

Quality of Care in Emergency General Surgery

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ABSTRACT

There are more than 600,000 emergency general surgery admissions per year in England. These patients comprise about 50 percent of general surgical workload but make up 80-90 percent of all general surgical deaths. In recent years surgical colleges and societies in the UK have warned of significant variability in the quality of care between hospitals but, to date, little formal evaluation of the quality of care in emergency general surgery exists.

This thesis uses the Structure/Process/Outcome quality assessment framework, devised by Avedis Donabedian, to examine quality of care in emergency general surgery across all three of these domains.

A study of high risk emergency general surgical admissions using the administrative Hospital Episode Statistics dataset demonstrated significant variability in 30-day in-hospital mortality between NHS Trusts. Investigation of NHS Trust structure was performed using data from the Department of Health. There were significant differences in the provision of intensive care beds and in the utilization of computed tomography and ultrasound scanning between low mortality and high mortality NHS Trusts.

The process of care was assessed using an explicit checklist for the admission phase of care and using ethnographic field notes for patients' subsequent hospital stay. Across 5 London hospitals, process reliability during admissions to hospital was poor, with nearly 20% of recommended processes omitted. Failures in the process of care were also common in subsequent ward based care. Failures were considered to be highly preventable and frequently caused harm to patients or delayed their discharge.

Overall, this thesis has identified significant variability in the quality of care for emergency general surgical patients in structure, process and outcomes. While the thesis does not evaluate every single

aspect of patient care it demonstrates the degree of improvement required in emergency surgical care and provides some recommendations for future quality improvement.

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LIST OF ABBREVIATIONS

A&E	Accident and Emergency (analogous to Emergency Department)
ASGBI	Association of Surgeons of Great Britain and Ireland
CCrISP	Care of the Critically Ill Surgical Patient
CI	Confidence Interval
CT	Computerised Tomography
DoH	Department of Health
DVT	Deep Vein Thrombosis
EBM	Evidence Based Medicine
EGS	Emergency General Surgery
ERCP	Endoscopic Retrograde Cholangiopancreatography
FY1	Foundation Year 1
HDU	High Dependency Unit
HES	Hospital Episode Statistics
ICU	Intensive Care Unit
IQR	Interquartile Range
LSRG	London Surgical Research Group
MRI	Magnetic Resonance Imaging
NCEPOD	National Confidential Enquiry into Patient Outcomes and Deaths
NICE	National Institute for health and Clinical Excellence
NHS	National Health Service
NRE	Non-Routine Event
NSQIP	National Surgical Quality Improvement Program
PDSA	Plan-Do-Study-Act
PTWR	Post-Take Ward Round
RCS (RCSEng)	Royal College of Surgeons (of England)
SBO	Small Bowel Obstruction
SHO	Senior House Officer
SD	Standard Deviation
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation

DECLARATION OF ORIGINALITY

I, Nicholas Robert Alexander Symons, declare that this thesis is the result of my own personal efforts. Where this has been contributed to by others, all collaboration has been appropriately acknowledged and referenced.

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Introduction

1. EMERGENCY GENERAL SURGERY

1.1. Background to thesis

Emergency General Surgery (EGS) services form a vital part of any acute hospital. EGS is one of only a few services that admit, diagnose and treat large numbers of emergency admissions; general medicine, paediatrics and orthopaedics being the main alternatives. Emergencies make up 50% of all general surgical workload (Association of Surgeons of Great Britain and Ireland, 2007) and the majority of people living in the UK will come into contact with the National Health Service (NHS) EGS service at some point in their lives. Though EGS is an important and busy service, it has suffered from a lack of emphasis. Very few surgeons in the UK treat emergencies as their primary surgical interest; the majority are sub-specialist elective surgeons first and foremost and emergencies make up, for some, an inconvenient addition to their workload.

