F1 clerking which had a different working diagnosis documented.

Antibiotics were prescribed by the surgical F1 on the ED prescription sheet; this was not handed over to nurses. The patient left ED and the main hospital drug chart was commenced. Nobody noticed ED medication had not been given, this led to an 8 hour delay until first dose of antibiotics were received

All of these are examples of adverse events that compromised patient safety and care.

Non-routine events related to environment:

A patient was seen in a side room that was not routinely used for clinical reviews. Due to lack of space confusion followed and meant that the patient was asked to undress in front of his mother leading to embarrassment. The mother was asked to wait in the bathroom whilst her son had a rectal examination.

Two patients had there clerking delayed in the ED, as the SHOs were unable to find free computers to check notes and records.

A male patient was seen in the female bay of SAU, as there were no available male beds.

A tertiary referral patient was transferred from another hospital. The specialist hospital had no beds so patient was transferred from the ED to a normal inpatient ward. The patient asked “What was the point in me driving over 100 miles for this?”

These are examples of non-routine events, not causing harm but arising from process and systems failures

Adverse events related to environment:

A patient was seen on SAU, the patient who had previously occupied the bed space had not left the hospital and was sat in the chair next to the bed. The new patient was placed in the bed next to the previous patient in the chair.

One of the patients seen was morbidly obese, they did not fit onto a trolley properly however the ED team had no bariatric trollies so the patient was required to use a trolley that was too small for them.

The SHO on duty believed that the hospital was on divert due to a bed crisis so delayed a GP from sending a patient into SAU. The hospital had been taken off divert that morning and the SHO was not aware of this, leading to a delay in review.

One patient was asked to walk to x-ray and was left unaccompanied for 25 minutes, as there were no porters available.

These are all adverse events that could have contributed directly to patient harm

Adverse events based on infection control:

Five (25%) of patients in this study saw a clinician during their admission who did not wash their hands prior to examination

Adverse events related to investigations:

Four patients had significant delays (greater than four hours) in having their bloods reviewed due to junior doctor workload.

Three patients had significant delays (greater than nine hours) for radiology to be performed. All three patients were admitted for ultrasound scans.

Adverse events related to medication:

Two patients had significant delays (one nine hours, one 33 hours) before receiving antibiotics due to prescribing errors.

Two patients did not have analgesia prescribed and were left for prolonged periods in pain

Adverse events based upon staffing:

Two patients were transferred (one from ED to ward and one from ward to theatre) with no nurse escort due to inadequate staffing levels.

The registrar is reviewing patients when the consultant asks for him in theatre. “I cannot win, it is ridiculous. Busy units need two on-call registrars, one for admissions/ward and one for operating”

The associate specialist covering the SAU is not on-call and reviews two patients with the SHO, his plan differs to the registrars and they end up arguing. The associate specialist ends up leaving the ward saying he “is the boss”.

One post take ward round does not have a consultant present as he was up the previous night operating. He does not ask the registrar about the patients who have been reviewed.

Adverse events based on timing:

On average patients waited over five hours to see a surgical registrar whatever their method of admission, (range 35 minutes – eight hours for review).

4.8 Discussion

It is very clear that the EGS pathway is a high-risk environment. Given the complexity of the admission process coupled with the number of healthcare professionals involved in the care of these patients, error commonly occurs. When comparing the Vincent paper from 2001 to our findings the adverse event ratio differs from 10% to 85% in the EGS cohort (Vincent, 2001). It may

be that as Vincent *et al* only used case-notes to explore their cohort that many of the subtle interactions and behaviours that lead to adverse events occurring were missed and the figure from his cohort was actually higher than described. However, the discrepancy between the numbers of adverse events seen between the two cohorts is of concern.

From this study it is clear that many of the non-routine and adverse events that occur in the EGS setting are avoidable. There were no events that were deemed unavoidable and therefore the EGS pathway and system must be explored to make it a safer and more efficient environment for our patients. A key finding from this study is that most of the errors that occur in an EGS admission happen during the early stages of the admission and are related to the initial assessment, decision making and primary investigations, this makes the ED and its associated transfers particularly high-risk environments and the introduction of SAUs to streamline services to a dedicated EGS pathway with associated protocols of care may help to improve outcomes.

Another interesting observation is that errors do not occur in silos and cross many domains of clinical care. An example of this was the pregnant patient described in the results who was admitted with peri-anal sepsis. She took a number of medications, including immune system modulators, that were potentially harmful to her foetus and this coupled with sepsis and the need for an operative intervention with a general anaesthetic made her first trimester pregnancy very high risk. The errors involved in her care covered the domains of: assessment, management, communication, documentation, environment,

medication, staffing and timing. She was admitted with a large peri-anal abscess causing her to display signs of sepsis. This was on the background of inflammatory bowel disease for which she took strong medication. She had recently found out she was pregnant and had not had her booking appointment with her GP and midwife yet to discuss her pregnancy, therefore this was her first medical interaction since becoming pregnant. The surgical team correctly diagnosed her acute pathology however failed to recognise its association with risks to her pregnancy. Therefore the patient was not informed of the risks nor was she correctly consented for surgery, as the risk of miscarriage was not discussed. A high-risk patient like this should have had immediate obstetric/midwife involvement for appropriate counselling. Given the strains placed on the EGs service and the missed recognition of the risks associated, the patient waited 18 hours after admission before she went to theatre, some of this time was spent in a waiting room as no beds were available. Had the EGS system met the Institute of Medicine definition of quality it would have been: safe, timely, patient centred and efficient. I cannot be convinced that this patient's care met the requirements of those domains.

A key finding from this study is how technology can impact upon the day-to-day running of a high quality health service. Many of the events that occurred in the journeys of these twenty patients could have been avoided with utilisation of modern technologies. Errors in prescribing and the timings of medication delivery could all be addressed with an electronic prescribing system (Donyai, 2008). Errors and delays in communication could be avoided by the use of up-to date app based communication tools that allow for instant

communication and feedback to be provided rather that the reliance of out-dated technologies such as pagers and desktop computers (Przybylo, 2014). Hospitals can have the appropriate infrastructure to deliver a truly paperless system however investment and trust needs to be placed in these technologies.

The need for senior clinicians to deliver high quality EGS services was seen in this study. Several errors occurred and were avoidable because of a lack of senior co-ordination. The registrars were being “pulled in many directions” and were therefore unable to provide timely patient reviews and support the juniors who were involved in many of the medical errors. Unscheduled Care from the RCS explores the early involvement of senior surgeons (ST3 and above) however fails to recognise the number of demands placed on these surgeons during an average on-call shift (Royal College of Surgeons, 2011). The delivery of trauma care and the principles of ATLS, which remains the ‘gold standard’ in trauma across the world, can be applied to EGS service delivery. In the ATLS setting, the team leader takes a step back and provides a ‘helicopter’ view. This allows them to maintain an overview of the entire situation and changes that may occur, they delegate tasks to others rather than becoming task orientated which can lead to things being missed. The introduction of the EGS specialism has already been discussed in the introductory chapter of this thesis but may provide a start point for focusing the working patterns of consultant surgeons delivering high-quality EGS care.

We know that EGS admissions are associated with higher risks of morbidity

and mortality as seen in the organisational report of NELA and findings from Symons *et al* where mortality following emergency laparotomies remains much higher than those seen in elective practice. The reason for this is almost certainly that our acute populations present with greater physiological derangement from sepsis and its associated complications. However the surgical technique used in emergency surgery both in terms of ward-based management as well as operative intervention is similar between the elective and emergency populations with laparoscopic surgery becoming increasingly prevalent in the emergency setting. Therefore this thesis proposes that structural factors and their association with the increased incidence of adverse events are almost certainly partially responsible for the worse outcomes seen in emergency care.

It is this level of in-depth qualitative analysis that really adds weight to the big data studies previously described in this thesis.

Work has already been conducted looking at elements surrounding the delivery of EGS service delivery. However, this is the most in-depth analysis of patient level ethnographic observation performed to date.

The limitations of this study are that it was only a snapshot of a small number of patients taken at a certain time in two hospitals. Therefore sweeping statements about the overall delivery of EGS delivery across the NHS cannot be made. It may be that some of the nuances seen in these hospitals are not present in other units and patients would receive different care had they been

admitted to other units. However, as the description of the two hospitals state, they are both large, well-resourced units who claim to deliver outstanding care for their EGS patients. A further criticism of this type of work may be that the clinicians involved were influenced by the Hawthorne effect, as they were aware that they were being observed during the period of the study. As the observer I felt that this was not the case and there is much evidence to support the fact that human behaviours revert to normal practice and Hawthorne effect is diminished, particularly in stressful situations. The sheer number of non-routine and adverse events seen support this finding. A real strength of this study is that it followed patients through all aspects of their admissions. It witnessed clinicians working in different environments, from the emergency department to the general surgical ward. This cross-speciality analysis is incredibly important when examining the effect of hospital structure on outcomes in EGS because it is such a multidisciplinary speciality with general practitioners, emergency department physicians, surgeons, radiologists, nurses and anaesthetists all being involved in the care of our patients. Such a cross-sectional analysis of UK EGS service delivery has not been previously published in the established literature.

The implications of this work are far-reaching and will be discussed in further chapters. It provides a solid foundation for academics; clinicians and service providers to examine the potential pitfalls associated with systems failures in the delivery of high-quality EGS.

Given that this thesis has the theme of examining outcomes across the world

in the delivery of EGS and based on the premise of sharing best practice between different units and healthcare systems, a further study was performed where using the same ethnographic methodology as well as the same observational pro forma the observer went to the United States to observe twenty acute EGS admissions in a Level 1 ACS and Trauma centre which will be discussed in the following chapter.

Examining the Emergency Surgical Pathway in the United States and Comparing it's Model to the United Kingdom

Chapter 5

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5.1 Background

This thesis has already touched upon several of the aspects of how healthcare, in particular EGS delivery can be structured and aims to define/identify quality using a number of different methodologies. The previous chapter showed how observational studies could be used to highlight problems with service delivery; the solutions to this will be discussed in the following chapter. A limitation to the observational study was that it was performed in a small number of UK centres and therefore an accurate reflection of service delivery across the UK and the developed world could not be obtained to build upon the findings from the systematic review in chapter two. Regarding EGS care in the UK alone, this limitation is somewhat countered by the work conducted by Symons et al who established that there is little variation in EGS outcomes between English NHS Hospital Trusts implying that the care delivered and systems in which we work are fairly uniform and the previous chapter may be reflective of UK practice (Symons, 2013).

However this thesis is aiming to identify key quality indicators that can be utilised across the world as discussed in chapters one, two and three.

Therefore rather than solely observe UK practice, we proposed examining how EGS care is delivered in a different healthcare system. The results in the quantitative chapter of this thesis showed that US hospitals within the cohort examined seemed to have better outcomes and this was perhaps explained by the greater resource allocation given to EGS services in those hospitals. This study therefore used the same methodology as in the previous chapter however looked at how EGS care is delivered in a large US hospital.

This will allow for international comparisons of service delivery to be made as were for the outcome data in the quantitative analysis.

5.2 Study design and method

5.21 Ethics

The study was discussed at the local ethics committee meeting in Miami. A detailed study protocol was submitted and the study was approved as a QI project. The observer (PC) was given an Honorary Observer Contact by the Hospital for the duration of the study. This allowed for access to all areas of the hospital under supervision but did not permit the delivery of healthcare in any form.

5.22 Hospital structure

The hospital selected was Ryder Trauma Centre, a dedicated EGS and trauma hospital as part of a wider university network of hospitals under the umbrella of Jackson Health and the University of Miami. It is the largest hospital in its state and covered a population of 1.5 million people. The hospital network has 5,226 the largest number of beds of any hospital trust in the US.

The hospital was selected as the Professor of Anaesthesia at Jackson Health, (DB) had strong links with Imperial College London having worked as a Visiting Professor at St Mary's Hospital during the previous year. He has an academic interest in patient safety and the delivery of high-quality care in anaesthesia and had heard about our work. He was interested to explore the similarities and differences seen in his hospital to UK centres.

Jackson Health is a unique institution in the US given its size but also that it looks after a large immigrant population in downtown Miami and receives complex patients from the Caribbean and Central/South America. This means that the hospital is publicly funded and open to all and healthcare is free at the point of contact. This means that it has many similarities to UK NHS hospitals and is subject to significant financial scrutiny and restraints.

The Ryder Trauma Centre is a stand-alone hospital within the grounds of the main hospital complex. It is dedicated to ACS, as previously described (EGS, trauma and surgical critical care).

The hospital has been designated as a Level One Trauma Centre by The American College of Surgeons; it is equipped to deal with the most complex injured patients. It has its own dedicated ED, staffed 24/7 by attending physicians.

The ACS service is run by a team of 21 dedicated ACS surgeons who provide 24/7 resident on-call care, two attending surgeons will be on-site at any time, one to cover EGS and trauma whilst the second will run the 12-bed critical care unit. A team comprised of an on-site fellow, resident and intern support them. Handovers of care are formal and occur every 12 hours given the intensity of the workload.

There are three dedicated EGS and trauma operating rooms that function 24/7 and on-site interventional radiology services

5.23 Study protocol

The same observer who had worked on the UK arm of the study observed twenty acute EGS admissions over a period of four weeks. The same study protocol as the UK arm was used and is described in chapter four in detail

5.3 Results

The findings from the US arm of the observational studies are described below. They are presented in a similar manner to the UK arm and are

therefore separated into non-routine events and adverse events and are based upon the structural factors being examined in this study.

A total of twenty patients were observed from admission to discharge:

- 6 patients admitted with acute appendicitis
- 3 patients admitted with acute cholecystitis
- 3 patients admitted with biliary colic
- 1 patients admitted with acute ano-rectal abscess
- 1 patient admitted with small bowel obstruction
- 1 patient admitted with a femoral hernia
- 1 patient admitted with an inguinal hernia
- 1 patient admitted with an axillary abscess
- 1 patient admitted with a deep vein thrombosis
- 1 patient admitted with gallstone pancreatitis
- 1 patient renal colic

The mean age of the cohort was 34 (range 20 to 62). Of the patients admitted, 17 patients (85%) went to theatre. There were no deaths seen in this cohort of patients. Comorbidity ranged from ASA Grade 1 - 3. Sixteen patients were female with four male patients included in the study. Of the patients admitted, a total of fewer non-routine events were recorded than in the English study 24, however 75 adverse events were seen affecting all 20 patients included in this study (100% patients experienced an adverse event during their admission). These were seen across all areas of the pathway.

Non-routine events based on assessment:

A patient was admitted overnight with upper abdominal pain. A CT scan confirmed the presence of a gallstone in a thin-walled gallbladder. They settled with analgesia and the resident discharged the patient. In the handover meeting the following morning the attending surgeons present shouted at the resident as they felt the patient should have had a cholecystectomy. “Is this appropriate, why are you sending someone home with a large gallstone” No further action was taken and the patient was not asked to return.

This has been deemed a process failure with no harm occurring as biliary colic can be safely managed as an outpatient however the resident was unaware that his attending wanted to operate.

Adverse events based on assessment:

A Patient was admitted with possible appendicitis and was referred to the surgeons by ED after a CT confirmed the diagnosis. The patient had a very brief clerking by the student; on review the resident was not happy. A heated conversation followed

“What are the vitals?”

“I don’t know”

“Why are they called vitals?”

“Well none of you check them so I didn’t know I had to”

A further patient with a history in keeping with cholecystitis was referred to the ACS team by ED, during the telephone discussion the resident asked, “Which Attending do you think will operate without a CT – get one”

A patient presented to ED with epigastric pain and was not felt to have a surgical problem by the ACS service so referred to medicine where he was found to have pancreatitis. He was re-referred to the surgeons for consideration of a cholecystectomy, which happened that day.

A 16-year old female was seen with a possible ectopic pregnancy, she was sent for an ultrasound scan prior to BHCG testing, the scan request read “USS to rule out ectopic pregnancy” The radiologist requested correlation with BHCG as a cystic structure was seen on scan however a CT scan was instead requested as the ultrasound was inconclusive.

These were all deemed as adverse events as they extended the patients hospital stays and exposed them to additional investigations and radiation.

Adverse events based on management:

A female patient of childbearing age with suspected appendicitis had a CT scan on admission; this was prior to a BHCG being performed. This test was performed six hours after the CT scan was done

Another patient was admitted with pancreatitis, this was diagnosed on CT scan. No objective biochemical assessment of the severity of the pancreatitis such as a Modified Glasgow Score was ever made.

Of the 17 patients who had an operation, none of them had a post-operative decision made about nutrition on their operation note or review. Patients were left to eat (or not) at their own will

A post operative patient with potassium of 2.7 was sent home with no follow up planned, the attending, fellow and resident were all made aware of the blood test result.

A secret service agent was admitted with a deep vein thrombosis of unknown aetiology. After being anti-coagulated, he was discharged and no follow up or thrombophilia screen was discussed even though he was a young, fit patient.

These were all deemed as adverse events as they could be directly responsible for patient harm.

Adverse events based upon communication:

The resident who reviewed a patient with appendicitis and arranged for transfer to theatre did not communicate his management plan to the nurses. They had to look at notes. The nurse answered on questioning by me “We do

not really talk to doctors". There was no surgeon, ED nurse communication seen in all 20 admissions. For the same patient the resident called the fellow to inform him of the case "If it shows appendicitis just send him to the OR" "Don't you want to see him first?"

A patient with pancreatitis required a laparoscopic cholecystectomy. They were Spanish and spoke little English, no attempt was made to find an appropriate translator and the medical student who had 'high-school level' Spanish knowledge translated.

For the patient admitted with a deep vein thrombosis, no discussion was had regarding the possible impact on his career as a secret service agent as he would be on warfarin

These were deemed as adverse events as they could directly cause harm to the patient.

Adverse events based upon documentation:

No documentation of clinical notes or operation notes were made in real time for the 17 patients who went to theatre, the attending dictated his findings and follow up plan and this was typed at a later date making acute transfer of information inaccurate.

A patient admitted overnight with biliary colic was listed for theatre. In the anaesthetic room the intern was informed that the patient had not been consented. “The resident should have done this yesterday”

A patient with HIV was admitted with a painful inguinal hernia, the ACS team reduced the hernia and requested a pre-op work-up as he had HIV. He was therefore transferred to the infectious disease ward. There was no documentation of the ACS intervention. The ACS fellow reviewed the patient and reduced the hernia again. He told the patient that he would not be for surgery as his CD4 count was too low (<5). This decision was not documented or communicated to the infectious disease team.

Non-routine events related to environment:

A patient was seen in the ED with acute appendicitis, the ED was busy and there was no free cubicle, he was therefore reviewed and consented in an open bay with another patient in close proximity.

Adverse events based on infection control:

Of the twenty patients in this study 13 were examined by a doctor who had not washed their hands prior to examination.

One patient was seen with necrotising fasciitis from a groin abscess, his wounds were left open in ED and not dressed.

A patient with a breast abscess was found to have MRSA on a wound swab, she was not isolated and gowns and gloves were not worn to examine.
Switch to linezolid

Adverse events related to investigations:

A Patient admitted with pancreatitis had an ultrasound, CT and MRCP all within 24-hours to make diagnosis. The CT and MRCP added no further information to the ultrasound.

Another patient who was known to have gallstones was admitted with biliary colic. Her bloods (LFTs, lipase and inflammatory markers) were all normal. She had an MRCP. The attending asked the junior staff, "Why was an MRCP performed? This is a monumental waste of resources and bed space. She could have had an intra-operative cholangiogram if there were any concerns"

A patient presented with intra-abdominal sepsis and had a Hartmann's procedure. Post operatively he had three CT scans on successive days to monitor sepsis.

Adverse events related to medication:

All surgical discharges post operatively were placed straight onto opiate-based medication, no WHO analgesia ladder was followed.

5.4 Discussion

5.41 Clinical findings

As the aforementioned results clearly demonstrate there are similarities in the variation of workload seen in EGS in the United States as compared to the UK.

The demographics of the patients different with the US centre seeing a much younger cohort of patients. Also more patients in the US underwent an operative intervention. Fewer process failures and adverse events occurred in the US hospital, however it could be argued that those that did were of much greater clinical concern and could have caused greater harm than those seen in the UK and crossed the entire pathway, also every patient in the US experienced an adverse event which was not seen in the UK arm.

The most striking difference seen however was in the differences demonstrated in the first few hours of the patient's admission. In the United States patients were rapidly triaged within minutes and given the availability and access to on-site radiology, all underwent some form of radiological procedure within the first two hours of their admission. This allowed the emergency department physicians to confidently diagnose pathology and refer the patients on to the surgical team with a diagnosis; this is not seen in the UK. This also resulted in a much shorter length of hospital stay, as patients were not waiting for investigations or definitive treatment. The longest

wait for a primary scan (they were often followed up with repeat imaging) in the US cohort was two hours, forty minutes whereas a patient in the UK cohort waited for eighteen hours before receiving an ultrasound.

The use of CT scanning in particular remains a controversial point for discussion in the UK. However, there is an increasing body of evidence showing that the volumes of radiation that patients are exposed to during a CT scan are not as harmful as once thought (Berrington de González, 2009; Lee, 2004). This can be explained by developments in technology and the longer-term follow-up data seen in patients undergoing CT scans. This was the most striking difference between the two cohorts.

A second, very telling difference, was the presence of attending (consultant level) surgeons in the United States. As the attendings were resident and were required to be present in the operating room for billing purposes, they were involved in reviewing patients at a much earlier date than seen in the UK (Laratta, 2016). They were also present for all operating room interventions. There was also a marked difference in intensive care bed use. It is thought that this was due to the increased availability of dedicated EGS high dependency level beds seen in the United States.

However, what is interesting is given the degree of reliance on radiology and senior surgeons there was a much different role for the junior doctors in the American hospital. There seemed to be greater diagnostic and management uncertainty between them and they were not as confident in their clinical

capabilities. Adverse events also occurred frequently in the American hospitals and they tended to be related to communication between teams of healthcare professionals leading to errors in care.

Communication seemed to be an issue that ran through all aspects of the ACS service. The model I witnessed in the US was much more hierarchical than that seen in the UK and it was reflected by tensions seen in communication between members of the surgical team, other specialties and allied professionals. EGS delivery in the UK is tackled as a team approach with surgery, ED, anaesthetics, ICU and radiology all working together to provide the best care for our patients. In the US a very different environment was observed. The communication between teams (both verbal and written) was minimal with the surgeons appearing to “call the shots”. An example of this was the patient who had a possible ectopic pregnancy; the surgeons managed to get an ultrasound and CT scan before a BHCG was performed despite the radiologist raising concerns. Also as ACS surgeons manage their own critical care departments, there was little collaboration seen between them and anaesthetics/ICU. The most obvious observation made was the lack of communication between doctors and nurses. As all documentation and prescribing was electronic, alerts for medications and timings was raised by the electronic medical record and therefore doctors did not have to tell nurses what was required. Also on the ward, nurses rarely contributed to ward rounds and much of the care delivered in terms of washing and feeding was provided by the patient’s families making interactions minimal.

The big data analysis seen in chapter three showed a far superior set of outcomes for the US-based hospitals included in the study. The speed to intervention that having dedicated EGS resources allows for may account for these differences as well as the increased availability of intensive care beds. This study does not fully correlate with the findings from the previous chapter, as much of the pathology seen in the observational work was not in the same high-risk category as that of the big data analysis. An example of this is that appendectomies and cholecystectomies are associated with very low mortality rates.

Much can be learnt from global comparison and benchmarking. A well-used example of this is the collaboration of hospitals in Michigan, who examined their central venous catheter associated bacteraemia rates. By making five simple quality improvement interventions they almost halved their infection rates with an associated saving of approximately $2 billion per year (Weber, 2011). A team led by Professor Julian Bion from Birmingham attempted to use this intervention to improve care in the United Kingdom, and the matching Michigan project was born (Bion, 2013). By introducing the same interventions as were seen in the United States, a similar improvement in central venous catheter associated infection rates was seen across the UK. This adds weight to the argument that we should not only be using hospitals within our own healthcare system to benchmark and set standards by, but also utilise the expertise and knowledge of our colleagues across the world.

The limitations for the United States arm of the study remain similar to those seen in the United Kingdom. This was a single centre study and practices

may be different in other hospitals. We know that there is a much greater variation seen in healthcare delivery in the United States. This is because as a country they have embraced the concept of centralisation of services to high-volume specialist units. These centres seem to be associated with greater resource allocation and subsequently vastly improved outcomes to smaller rural district hospitals where specialist care can often not be given. It is also not unusual as described in the previous chapter for patients to have their acute management in a specialist centre and then be “downgraded” is to a smaller local unit for on-going rehabilitation and convalescence. Once again this study remains unique in that it is the first two-country direct comparison of EGS service delivery seen.

Identification and Prevention of Organisational Failures in Emergency General Surgery: A Healthcare Failure Mode Effects Analysis

Chapter Six

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6.1 Introduction

This chapter aims to critically examine the EGS pathway based upon findings from chapters four and five where the delivery of care within the EGS pathway was observed in real-time. This appraisal will allow for the establishment of the root causes of harm and failures in care that were so often observed in the previous chapters. The identification of causes of harm will allow for recommendations to be made that will aim to improve patient safety, care and clinical outcomes in the quest to identify quality in the delivery of EGS.

5.2 Background

Despite the phrase ‘Primum non nocere’ (first do no harm), being a core principle in the delivery of medical care, patients admitted to hospital remain susceptible to iatrogenic harm with over 10% experiencing an adverse event during their elective inpatient stay (Vincent, 2001). This problem is amplified in the delivery of emergency care with adverse event rates of 85% being seen in earlier chapters of this thesis.

EGS patients often follow complex pathways of care; commencing in the community, entering hospital via the ED before receiving a definitive surgical consultation in either a SAU or inpatient ward. This complexity is further compounded by the unpredictable timing of emergency presentations coupled with the urgent need for involvement of support services such as radiology, ICU and operating theatres, all of which require further transfers of location, care and information between teams.

Complex pathways within hospitals, such as those seen within EGS, therefore require increased scrutiny. The link between complexity and error in healthcare is well established due to the potential for failures seen within complex pathways. In EGS these failures and subsequent adverse events may place already vulnerable patients at risk of harm and be partially responsible for the poor outcomes seen.