There is undoubtedly variability in the way services are designed and run between hospitals and some NHS Trusts have greater resources than others. There is also variability between clinicians in the way they treat different diseases, mostly because treatments for EGS conditions have evolved over many years and because practice is largely based on expert opinion. Recent consensus statements have suggested that “there is evidence that there is wide variation in the quality of emergency general surgery” and that “standards of care for emergency admissions are often unsatisfactory” (Association of Surgeons of Great Britain and Ireland, 2007). Unfortunately the evidence base for a gold standard of care is limited and there is little empirical evidence of the degree of variation between providers and individual practitioners.

This thesis sets out to assess the quality of care in emergency general surgery and to identify areas of potential improvement. The introduction will provide general background on the form and function of the emergency general surgery service and describe methods of quality assessment in healthcare. The thesis will then use both quantitative and qualitative research methodologies to

investigate EGS outcomes, structure and process, to provide a broad picture of the quality of care currently provided by the NHS.

1.2. What is emergency general surgery?

Emergency general surgery is one of the principal diagnostic and therapeutic services present in all acute general hospitals. The service provides essential expertise in the management of relatively unselected emergency surgical admissions and complications in current inpatients (Association of Surgeons of Great Britain and Ireland, 2012).

EGS admissions comprise a broad spectrum of diseases but are primarily abdominal in nature. Several groups of conditions can be identified, including minor perineal conditions and abscesses, biliary tract disease, hernias and appendicitis (Association of Surgeons of Great Britain and Ireland, 2012). In addition there are a large number of less frequent but very high-risk conditions that require emergency laparotomy as the primary mode of treatment (Association of Surgeons of Great Britain and Ireland, 2012). These include perforation of hollow organs, intra-abdominal abscesses, ischaemia and bowel obstruction. Laparotomy literally means an incision through the abdominal wall but in surgical terms it involves a larger wound than an appendicectomy or hernia repair to allow all abdominal organs to be inspected and palpated. Laparotomies can be diagnostic, though this is increasingly infrequent in the era of high-resolution computed tomography (CT) scanning, or can involve resection or repair of intra-abdominal or retro-peritoneal organs. Patients undergoing emergency laparotomy are often the most acutely unwell in the hospital and they frequently require the involvement of multiple acute teams.

EGS defies easy definition in terms of the diagnoses treated because these are, in part, dependent on the skills, facilities and workload of individual hospitals. As an alternative to definitions based on diagnoses, the Royal College of Surgeons of England have defined the type of work that this service provides (Box 1.1).

Box 1.1: Elements of emergency general surgery provision

- The provision of assessment and advice for patients referred from other areas of the hospital (including the emergency department) and from general practitioners.
- The provision of on-going clinical care to post-operative patients and other surgical inpatients being managed non-operatively, including emergency patients and elective patients who develop complications.
- Undertaking operations for emergency admissions at any time, day or night.
- Undertaking further operations for patients who have recently undergone surgery (either planned procedures or unplanned 'returns to theatre').
- Early, effective and continuous acute pain management.
- Communication with patients and their supporters.

Adapted from (Royal College of Surgeons of England, 2011a)

In addition to providing care for emergency admissions, the EGS service also provides on-going care to inpatients of general surgical sub-specialities and specialist opinions on patients under the care of other specialities within the hospital. This often requires the emergency surgeon to care for, and sometimes operate on, elective patients outside their own sub-speciality. Emergency surgeons must also provide high-quality communication with patients and families of patients who are often very unwell. Management of dying patients with both acute and chronic conditions is integral to the EGS service.

EGS is often considered to include the treatment of those traumatic injuries that are not confined to the head (neurosurgical) or extremities (orthopaedic). The treatment of these injuries is becoming increasingly specialised and, to respond to this, a number of regional major trauma centres have been developed. In addition to this reconfiguration, the population that suffer traumatic injuries is dramatically different to the rest of EGS; trauma patients are approximately three quarters male and the average age of admissions is low. Vascular surgical services have also undergone a similar reconfiguration in recent years as a result of pressure to improve the quality of care. Many vascular surgeons do not now participate in the EGS service. For these reasons trauma and vascular surgery have not been studied in this thesis and will not be considered further.