6.21 What is failure mode effects analysis?

Failure mode effects analysis (FMEA) is a methodology developed to identify failures in complex systems. It was initially developed as a systematic analysis tool for use in the US Military but its use was rapidly adapted for industry where it has played a central role in quality control for several decades (McDermott, 2011). It has more recently been adapted for use in healthcare (HFMEA); the purpose being to prospectively identify failures in healthcare systems that may result in adverse events or harm (Institute for Heathcare Improvement, 2015). The US Joint Commission on Accreditation of

Healthcare Organizations has validated HFMEA as an appropriate tool for measuring patient safety systems. (Joint Commission 2018).

Previous studies have successfully used the HFMEA methodology in surgery. However, these studies focussed their attention on the structure of a surgical ward and its effect on process outcomes and the communication channels within the elective surgical pathway (Steelman, 2011). To date there has been no study seeking to prospectively identify the risk of harm to EGS patients across the entire admissions pathway or to recommend interventions that could circumvent the organisational failures that contribute to the poor outcomes seen in EGS.

6.3 Aim of this study

The aim of this study was to systematically risk-assess the EGS admission pathway to provide recommendations for intervention so as to improve the quality of care in EGS.

6.4 Method

A modified four-stage HFMEA was conducted using a method based upon the Veterans Affairs National Centre for Patient Safety Model (Heget, 2002).

Stages comprised of: observation, risk-assessment, focus group and root cause analysis.

6.41 Setting and Acknowledgements

This study was conducted in the general surgical departments of two large UK teaching hospitals. These were the same centres where the observational study described in chapter four was conducted. Approval for this study as a quality improvement project was gained from audit offices in each study centre.

The authors must thank Miss Ann Pullyblank (AMP), Clinical Director for Surgery and Consultant Surgeon, North Bristol NHS Trust for her involvement in all stages of this study and for hosting the FMEA focus group.

6.42 Inclusion and exclusion criteria

This HFMEA focused upon adult patients who were admitted to hospital as general (gastrointestinal) surgical emergencies. Therefore patients with gynaecological, orthopaedic, traumatic, urological and vascular conditions were excluded, as independent emergency cover for these specialties is now routine practice within the UK.

For the purpose of this study, the processes assessed focused upon ward-based care within the emergency surgical pathway and therefore excluded care in the operating theatre and ICU. These sub-groups are highly specialist areas, associated with unique hazards that have already been assessed in

studies looking at factors that compromise safety in the operating theatre and ICU.

6.43 Phase One - Observation

The aim of this primary phase was to gain an understanding of the EGS admissions pathway by identifying commonly occurring steps and exploring potential organisational failures and areas of harm and is linked to chapter four.

A trained researcher in ethnographic observational methodology (PC) observed the entire EGS pathway of 20 randomly selected patients from the time of referral to hospital through: admission, investigation, treatment and discharge over a two-month period, resulting in a total of 34 days of hospital admission time.

Ethnographic observations were conducted using a structured Pro Forma that focused upon organisational factors that affect the delivery of high-quality emergency surgical care. The Pro Forma was designed to capture the key features in the patient journey including: clinical decision-making, clinical management, inter-professional communication, distractions/interruptions, patient transfers, environmental and human factors. The observer assessed all of these factors and their impact on the delivery of care. This methodology allowed the observer to obtain detailed information on each stage of the inpatient journey for the entirety of the admission. The strengths of

observational methodologies are that they allow for an assessment of patient and professional interactions as well as inter-professional communication. Observation provides an alternative perspective of care that focuses upon the needs of the patient whilst highlighting organisational processes that affects the delivery of high-quality care, both positive and negative. Potential areas of harm were identified and recorded. During times when the observer was not present a detailed case-note and chart review was conducted to obtain further information on care. Potential adverse events and their link to organisational failures were recorded.

Following the observation period, key process steps recorded during the admissions were collated to create a 48-step admission pathway that summarised the essential processes encountered during emergency general surgical admissions, (see appendices) This was based upon a vignette of a theoretical emergency surgical presentation.

6.44 Phase Two – Risk Assessment

Each of the process steps identified in the admission pathway were risk assessed by an inter-professional panel of clinicians. This panel included all stakeholders involved in the care of the EGS patient and both registrars and consultants were present for each specialty represented:

- General Practitioners
- ED Physicians
- Radiologists

- Anaesthetists
- ICU Physicians
- Surgeons
- Surgical Nurses
- A Patient

Each of the 20 members of the panel were given an introduction to HFMEA before completing this risk assessment independently.

Risk assessment was based upon the severity, frequency and detectability of process failures related to organisational factors that may directly lead to adverse outcomes or harm. As seen in the matrix provided in the appendix, each component of the risk assessment carried a maximum score of four and therefore a combination of scoring for severity, frequency and detectability analysis the most hazardous process steps would carry a potential hazard score of 64.

6.45 Phase Three – Focus group

A focus group, chaired by an expert in HFMEA methodology was conducted where the aforementioned stakeholders met to discuss high-risk process steps within the EGS pathway. The discussion followed the chronological pathway seen in the index case.

6.46 Phase Four - Root cause analysis

The inter-professional panel discussed each step in the process map in order to obtain a list of root causes for organisational failures identified in phase-three. This identification of root causes allowed the panel to identify strategies that may be implemented to prevent these failures and avoid adverse events. The root cause analysis followed a decision-tree analysis as used in previous HFMEA studies. Each process step failure was discussed and strategies to address these failures were identified.

6.5 Results

6.51 Phase One

A total of 34 days of admission time were observed and resulted in the identification of 48 process steps commonly seen in EGS admissions. This degree of detailed ethnographic observation is significantly higher than previously published HFMEA studies.

6.52 Phase Two

A theoretical admission vignette was created and included the 48 process steps identified from Phase-One. These were subdivided into two groups. 21 steps involved in the initial clinical decision-making stage and 27 steps that form the basis of definitive care.

All 48-process steps were risk-assessed by an expert panel. The hazard score for each process step could potentially be between 1 and 64 with a hazard score threshold of 16 being pre-determined by the research team. All twenty members of the panel had completed hazard scoring prior to the focus group and 45 of the 48 process steps had exceeded this threshold.

Previous HFMEA methodologies have described the discussion of 50% of the most hazardous process steps in order to identify and focus upon high-risk process failures. This HFMEA was unique as there was universal consensus from all key stakeholders that a majority of the process steps and associated organisational failures were potentially high-risk and may result in adverse outcomes. As only three of the process steps were not deemed high-risk the stakeholders and researchers agreed that all 48-process steps would be taken forward for discussion in focus group and root cause analysis.

6.53 Phases Three and Four

All key stakeholders met as a group to discuss the EGS admission pathway and the 48 process steps identified. Numerous potential failures associated with hospital organisation were identified within the admission pathway and were linked to potential harm. Failures were identified across all stages of the EGS pathway. Following discussion it was apparent that the root causes for organisational failures could be divided into six key themes: inadequate and ineffective resource allocation, limited use of information-technology (IT), lack

of protocol driven care, poor clinical management and inadequate inter-professional communication.

6.531 Failures identified in community care

Organisational failures

The failures identified within the community care of EGS patients included: patient unable to attend their doctor's surgery due to lack of transport, being too unwell or lack of access. Within the surgery the following failures were identified: the doctor not thoroughly examining the patient or failing to make a referral to the surgical team on-call at the hospital. The availability of ambulances to take the patient to the emergency department was also seen as a problem.

Root cause analysis

Root causes for these failures were based upon several factors. It was felt that general practitioners were often overworked and this could be responsible for several errors in care. Inter-professional communication was also a problem as general practitioners often work in isolation and are reliant on effective communication pathways with ambulance services and hospital teams for advice and referrals. An immigrant patient population who had not yet registered with community healthcare services as well as early closing times and a lack of resources were identified as contributors to problems in accessing care.

Recommendation for improvement

The recommendations for improvement in community care pathways included directing more financial resources towards community care which would enable more doctors to be employed as well as keeping surgeries opened for longer hours and at weekends to address time pressures and access issues. The referral process into hospital could be streamlined by providing clinicians with mobile telephones and using dedicated referral telephone lines, rather than out-dated pagers, providing more immediate and accessible contact.

6.532 Failures identified in the ED

Organisational failures

It was agreed that a successful ED admission process would involve: triage, vital sign measurement, clinical assessment, ordering of appropriate investigations, specialist referral and review with safe transfer of care or discharge. A number of process failures associated with organisational shortcomings were identified within the ED. These included long waiting times, high staff workload, staff being unaware that patients were in the department, a lack of equipment, patients being expected by surgeons due to a prior direct referral from the general practitioner and errors in prescribing. The findings from the UK arm of the observational study showed that the ED is an area of great concern in the delivery of high-quality EGS as it is where errors most often occur. The observational chapter concluded that this was because of the number of clinicians involved in the patient's care and rapidly evolving management plans all of which require effective transfers of

information. It is also the time when patients may be at their most unstable as they are awaiting the commencement of treatment.

Root cause analysis

Root cause analysis of these process failures revealed that inadequate or inappropriate allocations of resources were a key factor to staff being overworked and having to frequently multi-task. A lack of protocol driven care in the ED was highlighted as an organisational failure when dealing with deteriorating or critically unwell patients. Protocols and pathways for presentations such as sepsis are well recognised and participants felt they should be enforced to ensure that patients receive appropriate timely care, (monitored beds, blood cultures, antibiotic and fluid therapy). Failures in IT systems also led to potential patient harm through a delay in both diagnosis and management.

Recommendations for improvement

The panel felt that having a minimum nursing and medical staffing to bed ratio would assist with the delivery of safe care. They also recommended that each ED patient be given a dedicated named nurse and doctor in order to allow for continuity of care and allow for better communication between staff. This would also lead to better accountability. A robust IT system that maps patient location and progress was discussed, the group agreed that the ideal IT system would incorporate all investigation requests, results and charts so that progress could be effectively monitored, ideally by the bedside of every patient.

An ED admission normally requires several transfers of location (e.g. to radiology, to the ward). These transfers are often delayed due to lack of porters. The group recommended that each ED have dedicated staff to reduce these delays as well as a hospital design which allows all acute services to be located in close proximity. Access to radiology services provided a unique set of challenges in EGS. The group agreed that an ED should have its own radiology services with dedicated emergency on-call radiologists to approve, perform and interpret investigations in a timely manner.

The prescription and delivery of medications and fluids was another problem that stemmed from poor inter-professional communication and a lack of IT and protocol-driven care. The panel recommended the use of dedicated emergency protocols to ensure that factors such as allergy status and co-morbidities (such as renal failure) that affect the prescription medications are recorded in the ED. Another problem commonly seen in the ED is that medications and fluid prescribed are placed on different charts to inpatient charts. This can potentially lead to the duplication of drug delivery and transcription errors. A single computer based system for prescribing would remove this problem and would also allow for alerts such as a missed medication dose to be flagged up to nurses.

6.533 Failures identified on the surgical ward

Organisational Failures

Process failures identified on the surgical ward often related to poor communication and a lack of protocol driven care. The panel felt that a critical transition point within an EGS admission is the transfer from the ED to the ward that is often fraught with incomplete information due to poor handover practices.

Other organisational failures described included: high surgical ward nurse workload leading to vital sign observations not being performed as frequently as required and subsequent failures in escalation of care.

Root cause analysis

Root cause analysis for these failures again recognised problems in communication, protocol driven care, inexperience in understanding of surgical pathology and inadequate resources.

Recommendations for improvement

The panel recommended that all handovers of care of emergency surgical patients should be formalised. A standardised checklist for handover could be created to ensure key questions such as allergy status, decision to eat and drink, medication already given/overdue were all discussed and signed for. For working patterns like this to succeed the panel agreed staffing on wards needs to be increased. This would also free nurses up to ensure that observations were regularly carried out and communicated effectively to medical teams.

The need for an early senior surgical review was discussed as well as having policies in place to ensure on-call surgeons were cleared from elective duties; with an ability to escalate care to members outside the team if necessary. Protocols for treating conditions such as sepsis or bleeding also empower nursing staff to contact doctors promptly if they have concerns.

6.534 Failures identified in the peri-operative period

Organisational failures

The organisational factors that may lead to a delay in transfer to the operating theatre included: a lack of porters to take the patient to theatre, patients not being appropriately fasted, consented, investigations not being complete, inadequate staffing in theatres and pre-operative checklists not being completed appropriately.

Root cause analysis

The root causes of these factors all stemmed from a lack of resources, lack of protocol driven care and crucially, poor communication.

Recommendations for improvement

The panel agreed that strategies to avoid these process failures included improved resource allocation with a dedicated EGS team, EGS operating theatre and dedicated surgical ICU beds. A standardised pre-operative checklist, which built upon the WHO checklist, would improve communication between clinicians, wards and theatres; it would ensure that patients are appropriately fasted, consented and prepared for an operation.

6.535 Failures identified in post-operative ward care

Organisational failures

Process failures in this setting included postoperative instructions not being documented and/or followed, no decision to eat or drink documented and daily ward review not always performed by a senior clinician. Failures associated with discharge planning were also identified as a significant concern leading to prolonged hospital stay and increased susceptibly to hospital-acquired infections.

Root cause analysis again covered the key themes previously discussed.