In summary, EGS provides a diagnostic and therapeutic service to acutely unwell patients with primarily abdominal problems. EGS covers a wide range of diagnoses and sub-specialties and requires diverse skills from the surgeons delivering the service.

1.3. Why is emergency general surgery important?

Emergencies make up about 50% of all general surgical admissions (Hospital Episode Statistics, 2011) and all facets of EGS comprise 40-50% of general surgical workload (Royal College of Surgeons of England, 2011a). In England alone there are nearly 600,000 EGS admissions per year (Hospital Episode Statistics, 2011) and the number of patients requiring assessment by the EGS service has increased by a third in the last six years (Association of Surgeons of Great Britain and Ireland, 2012).

In addition to the large number of admissions, EGS also has a large proportion of high risk patients. EGS accounts for 14,000 intensive care admissions per year, with a mortality rate of over 25% (Royal College of Surgeons of England, 2011b). Emergencies make up 80-90% of general surgical deaths and complication arising from emergency operations are significantly more frequent than following elective surgery (Association of Surgeons of Great Britain and Ireland, 2012).

Those patients requiring emergency laparotomy are at greatest risk and the mortality for this procedure remains at least 15%, rising to about 50% in the over 80s (Clarke et al., 2011, Cook et al., 1997). This compares unfavourably with even the most high risk elective surgical procedures. Coronary artery bypass grafting, for example, has a mortality of 1.6% (Society for Cardiothoracic Surgery in Great Britain and Ireland, 2010) but benefits from far greater resources, research and political focus than EGS.

Elderly patients are an increasing problem for EGS. The proportion of patients over the age of 65 is increasing rapidly as the overall population becomes older. Age is one of the best predictors of outcome following emergency surgery (Clarke et al., 2011, Cook et al., 1997), which suggests that, unless standards of care in EGS improve dramatically, the mortality from emergency surgical

operations will rise in future years. Emergency laparotomy in particular puts huge physiological strain on the body. Elderly, frail patients often lack the physiological reserve to cope with large changes in blood pressure, circulating blood volume and oxygenation and therefore the margin for error in emergency surgery is often very small.

A further complication for EGS is the high proportion of patients with multiple co-morbidities. Patients with co-existing vascular disease, neurological diseases and cardiovascular disease, as well as other co-morbidities, are at greater risk of developing emergency gastrointestinal diagnoses than the general population. These co-morbidities increase the risks of surgery in terms of mortality and morbidity. The EGS service frequently needs to deal with patients who have been refused an elective operation on the grounds of ill health but have subsequently presented as an emergency once the condition has progressed. Decision making about which patients are fit enough to withstand and recover from an operation is a crucial part of EGS management but one on which there remains almost no research or guidelines.

Emergency general surgery is very common and has mortality and morbidity that far exceeds comparable elective procedures. This makes EGS a “low-hanging fruit” for quality improvement and an important target for research.

1.4. How is emergency general surgery delivered?

Emergency general surgery in the NHS has become an increasingly consultant led service. In past years EGS was often delivered by a surgical registrar and their anaesthetic, radiology and other colleagues with limited input from consultant staff, especially out-of-hours. Seventy five percent of consultants responding to a recent ASGBI survey say that their involvement in EGS is increasing and more than 80% of consultants now believe that they provide the principle continuity of care for patients (Association of Surgeons of Great Britain and Ireland).

The vast majority of surgeons that deal with EGS have an elective sub-specialty interest and staff the EGS service on a rotational basis. Approximately half of these surgeons work in a “surgeon of the week” system, in which they cover all emergencies for a whole or half week at a time. About 40% of surgeons cover EGS on an “on-call” system, covering one day at a time (Association of Surgeons of Great Britain and Ireland). Fewer than 60% of surgeons are released from their elective sub-speciality practice when covering the EGS workload (Association of Surgeons of Great Britain and Ireland). If consultants have to perform elective operating lists or clinics whilst covering EGS this may limit their ability to provide a timely and consultant led service. A small but increasing number of NHS hospitals have employed a dedicated EGS surgeon who cares for all daytime emergency admissions and referrals, with sub-specialists solely covering the out-of-hours service. This does however risk the sub-specialists becoming deskilled at treating EGS patients through lack of exposure. The number of consultant surgeons practicing in the NHS has increased in recent years but many vascular and breast surgeons are ceasing to practice EGS such that the number of consultants available to treat EGS patients will fall by 40% in some hospitals (Association of Surgeons of Great Britain and Ireland, 2012).