Recommendations for improvement

The panel discussed standardising typed operation notes to ensure that clear instructions regarding drains, dressings, sutures, antibiotics, VTE medication and nutrition were all completed. To solve the issues surrounding discharge planning the group recommended protocols to ensure that vulnerable or high risk patients receive appropriate social support. This requires additional funding and pathways need to be in place to expedite this. Also by working more closely with physicians, (perhaps with joint ward rounds) outstanding issues can be resolved more efficiently.

6.6 Discussion

This novel HFMEA is the first to assess the organisational failures in EGS delivery. The number of potential organisational failures identified within the admission pathway highlighted the complexity of EGS admissions and need for this work. The systematic mapping of commonly occurring process failures, with subsequent root cause analysis and provision of recommendations for improvements in practice has allowed for an identification of high-risk areas within the EGS pathway that may account for the poor outcomes often seen in EGS.

The importance of effective care pathways and their effect on outcome cannot be underestimated. As previously discussed, Donabedian first described the association between Systems, Processes and Outcomes in healthcare in 1966 when examining quality in healthcare. The 'system' in the Donabedian model assesses the attributes of the setting in which care is delivered which equates to the pathway undertaken by the patient (Donabedian, 1966). Despite the 'system' being recognised as a critical element in determining quality much more attention has been given to the 'process' (medical practice) in research. This study highlights the need for increased focus on the systems in which we work and how they may influence outcomes.

6.61 Translation into clinical care

This study builds upon previous statements from both the RCS and the ACS that describe the need to modify the delivery of unscheduled care in order to

improve patient outcomes. Many of the organisational factors described, such as modifying working patterns for clinicians and access to support services like radiology were reinforced by this work. However this study provides a more in-depth analysis into organisational failures and how they affect patients on a day-to-day basis. An example being that the RCS has recently described the need for timely reviews of newly admitted emergency patients by senior surgeons. This HFMEA allowed for an assessment of the reasons why timely reviews may not occur and concluded that it may be due to failures in communication and resource allocation. The HFMEA analysis also provided recommendations as to how these failures may be improved, for example by providing mobile telephones to on-call teams rather than pagers meaning that they can be contacted more easily and messages can be sent via SMS or voicemail if immediate contact cannot be established. This is supported by recent work assessing the benefits of smart phone technology to improve inter-professional communication during handovers and escalation of patient care.

6.62 Strengths of this study

It is this in-depth analysis that makes the HFMEA process a useful tool in assessing current practice and shaping modern surgical services. A strength of HFMEA methodology is that it allows for a prospective and systematic approach to assessing failures within the delivery of EGS rather than relying on incident reporting which is retrospective and often reactionary. Further strengths of this study were that it encompassed the entire EGS pathway and therefore will provide an overview of general themes that recurrently can

result in adverse outcomes or patient harm. An example being that poor inter-professional communication was identified as a root cause of process failures throughout the pathway. This is a factor that is not discussed in previously published statements on the delivery of high-quality emergency care and by demonstrating its recurring presence in organisational failures we can begin to modify working practices in order to prioritise and encourage effective communication between emergency teams. It correlates with findings seen in the previous two chapters that address concerns about communications between teams in hospitals.

Also by involving all stakeholders in the delivery of EGS, each specialty was able to highlight difficulties they encounter that may result in adverse outcomes. Had the study involved solely hospital clinicians, an insight into the difficulties faced by general practitioners in keeping up with their workload whilst trying to refer unwell patients may not have been fully understood. However involving them in the process allowed for recommendations to be made such as dedicated emergency referral pathways that may streamline the referral process and subsequently reduce the burden of EGS patients within the ED.

6.63 Limitations of this study

A limitation of this study was that a key root cause identified as affecting the delivery of high quality care was a lack of resources. Although this is an important point to address, modern healthcare has to be delivered on a

budget to remain sustainable and requesting greater financial support may not be seen as a constructive solution to the problems encountered in delivering EGS services, particularly within the current economic climate. However if the other five root causes are addressed, considerable efficiency savings can be made potentially allowing for further financial resources to be diverted to resource poor areas such as medical and nursing staffing.

6.64 How can we take these results forward?

The implications of this study are far reaching and may result in a complete remodelling of the emergency surgical pathway which is not only applicable to the UK but also for healthcare systems around the world. The recommendations described can be implemented with relative ease in hospitals and their effect monitored using clinical audit and PDSA cycles. Concentrating resources on training healthcare professionals in technical skills remains crucial. However providing effective systems for them to work efficiently and safely within are just as important in providing high-quality care and satisfaction for healthcare staff and patients and may help us to achieve the goal of Primum non nocere.

Examining the Burden of Acute Gallstone Disease in Hospitals Participating in an International Benchmarking Collaborative

Chapter Seven

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7.1 Introduction

As this thesis is looking at the identification of systems factors that contribute to high-quality care in the delivery of EGS it is crucial that we explore all facets of the acute surgical pathway.

Previous chapters have described the impact of systems factors on high-risk pathologies and procedures such as emergency laparotomy. However, the qualitative chapters have shown that a majority of the workload performed by the EGS service is for cases that are not associated with such high levels of mortality.

The management of gallstone disease is something that has become increasingly seen as a key quality indicator for surgical units in their quest to ever improve the delivery of emergency services. It can be seen as a proxy measure to identify a hospitals ability to deal with commonly occurring pathology in a timely manner and therefore this chapter will examine how gallstone pathology is managed within hospitals participating in the Dr Foster GC Project.

7.2 Background

7.21 Gallstone disease

Gallstone disease is incredibly common and it's burden makes up a significant part of an EGS service's workload. It is thought that that approximately 10% of the UK adult population will have gallstones, most of who will not be troubled by them, however a proportion of these patients will become symptomatic during their lifetime.

Gallstone disease can be separated into five main clinical presentations:

- Biliary Colic
- Cholecystitis
- Choledocholithiasis
- Cholangitis
- Pancreatitis

Traditionally the management of these conditions involved conservative therapy in the acute setting. This would consist of: analgesia, intravenous fluids, antibiotics and if indicated endoscopic therapy (in the form of ERCP for bile duct stones). This would later be followed up with a cholecystectomy performed in the elective setting when the patient was "well".

However over recent years, there has been an increasing body of evidence

showing that gallstone disease may be best managed in the acute setting (Lau, 2011). This is primarily to control sepsis acutely and to minimise its associated complications and secondarily as patients awaiting elective surgery often experience on-going symptoms and can require multiple hospital admissions. This in turn places an increasing demand on our ever-stretched resources.

The CholeS study, which was part of the West Midlands Surgical Research Collaborative has now published four papers looking at outcomes following cholecystectomy in the UK and Ireland (CholeS Study Group, West Midlands Research Collaborative, 2016; Sutton, 2017; Griffiths, 2016). Key findings from the CholeS series show that:

- Emergency cholecystectomy is less costly and more effective than delayed surgery in the acute setting, making it beneficial to patients in terms of improved healthcare outcomes and to healthcare providers due to reduced costs.

- Patients presenting to different UK and Irish hospitals with acute gallbladder pathology do not receive comparable care.

By managing patients acutely it is hoped that crucially they are saved from on-going symptoms and potential complications but also their demand on NHS services is reduced. There is therefore a growing desire from both clinicians and healthcare providers to treat acute gallstone disease definitively in the

acute setting (in the same way that conditions such as acute appendicitis have always been treated).

7.22 The association between delivering an acute gallbladder service and quality

The provision of acute gallbladder surgery really does test the resilience of EGS service to its limit. Clinicians providing EGS services are struggling with the demands of high-risk cases as described in previous chapters and remain aware that patients with acute gallstone pathology can on the whole be safely managed without acute surgery, as they have been for many years. Therefore there will obviously be resistance to change practice and poor uptake in delivering emergency cholecystectomies.

This is the reason for incorporating the management of acute gallstone disease into this thesis, as it complements the work already done on high-risk EGS along with the description of how efficiency within healthcare systems can affect pathways of care and the quality of care delivered.

Referring back to the introductory chapter and The Institute of Medicine's definition of quality in healthcare being:

- Effective
- Efficient
- Equitable

- Patient-centered
- Safe
- Timely

The running of a successful acute gallbladder service as part of a wider EGS department is a marker of high-quality care (Chana, 2016).

7.23 Example cases of acute gallstone presentations

Below are two example pathways a patient presenting with acute gallstone disease may present to an EGS team and the differences in how they may be managed:

Exemplar pathway one: A patient is admitted to the SAU via the ED with signs of sepsis and right upper quadrant pain. Biochemistry and radiology confirm the presence of acute cholecystitis. The patient is managed with analgesia, IV fluids and IV antibiotics and is discharged home on day three. They are placed on an elective waiting list for a cholecystectomy. The hospital to which the patient is admitted has a long waiting list for elective procedures and the patient waits six months for their operation. During this time they are readmitted on two further occasions; both times further scans, blood tests and antibiotics are required.

Exemplar case two: A Patient is admitted to the SAU with signs and symptoms of acute cholecystitis. These are confirmed with radiology and

biochemistry. The on-call surgeon is a dedicated emergency general surgeon and places the patient on a waiting list for an acute cholecystectomy. This is performed the following morning by the consultant and registrar. The patient makes a good post-operative recovery and is discharged home on day one post-op. He has no further hospital admissions related to this condition. He returns to work two weeks later.

It is clear that looking at these two exemplar cases that the management of acute gallstone disease can be made much more efficient both for the patient, the hospitals delivering acute services and the general economy as described in CholeS. These are the main benefits of providing an acute gallstone disease service. However, there still remain concerns as to the safety and efficacy of performing the procedure, particularly to do with resource allocation particularly in the form of dedicated emergency lists as well as surgeon competence and expertise. This will be discussed in the concluding chapter.

This second case example is a perfect demonstration of the Donabedian model in action. An efficient system leads to a process to be delivered effectively which leads to a positive outcome for both patient and healthcare providers. This should be seen as the standard in providing high-quality care.

7.3 Local audit

As well as using the established literature, a local audit was performed to

confirm the burden of acute gallstone disease in UK hospitals.

7.31 Audit design

The audit was performed in an English district general hospital where there was a single upper gastrointestinal specialist.

It was a retrospective, note review and the audit was conducted using a standard audit cycle methodology as illustrated below:

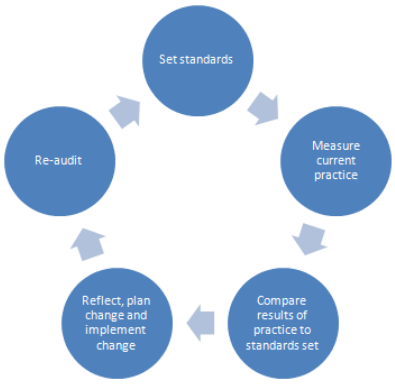

Figure – 7.1: The Audit Cycle

The cohort that was examined in this audit were all adult patients (regardless of co-morbidity, BMI or age) who presented with one of the acute gallbladder pathologies listed at the start of this chapter. The audit recorded the burden of disease and the standard of care used for the audit was whether an acute cholecystectomy was performed on the index EGS admission.

The project was approved and registered by the local audit office.

7.32 Audit results

A snapshot was taken over a four-month period and all EGS admissions during this time were included. There were 494 emergency admissions to the EGS service.

Of this cohort 44 patients (9%) were admitted with gallstone disease (as one of the conditions listed at the beginning of this chapter).

Of this cohort, 26 (59%) of these patients had previous admissions with gallstone disease. This equated to over a hundred bed days taken up unnecessarily by gallstone-related readmissions.

During the time of the audit, no acute cholecystectomies were performed.

The results were presented locally and a county-wide (covering two hospitals) once-weekly gallbladder list is currently being developed in response to this project

7.33 Audit conclusions

The benefit of performing acute gallbladder surgery can be seen in not only freeing up resources but also in reducing future admissions. As described in the FMEA analysis in previous chapters, this could be a very cost-effective means of freeing up financial and bed resources for high-risk patients.

So the problem remains how can we best deliver an acute gallbladder service across NHS hospitals in the country? Options include:

1. Centralising acute gallbladder services to units with specialist upper GI units
2. Providing regular (weekly) dedicated acute gallbladder lists where patients can be managed and investigated and listed for surgery in a safe and timely manner
3. By managing patients on the acute surgical operating list (as is done with acute appendicitis and presentations with acute hernias)

The Royal College of Surgeons of England is currently running the Chole-QuIC project as a QI intervention to see if 80% of eligible patients admitted to 13 NHS trusts can receive an acute cholecystectomy within eight days (Beckingham, 2016). The information gained from this project will identify the barriers to providing this standard of care and will help determine how best to provide this service in the future.

7.4 Aims of the benchmarking study

For the purposes of this thesis and the on-going theme of international benchmarking we examined the burden of acute gallstone disease within Australian, UK and US hospitals participating in GC.

The aims of this study were to:

- Examine the burden of acute gallstone disease within participating hospitals
- Assess the time taken from index admission to cholecystectomy
- Examine factors that may influence service delivery

7.5 Methods

7.51 GC and acknowledgements

The GC network has been described in detail in previous chapters and therefore will not be repeated here. However Dr Mark Joy PhD (MJ), Senior Analyst at Dr Foster and Reader in Medical Statistics at the University of Surry must be acknowledged for his help in data collection and analysis in this chapter. Professor Wendy Brown (WB), Professor of Surgery at Monash University in Melbourne and Mr Shaun Appleton (SA), Consultant Upper GI Surgeon at Buckinghamshire Healthcare NHS Trust were involved in all stages of this study as external co-authors.

7.52 Patient cohort

A cohort of patients presenting with acute gallstone disease were identified using ICD–9, ICD–10, ICD–10A diagnosis codes used in the three respective countries. This was based upon the five previously mentioned conditions.

7.53 Primary endpoint

The primary endpoint measured for the study was time to cholecystectomy and therefore procedure codes for cholecystectomy from the three countries were also identified.

7.54 Protocol

Using the cohort described and the relevant procedure codes the first part of this study examined how many cholecystectomies were performed over the period of the study. It was then possible to determine how many acute admissions patients had from their index admission to cholecystectomy. Finally we observed the time from index admission to cholecystectomy looking at how many patients had surgery within three and six months of their index admission. As well as this, a logistic regression model was created to determine whether there were any country level differences and patient level factors that determined time to surgery. The factors included in the regression model included: age, sex, comorbidity using the Elixhauser classification system and the underlying gallbladder pathology (Lieffers, 2011).

Biliary colic was deliberately excluded from the study as on discussion with Australian and US colleagues (DC and WB) it was felt that patients presenting with biliary colic in their countries would often be managed as day cases with a same-day-discharge. This would mean patients would be admitted, operated on and go home on the same day. This would introduce significant

error to the study as our administrative dataset does not have access to day case procedures and therefore many biliary colic patients would be missed giving a false representation of numbers. This point was clarified at a face-to-face GC meeting in LA where all Australian and US member hospitals were in agreement. There was general consensus that the other three grouped conditions (cholecystitis, biliary tree pathology and pancreatitis) would all have at least an overnight stay and therefore would be picked up in our dataset.

7.6 Results

A cohort of 36,532 patients was collected over a nine-year period between 2007 and 2015 across 23 centres.

	Australia	**England**	**USA**
Age Band			
Less than 60	10796	6220	7158
60 -80	4407	3220	3066
Over 80	776	258	631
Total	15979	9698	10855
Gender			
Female	10880	6992	6801
Male	5099	2706	4051
Diagnosis Group			
Cholecystitis	14492	8910	8083
Biliary Tree	115	51	1611
Pancreatitis	1372	737	1161

Table – 7.1 Demographic Table

A majority (24,174) of patients were under the age of 60 years old.

24,673 (68%) of patients in this cohort were female.

86% of patients were primarily admitted with cholecystitis

	Odds Ratio	p Value
Age Band (ref level under 60 years)		
60-80	0.80	<0.0001
Over 80	0.93	<0.0001
Gender (ref level Female)	0.75	<0.0001
Admission Diagnosis (ref level Cholecystitis)		
Biliary Tree Pathology	0.34	<0.0001
Pancreatitis	0.47	<0.0001
Year of Primary Admission (Continuous)	1.10	<0.0001
Country (ref level England)		
Australia	3.64	<0.0001
USA	9.47	<0.0001

Table – 7.2: Odds Ratios of Having Surgery Within Six Months of Index Presentation

Across the cohort of patients in this study older patients were less likely to have their cholecystectomy performed within six months of primary admission. Those who were aged 60-80 were 20% less likely than those under 60.

Males were 25% less likely to have surgery within six months compared to females.

Patients presenting with biliary tree pathology were 66% less likely to have early surgery than those presenting with cholecystitis and those with pancreatitis as their primary condition were 53% less likely to have early surgery.

Each year from 2007 to 2015, patients were 10% more likely to have a cholecystectomy within six months.

Patients presenting to US centres were almost ten times more likely to have an early operative intervention than those in the UK and Australian patients were 3.5 times more likely to have early surgery than UK patients.

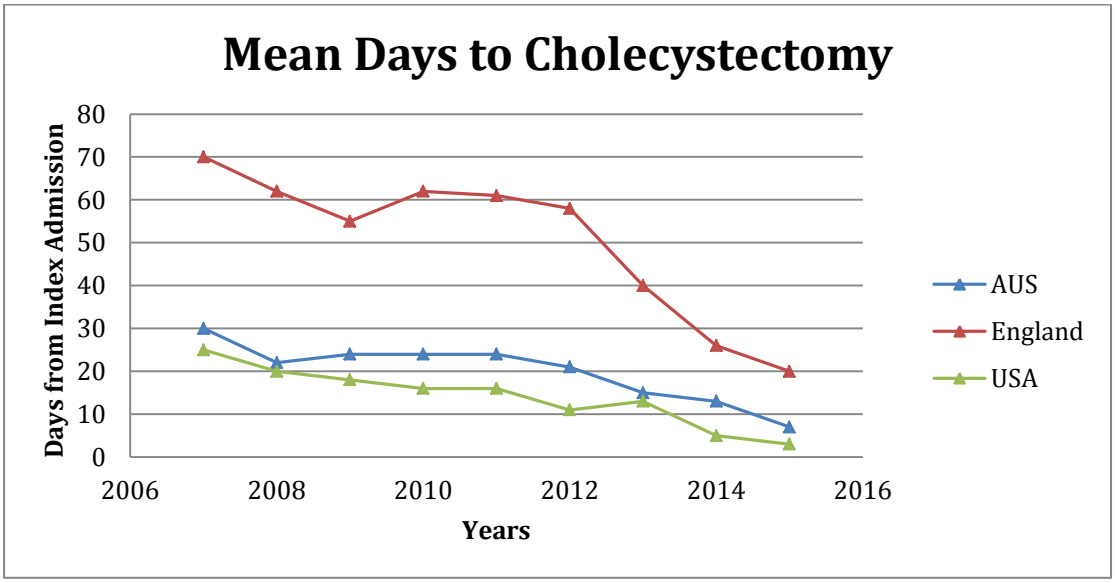

Figure – 7.2: Mean Days to Cholecystectomy

The graph above shows a year-on-year improvement in average times waited to cholecystectomy across all three countries. English hospitals saw the greatest improvement in waiting times over the period of the study (70 days in 2007 reduced to 20 days in 2015)

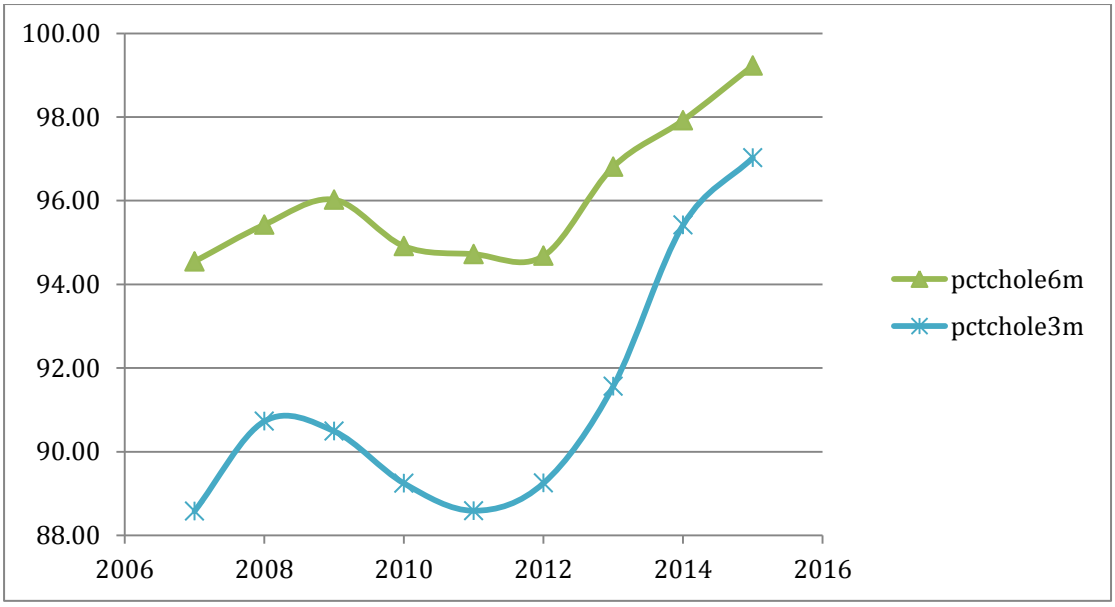

Figure - 7.3: Patients Receiving Cholecystectomy Within Three and Six Months of Index Admission

The graph above shows that in 2007 just over 88% of patients were having cholecystectomies within three months of their index admission and this figure improved to 97% in 2015. 99% of patients were having a cholecystectomy within six months in 2015.

7.7 Discussion

7.71 Findings from this study

The findings from this study are interesting and they fit with the current paradigm shift across the world in the management of acute gallstone disease (Chana, 2016).

The results have demonstrated that over the period of the study there has

been an overall improvement in timings to definitive treatment, (surgery) along with a reduction in the number of admissions seen whilst patients await surgery.

The findings seen in the previous quantitative and qualitative chapters are supported in this study as patients admitted to American centres have the shortest wait time to surgery.

Patients who present with primary biliary tree pathology experience the longest waits for surgery. This may be because they require an endoscopic procedure prior to cholecystectomy or await specialist Upper GI surgical input for bile duct explorations.

7.72 Translation to clinical practice

Guidelines produced by the British Gastroenterology Society recommend that patients presenting with acute gallstone-related pancreatitis should undergo a cholecystectomy either on their index admission or within two weeks of discharge (Johnstone, 2014). As this data shows, the centres across the three countries on average do not achieve this target.

The improvement in time to surgery seen in English hospitals was one of the most striking findings from this study. The timing of improvements seen are of interest as they correlate with a drive to improve the delivery of EGS services nationally with the publication of documents such as Unscheduled Care in

2011 (Royal College of Surgeons, 2011). The sudden fall in time to surgery seen since 2012 (58 days – 40 days – 26 days – 20 days) may be attributed to the drive to improve standards as a result of this document. This shows the importance of central policy setting and its effect on improving quality and outcomes. Based on this theory, the RCS have commenced a large, national quality improvement exercise called *Getting it right first time* and in this NHS hospital trusts are benchmarked at a unit level to see their ability to adhere to various targets. The national pilot is in keeping with the findings from this study and its publication will hopefully continue the drive for an improvement in standards (Abercrombie, 2017).

7.73 Limitations of this study

The limitations of this study remain similar to those seen in chapter three. There were only a small number of selected centres from each country and therefore the results may not be representative of countries as a whole. The centres selected are also likely to be high-performing outliers within their own countries as GC is made up of large academic medical centres that are committed to QI. The cohort is self-selecting in this respect as the hospitals have invested in the project and are therefore aware of the importance of QI to improving standards and quality. It can therefore be inferred that the results seen demonstrate the best that each country has to offer although this statement cannot be supported by data at this time. It may be possible to run the relevant codes in a national dataset such as HES to determine where the GC members sit within their own countries and this will be explored in further

work beyond the remit of this thesis.

The results do provide valuable information as to how gallstone disease is acutely managed in each centre. At a unit level much can be learnt from our colleagues across the world in the same way that Matching Michigan taught us about reducing central line infection rates.

There is also the on-going debate as to errors in coding seen in routinely collected administrative data. It is hoped that with such a well-defined cohort of conditions and a simple intervention (cholecystectomy) there should be hopefully fewer errors in coding. However with the numbers of patients we are seeing in the study, small numbers of coding errors are not significant as it is the overall temporal trend we are examining.

The clinical implications of this work show that standards continue to improve with time and hospitals across the world should be praised for this. Policymakers such as the RCS and the ASGBI who supported the CholeS study should also be praised as their interventions and recommendations over the past three years quite clearly are reflected in overall improvements in practice.

There remains the debate as to who should be performing emergency GI surgery as discussed in the introduction and whether the introduction of emergency general surgeons as well as specialist units providing complex biliary surgery are responsible for these improvements.

For the purposes of this thesis we have demonstrated how service delivery can affect high-risk presentations as well as more commonly occurring low-risk procedures that make up the majority of a general surgeon's workload. This, combined with the qualitative assessment made in previous chapters, will hopefully provide a comprehensive overview for the delivery of emergency general surgical cases for clinicians and healthcare providers.

Discussion

Chapter Eight

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8.1 Introduction

The final summarising chapter provides an overall synopsis of this thesis.

An overview of the current issues affecting the delivery of high-quality care in EGS within the NHS is first presented to put my body of work into context.

The different methodologies used are then discussed to justify the structure of this thesis.

This is followed by a summary of the main findings from this work and their implications on clinical practice and finally this thesis concludes with my personal reflections upon this work.

8.2 The current state of EGS delivery in the NHS

At this time, in 2017, the NHS has reached a crossroads as to how it can continue to deliver high-quality care for the people of the United Kingdom using the current model of healthcare delivery and funding structure (The King's Fund, 2017).

The aftermath of the economic downturn over the past decade has had far-reaching effects on the public sector purse and therefore the delivery of frontline services, which remain free at the point of contact for all patients. The government currently faces a dilemma in whether to focus resources to elective services such as cancer care delivery, which remain very emotive for the public yet are becoming increasingly more complex and costly. On the other hand demands on emergency services continued to rise. The implications of this are that hospital bed capacity remains at an unsafe level in most NHS trusts (National Health Service, 2016).

Issues surrounding social and community care for our elderly and most vulnerable patients further compound this problem. The expectation for hospitals to continue to care for these patients well beyond the resolution of their acute symptoms remains a problem.