Consultant surgeons are assisted by a team of junior staff in almost all NHS hospitals. This team varies from hospital to hospital but usually consists of three tiers of doctors: a higher specialist surgical trainee, a core surgical trainee and a foundation doctor or equivalently qualified doctors (Association of Surgeons of Great Britain and Ireland, 2012). At night 58% of surgeons work in hospitals that have only two tiers of junior staff and these doctors often cross-cover other specialties such as orthopaedics (Association of Surgeons of Great Britain and Ireland, 2012). Changes in working patterns and the introduction of the European Working Time Directive have reduced junior staffs’ experience and exposure to EGS by as much as 50% (Association of Surgeons of Great Britain and Ireland, 2012). Reductions in the level of staffing and in the experience of junior staff have resulted in greater responsibility falling on consultants for delivery of the EGS service.

The surgical team are assisted by a number of other professional groups in providing an EGS service. These include the emergency department, radiology, theatre and critical care staff in the immediate management of patients and nursing, physio- and occupational therapists and other rehabilitation staff in the recovery phase of care. In particular anaesthetists play a crucial role in the pre-operative assessment and optimisation of patients and post-operative management, especially in terms of pain control. In addition, anaesthetists provide the overwhelming majority of the critical and high dependency care support for EGS patients.

Some NHS trusts have chosen to split their service delivery across “hot” sites, which deal with emergency admissions, and “cold” sites, that exclusively perform elective surgery. This minimises the need for duplication of support staff at multiple sites but runs the risk of lack of services for elective inpatients that become unwell during their stay. There are many other, less radical, variations between units including the availability of operating theatres, critical care and radiology services as well as the individual practices of the staff within those units. The lack of high quality evidence on which to configure services results in a large number of different models of care with little evidence as to which provides the best quality service.

1.5. What are the perceived problems in emergency general surgery?

The cause of many of the perceived issues in EGS has been the lack of interest and investment in the service over a number of years. Political focus in the NHS has generally been on waiting lists for elective surgery and large amounts of increased funding have been provided to meet political targets (Association of Surgeons of Great Britain and Ireland, 2012). This political focus has been matched by surgeons’ interests, which are overwhelmingly in their elective sub-specialty practice. These interests have resulted in very high levels of care provision for elective operating that have not been matched in emergency surgery. To take the example from the previous section; patients undergoing coronary artery bypass grafts are routinely treated on an intensive care unit in the post-operative period despite an overall mortality of 1.6%. Patients undergoing emergency laparotomy

have a mortality risk of approximately 15% but only about a quarter are admitted to an intensive care unit post-operatively (Clarke et al., 2011, Findlay et al., 2011). Not surprisingly EGS patients admitted to intensive care post-operatively have lower mortality when adjusted for disease severity (Clarke et al., 2011).

In addition to the lack of clinical focus on EGS, there has been a lack of focus on research. Funding for research in emergency surgery has been limited, compared to the large charitable organisations backing, for example, breast and heart surgery research. This lack of funding has been mirrored by the paucity of research output in EGS. The low volume of research has hindered the development of a robust evidence base for many treatments in EGS and there is a corresponding lack of guidelines and consensus on best practice in many areas. This lack of consensus may lead to variability in practice between units and surgeons and this is often attributed as the cause of variability in outcomes between providers.