Not only are resources related to beds scarce but morale of frontline staff is at an all-time low. Junior doctors have been involved in a series of strikes and on-going industrial action remains a real possibility. This has now spread into the profession of nursing. The background of this industrial action is that the front line feels less valued by healthcare providers and ultimately the government. A series of cost-saving measures have meant that there has been a year-on-year pay freeze for both doctors and nurses for over a decade now and with ever-increasing workload and demands placed on these members of staff to deliver the highest quality of care, something had to give (Toynbee, 2016).

Emergency service delivery finds itself heading towards the “perfect storm” where a combination of systems and resource shortages coupled with a crisis in workforce planning may have significant effects on patient care.

During this time hospital trusts remain under increasing pressure to deliver the highest quality care possible. The Care Quality Commission (CQC) continues to monitor trust performance regularly (Francis, 2013). In general surgery the RCS continue to benchmark standards and the introduction of the *Getting it right first time* project along with projects like NELA are all placing the delivery of EGS services in the public eye (Abercrombie, 2017; NELA, 2015; Royal College of Surgeons, 2011). Nobody involved in the delivery of healthcare wants to see a repeat of the problems seen in the mid Staffordshire enquiry. However, the fear is that many trusts are on the verge of similar collapse due to lack of resource investment and workplace pressure.

Successive governments over the past two decades have placed a real emphasis on improving the quality of cancer care and diagnostics with strict waiting times and subsequent penalties being put in place. However there now appears to be a shift towards focusing attention towards providing safe and appropriate emergency services. This may come to the detriment of elective care and the government is considering removing the 18-week target for elective operations (National Health Service, 2016).

The issues raised above highlight the reason why this work is important. We

need to recognise as an industry that the delivery of high-quality care is dependent on the system in which we work functioning to its best ability to allow our incredibly talented doctors, nurses and allied healthcare professionals to perform their jobs safely, effectively and efficiently to not only provide optimal patient safety but to also provide the best patient experience possible.

Healthcare has much to learn from other high-risk industries such as the aviation industry, the motor industry and the nuclear industry where systems processes are made ever more efficient and effective by utilising the vast potential of 21st century technology. Although we are at the cutting edge of the surgical techniques and processes that we can provide our patients, our systems in the NHS continue to lag far behind our peers' in the developed world and notably when compared to these other allied industries. The starkest example of this is our continued reliance on the human body and mind to provide much of the workload that can now be automated by technology to make it safer and more efficient. This has been raised in this thesis. Along with this, there continues to be the on-going problem of communication within hospitals and the on-going reliance on out-dated technology such as the pager, and the reliance on a paper-based patient record remains an ever-present barrier to us delivering high-quality, effective, efficient and safe patient care (Johnston, 2015).

8.3 Key phases of work

Although much work has been completed exploring issues related to healthcare delivery, it is often done in silos with little opportunity for direct translation to patient care. There has yet to be a comprehensive piece of work that summarises the key issues affecting the delivery of high-quality EGS in the UK.

It commenced with a systematic review of the current literature that highlights various ways to deliver an emergency service effectively and identifies key structural factors that will allow for the delivery of these services. This review confirmed that we are yet to find the ideal model of healthcare delivery across the world although an ACS model which is now being used as standard practice in much of the US and Australia seems to be associated with the most favourable outcomes and there is much to be learnt from this.

It was then important to identify whether there really was a problem in the delivery of emergency general surgery both in the United Kingdom and across the world. In order to do this big data analysis was conducted with the assessment of routine hard end points: in-hospital mortality, readmissions and length of stay. It was clear from this analysis that the UK has much to do to keep up with the US and Australia. The unique aspect of this study is that it then went on to explore which system factors may be associated with the best outcomes measured. It was here that we saw that the key factor was the supportive care that we can offer our patients in the emergency setting, in particular the availability of ICU beds.

As well as looking at the high-risk cohort this thesis also looked at group of conditions that formed the backbone of everyday EGS. These were conditions related to acute gallstone disease. Again it showed temporal improvements in the delivery of acute gallbladder services with our time to cholecystectomy being measured as our end point. However again we saw that work needs to be done for the UK to reach the standards set by our colleagues in the US and Australia.

However, in order to fully understand the Donabedian model and how systems can ultimately affect outcome I felt it was important to explore how healthcare is delivered on a day-to-day basis and to identify the problems encountered by our frontline staff. In doing this we would hopefully be able to understand the data seen in the quantitative chapters. Therefore detailed ethnographic qualitative research studies were performed both in the UK and the US. Once again it demonstrated differences in the patient pathway in these two countries.

As discussed, the most striking difference came in the first few hours of the hospital admission where access to diagnostics, senior clinicians and definitive treatment was much faster in the United States than compared to the English hospitals examined.

However it is important to realise that errors in healthcare exist in both systems and work still needs to be done to ensure that patient safety is at the level where we can truly say we are delivering high-quality care.

This was followed by an in-depth HFMEA analysis into the root causes of why problems occur in the delivery of EGS. By breaking the admissions pathway down into a production line, clinicians involved at every stage of service delivery were able to identify the reasons why failures in healthcare delivery occur, as well as addressing solutions that could help prevent this from happening in the future. The five root causes of these problems that are identified form the backbone of this thesis and they will inform service providers and surgeons as to the interventions that are required to help improve standards in patient care.

8.4 Methodological considerations

As discussed in the previous paragraph I felt it was important to tackle the delivery of EGS from both a quantitative and qualitative perspective to ensure that we gained a deep understanding of the issues. It really did allow us to develop a feel for which structural interventions are required and should be used to monitor trust level performance.

A series of research methodologies have been used in the creation of this thesis including:

- Systematic review
- Big data analysis
- Logistic regression modelling

- Qualitative methods
    - Ethnography
    - Grounded theory
    - Organisational storytelling
- FMEA
- Audit

As a final summarising chapter I hoped to perform a Delphi survey from hospital medical directors, CEOs and senior clinicians to question which of the systems factors highlighted in this thesis would be required to deliver a high-quality service in their opinion.

Delphi is a methodology that is widely used in academia to determine a consensus amongst a panel of experts using an iterative survey approach.

Interestingly when the factors listed in the next section (8.5) were distributed to CEOs, medical directors and senior clinicians from the 41 hospitals in GC I was surprised to see an almost unanimous consensus on the first round of Delphi and these findings and therefore this study was abandoned due to unanimous consent of what constitutes high-quality care in he delivery of EGS.

8.5 Summary of key quality indicators in the delivery of EGS

Based upon the work that has been completed, this is perhaps the most

important sub-section of this thesis as it lists the key hospital-level factors that can contribute to high quality care in the delivery of EGS. Each of these factors has been investigated in the preceding chapters and now has an evidence base behind its recommendation:

- An ACS model of care should be used in the delivery of EGS services and should be made up of:

- Workforce:
    - Consultant surgeons should be present on-site and cleared of elective duties to reduce mortality rates and length of stay (Chapter three)
    - Dedicated EGS surgeons have similar outcomes to specialist GI surgeons and therefore dedicated emergency surgeons can appropriately and safely provide an EGS service (Chapter Two)
    - Registrars provide an appropriate and safe primary assessment and therefore should be utilised in service delivery and planning (Chapter Three)

- Support Services:
    - SAU provides a safe alternative to the patient journey through the ED which is known to be a high-risk environment (Chapter Four)
    - Swift access to radiology services reduces time to definitive operative treatment and length of stay (Chapter Five)

- ICU bed availability is associated with a significant reduction in mortality (Chapter Three)

- Technology and Communication:
  - Inter-professional communication is associated with improved outcomes and safety (Chapters Five and Six)
  - Communication methods need to be modernised to reflect current technology and the reliance on outdated technology such as pagers and desktop computers are associated with increased harm to patients (Chapter Six)
  - Paper based notes and prescribing result in error and potentially harm. The use of electronic records improves safety and efficiency (Chapters Four and Six)

- Pathways of care
  - Patients with commonly occurring EGS pathology, including those related to gallstones should be treated acutely. A timely intervention is safe and reduces the burden of readmissions and morbidity.
  - Protocol driven care in all aspects of the EGS pathway are associated with reduced errors and increased safety (Chapter Six)
  - The introduction of the factors listed above is associated with greater efficiency and therefore frees resources and reduces cost in deliver high-quality care

All of the factors listed above fit into the Institute of Medicine's definition of Quality and the Donabedian model of delivering high-quality outcomes. The interventions listed are achievable, as everything listed already exists in healthcare delivery across the world. Its implantation into everyday NHS practice requires the adoption of the philosophies related to marginal gains and Atul Gawande's "Better" as described in the introductory chapter.

By embracing the potential of QI and Codman's philosophy of recording and analysing outcome data it is hoped that the interventions listed can help to improve quality in the delivery of EGS.

8.6 Limitations to this thesis

As with any body of work there are limitations to this thesis, the most notable being that due to the heterogeneity of EGS it is not possible to provide an in-depth analysis into how carers provided for a specific condition as if we were looking at a certain malignancy. The sheer breadth of conditions that are covered by the term EGS with their differing levels of severity, morbidity and mortality make this a difficult cohort to examine. However, by not relying solely on a single methodology to analyse the system I hope that this has been addressed as well as it could be.

A further limitation is that I did not look at any national datasets in any part of this thesis. In England we have HES data for all hospital trusts and this would

provide a better idea of healthcare delivery across the country. However, similar work has already been conducted by my predecessors at Imperial College London and we know that variation between NHS hospital trusts remains small, therefore by choosing a select group of centres across the world we were able to identify meaningful differences which can be taken back and shared at a country level (Symons, 2013). As was previously discussed, this methodology has successfully been used in the past in the matching Michigan project. There is also increasing evidence in the form of HiPER that more can be learnt from examining outcomes in high- or low-performing outliers rather than looking at population level data where differences may not be as clear (Almoudaris, 2011).

When examining the EGS pathway, this thesis deliberately focused upon the effect of the system on outcome. The process in the Donabedian model forms the backbone of most surgical research as our surgical techniques and perioperative care regimes/protocols have been increasingly developed over the past few years. However the third facet to the triad of effective healthcare delivery remains the individual clinician and this is an area that this thesis did not explore. Working in the emergency surgical environment can be an incredibly stressful and demanding task and therefore there is much to be looked at in terms of the workload and response to the stressful environment that surgeons embarking on emergency work face. This went beyond the remit of this thesis and can be explored in further projects.

8.7 Implications for practice

The findings of this work are directly translational to patient care. By truly understanding the pathway that patients follow, we can implement a range of interventions spanning from small-level local quality improvement projects through to national guidelines.

The implications on service delivery remain at the forefront of clinicians' minds, as we do not know what is the best way to deliver high-quality EGS care.

Various models may include the introduction of centralisation of complex emergency services as has been done with trauma care and elective surgical specialties such as cardiac and vascular surgery. The findings from the data analysis chapters would support this in that there may be greater resource allocation towards ICU facilities to reduce mortality, greater consultant presence to reduce length of stay and a greater use of dedicated emergency operating theatres. The implementation of a centralised model would require much thought at a national policy level.

Repeatedly in the qualitative assessment and subsequent FMEA analysis we saw issues surrounding communication. This was highlighted by the fact that handovers of care were deemed the most dangerous time of an EGS patient's journey. The NHS continues to rely on out-dated technologies to communicate and much work is being done, with Imperial College London

being at the forefront of developing novel technologies such as smartphone apps to aid communication. We live in a digital world and need to embrace new technologies to make our work more efficient and safe.

This comes at a particular time where demands on our junior workforce are at there highest coupled with restrictions on working hours and rate of compliance. From a methodological perspective we discussed the implications of big data analysis of routinely collected administrative or registry data potentially being the future in examining surgical outcomes.

The traditional gold standard of randomised control trials and meta-analyses remain expensive, time and resource consuming and also very selective for small cohorts. However, an appropriate analysis of a large volume of patient outcome data can provide just as useful information to clinicians and service providers. This was demonstrated in the data analysis chapters of this thesis where outcomes for over 150,000 patients were examined. This would obviously be impossible in the world of RCTs.

8.8 Future work

Much more work is needed in the examination of the delivery of high-quality EGS services. Now that we have an understanding of basic structural factors that influence outcome it would be wise to implement these in a step-by-step basis to examine their efficacy and effectiveness.

Although the NHS remains a national organisation, the way healthcare is delivered across the country remains and should remain different depending on the population served. As discussed in the introductory chapter, the population of Greater London have very different healthcare needs, requirements and access to services than those in rural Cornwall and work needs to be done to ensure that any policy that is made or deliver is appropriate for each different part of our population.

One of the key issues that we will face in the on-going delivery of EGS is how we train the emergency surgeons of tomorrow. Traditionally emergency work, "the on call," has always been an extra part of a surgeon's workload. It has therefore become increasingly onerous, as demands have increased along with the complexity and demands of elective practice. Therefore the relatively new advent of the emergency general surgeon and its implementation in many hospitals needs to be further explored. If the emergency general surgeon is a viable option for the future then training in the United Kingdom needs to adapt to allow the RCS to develop an appropriate curriculum to train emergency general surgeons. Early issues seen in emergency surgeons' careers have been related to fatigue and burnout and these issues will also need to be addressed (Behar, 2013).

However, much of the future work related to the delivery of healthcare services is related to the overall strategy and policy-making behind the NHS. It is and will remain a resource-heavy and demanding service and support needs to be given by service providers and ultimately from governing

politicians, and works such as this thesis should be disseminated to organisations such as the Department of Health and the RCS to aid them in the planning of future EGS service delivery.

8.9 Personal reflection

Over the three years that I have been involved in this research I have learnt an enormous amount both at a personal level and professionally.

I have been involved in EGS at a time of huge change, both positive and negative.

Positively we have seen a real push for the improvement of EGS services championed by organisations such as the RCS, the ASGBI, NELA and the Royal College of Anaesthetists.

On a more negative note we have seen wave after wave of threats and then the reality of industrial action from junior doctors, the near collapse of ED services with demand at an unprecedented high and its subsequent domino effect on the hospital as a whole, and most worryingly of all, the huge underfunding placed on social care which is essential for hospitals to work efficiently and effectively. However, my work has allowed me to meet and work with some incredibly inspiring and talented individuals both in the UK and across the world. I am sure that with their passion and determination to ensure that standards continue to improve in the delivery of EGS, we will see

real improvements for our patients. This has been reflected in the much higher profile that emergency surgery has seen in both academic publications and the wider press as a whole.

On a personal level I have learnt much about different research methodologies and the way healthcare services are delivered and the barriers facing those who are responsible for service delivery.

My respect for consultants and hospital managers as well as national providers has grown insurmountably based on the daily obstacles they face in trying to deliver safe and effective care.

I think the opportunity to participate in a period of research has encouraged me to have a more enquiring mind and to question why we do what we do and ultimately how we can improve care for our patients. This is particularly pertinent as a practising surgical registrar who is often responsible for the running of an EGS service. I hope that my practice has improved and has filtered across to my peers, both junior and senior, in making sure that we are aware of the system in which we work and how to address issues in making it more efficient and safe.

As with any research project there have been times of difficulty and joy. I have learned much about working in difficult and stressful environments and the effect they can have on both my mental well-being and of those around me. However, I have been incredibly fortunate to be involved in such a

clinically relevant and interesting topic. This is been reflected in the positive feedback I have received from colleagues when presenting my work.

I have been fortunate enough to travel across the world spreading my research findings to clinicians and healthcare providers who are striving for improvements in their own countries, and this has been a hugely rewarding experience for me.

This thesis has certainly proven to be the start of my academic career as I have continued to pursue my research interests and have now entered the role of formally supervising research fellows.

For me, this certainly isn't the end, but the end of the beginning.

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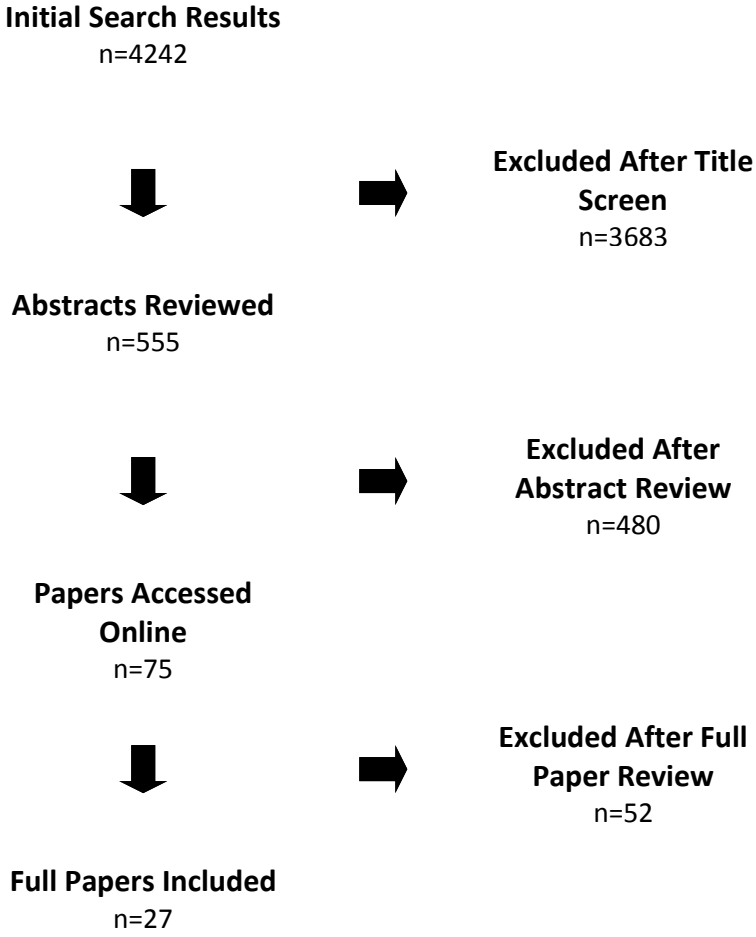
Appendices

Appendix 1: PRISMA Diagram for Systematic Review (Chapter Two)



Appendix 2: Key Search Terms for Literature Review (Chapter Two)

1. Emergency Surgery
2. ‘General surgery’ (mesh)
3. ‘Health care sector’ (mesh)
4. ‘Surgery department, hospital’ (mesh)
5. Acute surgery
6. Organisation
7. "Health Care Sector"[Mesh]
8. "Operating Room Information Systems"[Mesh]
9. "Health Personnel"[Mesh]
10. "Emergency Service, Hospital"[Mesh]
11. "Models, Organisational"[Mesh]
12. "Emergency Medical Services"[Mesh]
13. "Quality of Health Care"[Mesh]
14. "Health Resources"[Mesh]
15. "Health Manpower"[Mesh]
16. "Health Planning"[Mesh]
17. "Quality of Health Care"[Mesh]
18. "Health Care Quality, Access, and Evaluation"[Mesh]
19. "Regional Medical Programs"[Mesh]
20. "Quality Improvement"[Mesh]
21. "Specialisation"[Mesh]
22. "Health Services Research"[Mesh]
23. "Patient Preference"[Mesh]
24. "Quality-Adjusted Life Years"[Mesh]
25. "Patient Safety"[Mesh]
26. Provision
27. Model
28. Service
29. Surgical care
30. Factors
31. Structure
32. Resource
33. Systems
34. Optimization
35. Staffing
36. Quality
37. Quality improvement
38. Specialisation
39. Impact
40. Centralisation
41. Regionalization
42. Tertiary care
43. Quaternary care
44. Outcome

Appendix 3: Survey sent to CEO's and Medical Directors in hospitals participating in GC to inform quantitative study (Chapter Three)

GI GOAL
Global Outcome Differences in Urgent and Emergent General Surgery

Dear Colleague:

Thank you for agreeing to participate in this survey that aims to study differences in outcomes between the Global Comparator Centres for urgent and emergent gastrointestinal surgery (EGS).

The survey forms part of a review of current clinical practice in order to share best practice your responses are highly valued in helping to define priorities for future service provision.

The survey should take less than 10 minutes to complete and we assure you that your participation and individual responses will be strictly confidential to the research team and will not be divulged to any outside party.

Many thanks for your time.

Mr Prem Chana
Imperial College London

- For the purposes of this questionnaire all emergency: breast, endocrine, gynaecological, paediatric, transplant, trauma, urological and vascular surgery has been excluded as we aim to focus upon the delivery of emergency gastrointestinal surgery.

1) Name of your hospital?

2) Details of individual completing questionnaire:
    a. Name:
    b. Job title:
    c. Specialty:
        i. Surgeon
        ii. Anaesthetist
        iii. Intensivist
        iv. Other (Specify)

3) Does your hospital have an emergency department?

4) Does your hospital routinely accept urgent / emergent gastrointestinal surgical cases

5) Does your hospital accept acute transfers of very ill patients with gastrointestinal pathology from other facilities?
    a. Yes
    b. No

6) Where will your on duty surgeon be based?
    a. Onsite 24 hours a day
    b. Onsite during office hours then taking calls from home
    c. Taking calls from home

7) Is your duty surgeon cleared of all elective commitments when on call?

a. Yes
b. No

8) Who will perform your primary surgical assessment?
    a. Attending / Consultant
    b. Resident / Registrar
    c. Other (Specify)

9) How many operating rooms / theatres are in your hospital? (Please exclude interventional radiology suites and dedicated obstetric and minor ops theatres, but include day-case theatres)

10) Of these rooms / theatres, how many are reserved exclusively for emergency general surgical cases?

11) Does your hospital have pathways/protocols/policies for emergency surgery?

12) We need to know how many beds there are in the hospital to work out a bed to critical care bed ratio for EGS patients (a 1000 bed hospital with only 10 critical care beds isn't great compared to a 100 bed hospital with 10 critical care beds)
    a. Total Hospital Beds
    b. ICU Beds available to EGS patients

13) Does your hospital have a dedicated emergency surgical ward (surgical admissions unit)?
    a. Yes
    b. No

14) Do you have dedicated non-trauma emergency surgeons?

15) What are the subspecialties of the senior surgeon on the general surgical emergency rotation?
    a. Breast
    b. Colorectal
    c. Emergency
    d. General
    e. Upper GI
    f. Vascular
    g. Other (Specify)

16) Are emergency patients with continued clinical care needs:
    a. Transferred to another senior clinician's care at the end of the on-call shift?
    b. Retained by the admitting senior clinician?
    c. Other (Specify)

Once again thank you for your time

Appendix 4: ICD-10 diagnostic codes for the discharge diagnoses for the cohort of patients included in the quantitative analysis (Chapter Three)

Gastrointestinal ulcers
K25.1 Gastric ulcer, acute with perforation
K25.2 Gastric ulcer, acute with both haemorrhage and perforation
K25.5 Gastric ulcer, chronic or unspecified with perforation
K25.6 Gastric ulcer, chronic or unspecified with both haemorrhage and perforation
K26.1 Duodenal ulcer, acute with perforation
K26.2 Duodenal ulcer, acute with both haemorrhage and perforation
K26.5 Duodenal ulcer, chronic or unspecified with perforation
K26.6 Duodenal ulcer, chronic or unspecified with both haemorrhage and perforation
K27.1 Peptic ulcer, acute with perforation
K27.2 Peptic ulcer, acute with both haemorrhage and perforation
K27.5 Peptic ulcer, chronic or unspecified with perforation
K27.6 Peptic ulcer, chronic or unspecified with both haemorrhage and perforation
K28.0 Gastrojejunal ulcer, acute with haemorrhage
K28.1 Gastrojejunal ulcer, acute with perforation
K28.2 Gastrojejunal ulcer, acute with both haemorrhage and perforation
K28.3 Gastrojejunal ulcer, acute without haemorrhage or perforation
K28.5 Gastrojejunal ulcer, chronic or unspecified with perforation
K28.6 Gastrojejunal ulcer, chronic or unspecified with both haemorrhage and perforation
K28.7 Gastrojejunal ulcer, chronic without haemorrhage or perforation
K28.9 Gastrojejunal ulcer, unspecified without haemorrhage or perforation
Hernias
K40.0 Bilateral inguinal hernia with obstruction without gangrene
K40.1 Bilateral inguinal hernia, with gangrene
K40.4 Unilateral or unspecified inguinal hernia, with gangrene
K41.0 Bilateral femoral hernia, with obstruction, without gangrene
K41.1 Bilateral femoral hernia, with gangrene
K41.3 Unilateral or unspecified femoral hernia with obstruction without gangrene
K41.4 Unilateral or unspecified femoral hernia, with gangrene
K42.1 Umbilical hernia with gangrene
K43.0 Ventral hernia with obstruction, without gangrene
K43.1 Ventral hernia with gangrene
K44.0 Diaphragmatic hernia with obstruction, without gangrene
K44.1 Diaphragmatic hernia with gangrene
K45.0 Other specified abdominal hernia with

obstruction without gangrene
K45.1 Other specified abdominal hernia with gangrene
K46.0 Unspecified abdominal hernia with obstruction without gangrene
K46.1 Unspecified abdominal hernia with gangrene

Bowel ischaemia

K55.0 Acute vascular disorders of intestine
K55.1 Chronic vascular disorders of intestine
K55.8 Other vascular disorders of intestine
K55.9 Vascular disorder of intestine, unspecified

Bowel obstruction

K56.0 Paralytic ileus
K56.1 Intussusception
K56.2 Volvulus
K56.3 Gallstone ileus
K56.4 Other impaction of intestine
K56.5 Intestinal adhesions [bands] with obstruction
K56.6 Other and unspecified intestinal obstruction
K56.7 Ileus, unspecified

Diverticulitis

K57.0 Diverticular disease of small intestine with perforation and abscess
K57.2 Diverticular disease of large intestine with perforation and abscess
K57.4 Diverticular disease of both small and large intestine with perforation + abscess
K57.8 Diverticular disease of intestine, part unspecified, with perforation and abscess

Disorders of peritoneum

K65.0 Acute peritonitis
K65.8 Other peritonitis
K65.9 Peritonitis, unspecified
K66.1 Haemoperitoneum
K66.8 Other specified disorders of peritoneum
K66.9 Disorder of peritoneum, unspecified

Liver and biliary conditions

K76.2 Central haemorrhagic necrosis of liver
K76.3 Infarction of liver
K76.8 Other specified diseases of liver
K80.3 Calculus of bile duct with cholangitis
K82.0 Obstruction of gallbladder
K82.2 Perforation of gallbladder
K82.3 Fistula of gallbladder
K83.0 Cholangitis
K83.1 Obstruction of bile duct
K83.2 Perforation of bile duct

Miscellaneous diagnoses

K22.3 Perforation of oesophagus
K31.0 Acute dilatation of stomach
K31.1 Adult hypertrophic pyloric stenosis
K31.5 Obstruction of duodenum
K31.6 Fistula of stomach and duodenum
K59.3 Megacolon, not elsewhere classified
K59.8 Other specified functional intestinal disorders
K63.0 Abscess of intestine
K63.1 Perforation of intestine (non-traumatic)
K63.4 Enteroptosis
K63.8 Other specified diseases of intestine

Appendix 5: Protocol for HFMEA focus group including FMEA matrix (Chapter Six)

The Emergency General Surgical Admission Pathway

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

A 30-year-old male wakes at home with severe epigastric pain. He is a Polish builder, drinks half a bottle of vodka a day and smokes 15 cigarettes per day. He has suffered with gastro-oesophageal reflux for the past six months and takes PRN Ranitidine. He has no other significant medical history.

Stage 1: Decision Making:

Number	Process Step	Failure Mode	Effect	S	F	D	Hazard Score	Single Point Failure	Control
1	Patient telephones GP practice and gets appointment	Patient does not telephone GP practice and get appointment							
2	Patient attends GP practice	Patient does not attend GP practice							
3	GP assesses patient and takes obs	GP does not assess patient and take obs							
4	GP decides patient needs surgical review	GP decides patient does not need surgical review							
5	GP arranges ambulance	GP does not arrange ambulance							
6	GP refers to SAU	GP does not refer to SAU							
7	Patient attends ED	Patient does not attend ED							
8	Triage in ED	Not triaged in ED							
	Observations	Observations/EWS not							

9	taken/EWS	taken							
10	Patient placed in majors/minors	Patient not placed in majors/minors							
11	ED doctor assessment	No ED doctor assessment							
12	Bloods taken	Bloods not taken							
13	X-ray requested	X-Ray not requested							
14	Fluids prescribed and given	Fluid not prescribed and given							
15	Antibiotics prescribed and given	Antibiotics not prescribed and given							
16	Regular medications prescribed	Regular medications not prescribed							
17	Referred to surgeons	Not referred							
18	Reviewed by Surgeons in ED	Not reviewed in ED							
19	Review of tests by surgeons	Tests not reviewed							
20	Decision made to admit to ward	Don't admit							
21	Transfer to ward with porters	Not transferred by porters							

Stage 2: Definitive Care

1	Handover to ward nurses	No handover							
2	Obs on ward	No obs on ward							
3	Surgical review on ward	No review on ward							
4	Continuation of therapy	Therapy not given							
	Consultant review	No consultant review							

5									
6	Decision to operate	No decision to operate							
7	Scan	No scan							
8	For theatre	No theatre							
9	Transfer to theatre	Not transferred to theatre							
10	Pre op check	No pre-op check							
11	Surgery	No surgery							
12	WHO Check	No WHO Check							
13	Consultant surgeon/anaesthetist present in theatre	Consultant surgeon/anaesthetist not present in theatre							
14	Recovery transfer smooth	Not smooth							
15	Transfer to ward smooth	Not smooth							
16	Post op instructions followed	Post op instructions not followed							
17	ITU post op	No ITU							
18	Daily ward review by consultant	No ward review by consultant							
19	Decision to eat/drink	No decision to eat/drink							
20	Post op antibiotics/fluid	No post op fluids/antibiotics							
21	Post op rehab	No post op rehab							
22	Effective discharge	Not effective discharge							
23	OP follow up	No OP follow up							

Appendix 6: ICD 10 diagnostic codes for acute gallstone disease

- **Cholecystitis**
  - K800, K801 5740,5741, 5748, 5744,5743, K804, 5748, K8000, K8001, K801, K8010, K8011, K804, K8040, K8041, K81, K810, K811, K818, K819, K822
- **Choledocholithiasis/Cholangitis**
  - K836,5768,5769, K805, 5745**,**K830, 5761K805, K8050, K8051, K803, K8030, K8031, K830
- **Gallstone Pancreatitis**
  - K85, 5770, 5771, K851, K859

Appendices 7 and 8 follow this page:

Appendix 7: Evidence base for key structural factors contributing to high-quality care identified at the start of the thesis to plan studies (All Chapters)

Appendix 8: Example of ethnographic data summary sheet used in observational chapters (Chapters Four and Five)

Observation	RCS	Other Guideline	Published
Direct admission to SAU *Time from GP referral to admission Time from admission to clerking Time from admission to senior review/definite decision*			Boyle
Admission to ED			
Swift physiological assessment (EWS) Acute response team is available 24/7 *Recording of EWS Abnormal EWS appropriately escalated*	Yes	NICE Guidelines	
ED provision for Resus to deal with the sickest patients. Immediate availability of trained personnel, fully staffed and equipped resuscitation room	Yes	DoH Policy	
Admit within 4 hours from ED	Yes	DoH Policy	Jones
Hospitals receiving emergency surgical patients will need to consider the most appropriate facilities and layout. In many hospitals this is known as the 'emergency floor'. The area should be designed to ensure appropriate streaming of patients to the correct part of the service, avoiding duplication of assessment and of documentation. The ideal configuration would be a series of interlinked facilities where the skills of the emergency physicians, acute physicians, surgeons, anaesthetists, radiologists and critical care specialists work closely together to manage the early phases of acute illness *List involvement of specialties in acute assessment*	Yes		
Access to appropriate investigations – Pathology There is a 24/7 consultant led laboratory service	Yes		
24 hour availability of key blood tests	Yes		
Clinical haematology and biochemical telephone advice available 24/7	Yes		
Prompt availability of blood components and massive haemorrhage protocol available in all key areas	Yes		
Availability to appropriate investigations – Radiology Where imaging will affect immediate outcome, emergency surgical patients have access to CT, plain films and USS within 30 minutes of request. Advice on appropriate imaging is available early. A definitive report will be available within 1 hour *Time of request to scan Time of scan to report*	Yes		
Access to appropriate investigations – Radiology Interventional radiology services available for patients within 1 hour of request	Yes		Cochrane
Initiation of therapy without delay – Fluid Resuscitation *Recording of fluid therapy Recording of renal function Recording of fluid balance and urine output*		Surviving Sepsis	
Initiation of therapy without delay – Prescription of Antibiotics *Recording of prescription Recording of allergy status Recording of indication Recording of duration of prescription Recording of microbiology input*		Surviving Sepsis	
Initiation of therapy without delay – Access to Emergency Theatres 24/7 urgent access to 'life-saving' interventions *Time from decision to theatre Recording of reasons for delay*	Yes		Parasyn
Initiation of therapy without delay – Access to GI endoscopy 24/7 urgent access to 'life-saving' interventions *Time from decision to scope Scope performed by gastroenterologist or surgeon Haemostasis achieved Need for theatre*	Yes		Rosenstock

Initiation of therapy without delay – Appropriate VTE Assessment and Prescription. All patients undergo VTE risk assessment on admission and regularly thereafter *Recording of risk assessment Recording of prescription*	Yes	CQUIN	
Increasingly, services will need to be provided on a networked basis, that is via an interconnected system of service providers			
Services are consultant delivered	Yes		
For a typical major hospital, the emergency general surgical team will comprise a consultant surgeon (CCT holder), middle grade (MRCS holder), core trainee and foundation doctor			
The skills and competences expected of each role within the emergency surgical team are identified	Yes		Diaz
Patient assigned to appropriate clinical team who take responsibility for care of the patient	Yes		
RCS recommends a separation of emergency and elective surgical services, the surgical team is free of elective commitments when covering emergencies	Yes		Lehane
Hospitals accepting undifferentiated patients via the ED must have access to 24-hour on-site surgical opinion (at ST3 level or above) or a trust doctor with equivalent ability, (MRCS with ATLS provider status), with a supporting team both junior and senior to this surgeon.	Yes		Cubas
A patient for whom an emergency surgical assessment is required will receive the same with 30 minutes of referral being made in the case of life/limb threatening emergency and 60 minutes for a routine emergency referral *Notes audit*	Yes		Sorelli
Patients must be seen by at an early stage by a surgeon with the required skills and competence. In most cases, this will be a speciality trainee (ST3 or above) or a trust doctor with equivalent ability (MRCS, ATLS). This doctor must be able to assess the patient and make an initial decision about the seriousness and urgency of their condition.	Yes		
Should the designated first on-call surgeon be unable to attend due to other emergency duties, protocols are in place for another member of the surgical team, of similar or greater level of competence, to be available to attend ED, within the above timescale	Yes		
A consultant is available at all times for telephone advice	Yes		Dultz
The designated consultant is available to attend his/her base site within 30 minutes at all times	Yes		
All patients admitted as emergencies must be discussed with the responsible consultant if immediate surgery is being considered	Yes		
Those considered at high risk (patients with a predicted mortality of >10%) must be discussed with the consultant and reviewed by a consultant surgeon within four hours if the management plan remains undefined	Yes		
As an absolute minimum for patients not considered at high risk, all emergency admissions must be discussed with the responsible consultant within 12 hours of admission	Yes		
If a patient is admitted but not taken to theatre, he or she must be seen by a consultant surgeon within a maximum of 24 hours from admission	Yes		
Appropriate documentation in notes by all clinicians involved in care			

Access to specialist services – Vascular, Urology, Neurosurgery, Cardiothoracic, Paediatrics, T&O	Yes	Vascular Society	
A dedicated separate team is established for emergency theatres 24/7	Yes		
Adequate emergency theatre time is provided throughout the day to minimise delays and avoid emergency surgery being undertaken out of hours *Timing of surgery In/Out of Working Hours*	Yes		Stupart
Emergency theatre should not be conducting elective cases	Yes		Heng
Extending the traditional 'core hours' of service provides additional capacity, ensures more balanced staffing levels throughout busy periods and ensures senior clinician input during the service. 08:00 – 22:00 (including weekend cover) For this model of care to work, all supporting services (e.g. radiology, pathology etc.) and staff in the wider surgical team (e.g. anaesthetists, theatre nurses, recovery and ward staff) need to work in a similar pattern	Yes		
CCT level surgeon should be informed of all patients going to theatre	Yes		
Patients are optimally resuscitated before emergency surgery	Yes		
Patients are risk stratified prior to undergoing a surgical procedure			
In cases with predicted mortality of >5% a consultant surgeon and consultant anaesthetist must be present for the operation except in specific circumstances where adequate experience and the appropriate workforce is otherwise assured	Yes		Sanders
Communication with patients and supporters is a crucial activity	Yes		
There is a balance within service provision to ensure surgical trainees can develop their emergency experience to achieve the required competences in emergency surgery as defined in the ISCP	Yes		Ahmed
The WHO Surgical Safety checklist (or a local variant thereof) is used for all surgical procedures in theatre *Ward handover to theatre Equipment, Identity Site Operation, Communication Antibiotic VTE (ITCAS 1 and 2)*	Yes		Nagpal
Postoperative Handover *ITCAS 3*			Nagpal
Availability of peri-post operative ITU – Intensive care service is consultant led	Yes		Sanders
Critical care outreach services are involved if appropriate	Yes		
Critical care facilities are available at all times for emergency surgery patients	Yes		
Average bed occupancy rates should not exceed 82% and outlying should be exceptional and addressed as soon as possible	Yes		
Arrangements in many hospitals mean that sick surgical patients are often admitted to any available bed, with the potential for patients to be located in areas with limited surgical expertise available. The outlying of surgical patients on non-surgical wards leads to inefficient care and increases risk.	Yes		
Structured arrangements are in place for the handover of patients at each change of responsible consultant/medical team	Yes		Gandy
Patients are under the direct daily supervision of a consultant surgeon (CCT holder)	Yes		Sorelli
Appropriately trained nurses, specialist nurses, physiotherapy involved in the on-going care of patient			Diaz
Action taken upon acute changes in physiology			Tisherman

A consultant surgeon (CCT holder) should be present for all unscheduled returns to theatre	Yes		
Use of ERAS where appropriate			
All admitted patients have an estimated discharge date as part of their management plan as soon as possible	Yes		
Primary care colleagues receive timely and accurate discharge information in order to support the patient in primary care	Yes		
M&M review in cases with poor outcomes			

Event (POSITIVE NON-ROUTINE ADVERSE)									
Assessment	**Management**	**Communication**	**Documentation**	**Environment**	**Infection Control**	**Investigations**	**Medications**	**Staffing**	**Timing**
SHO "I do not know what is going on we will have to wait for the registrar"			SHO did not document review in notes as was waiting for SpR to review	Confusion in consultation room lead to patient being embarrassed at being asked to undress in front of mother. She was asked to wait in the bathroom whilst examined	SpR diagnosed a dehiscence and removed residual sutures in room, not sterile				Post op readmission, pilonidal abscess/sinus excised
SHO did not examine patient as was waiting for SpR, "I do not see the point in repeating things"		SpR called twice during review on on-call phone, had to leave the room No contact from lab with team to inform them of haemolysed bloods	No drug chart completed for regular medications No VTE risk assessment completed			No bloods for SpR review, SHO chased with lab, blood had haemolysed.	Analgesia prescribed by SHO but not given despite patient complaining of pain		Patient waited two hours before initial review, referred from UCC. EWS 2