Variability in EGS delivery affects the facilities available to deliver the service as well as the practice of individual surgeons. Nowhere is this better exemplified than in the provision of emergency operating lists. A quarter of surgeons have access to a dedicated EGS operating list during the daytime but 55% claim that they have insufficient access to emergency operating theatres of any type (Association of Surgeons of Great Britain and Ireland). Availability of other important services such as interventional radiology and intensive care are similarly variable. Hospitals with similar facilities may choose to use them in different ways. Differences in duty rotas, for example, were alluded to in the previous section but the influence that this may have on mortality and other outcome measures is unknown. A number of hospitals have started to designate certain ward areas as surgical admissions units (SAUs) or joint medical and surgical admissions units. This has the advantage of grouping acutely ill patients in one location.

Not only are there differences in the way that the EGS service is set up between hospitals, there are also differences in other hospital services. EGS is reliant on other medical teams to assist in the treatment of the many patients with multiple co-morbidities. Some hospitals have appointed elderly

care physicians to make specific ward rounds of older or more complex EGS patients whereas others are reliant of the good will of the, often overstretched, emergency medical team. Interventional radiology is becoming increasingly commonly used for patients with gastrointestinal (GI) bleeding and intra-abdominal abscesses however access is variable; 65% of surgeons have access to a comprehensive service in daytime hours but this falls to only 22% out of hours.

Though many of the alternative methods of service provision outlined above make intuitive sense in terms of improving the quality of care provided to EGS patients there is very limited evidence for the benefit or harm caused by many of them. Without evidence of improved quality and/or reduced cost it is very difficult for EGS staff to force changes in practice or investment in facilities. There are many other areas of medicine, not least elective surgery, which can demonstrate a cost and quality benefit for interventions that compete with EGS for the same pool of money within an institution.

Development of programmes such as laparoscopic colorectal surgery and enhanced recovery after surgery have benefitted from a developing evidence base that has driven investment by NHS trusts. Very little such evidence exists in emergency surgery and for this reason the status quo often prevails.

1.6. Conclusion

Emergency general surgery forms a large part of all acute hospital's workload, making up 50% of all general surgical admissions and 80-90% of general surgical deaths (Association of Surgeons of Great Britain and Ireland, 2012). In addition to caring for acute admissions, the EGS service looks after current surgical inpatients out of hours and provides surgical opinions for patients under other clinical teams. The EGS service is having to deal with rising patient numbers, increasing patient age and ever greater degrees of comorbidity, and these changes are putting increasing strain on the clinical teams providing this care.

The EGS service composition is variable. Consultants work various types of rota and are supported by differing numbers of junior staff. In addition the provision of support services such as radiology and

critical care varies greatly between hospitals. There is low utilisation of, for example, intensive care in comparison to elective surgery. Much of this variability can be attributed to the lack of evidence of best practice in EGS. There is a paucity of literature on the optimal management and infrastructure required for a high performing EGS service and, as a result, most units have evolved their own practice and protocols, often with little reference to other hospitals. The lack of robust evidence makes it difficult to demonstrate a business case for investment in EGS and this has, in places, led to resource limitations.

The next chapter will summarise the academic literature regarding quality of care and its measurement and will demonstrate how this can be applied to EGS.

2. QUALITY IN HEALTHCARE

2.1. What is quality of care?

Until quite recently the quality of healthcare was considered the sole preserve of doctors. The public had unequivocal trust that doctors provided the best possible care in an efficient manner and, if this was not the case, it was a matter for doctors to remedy themselves (Blumenthal, 1996). In more recent times the public, in part encouraged by the reports of significant patient safety deficiencies in Western healthcare systems (Department of Health, 2000, Kohn et al., 1999), have begun to question the quality of care they are given. Doctors and other healthcare professionals therefore need to ensure that they can measure and strive to improve the quality of care they provide, in order to meet the demands of patients and government funders (Blumenthal, 1996). Healthcare workers that are interested in measuring quality first need to define what quality actually is.

Quality in healthcare has been given many different definitions over time but the most widely cited recent definition comes from a report on Medicare and reads:

“The degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.” (Lohr and Schroeder, 1990)

Avedis Donabedian, the foremost researcher into quality of care has suggested that quality of care can be divided into a number of separate facets (Donabedian, 2003) (Table 2.1). These seven components of quality together make up a comprehensive overview of quality in healthcare and allow us to focus on certain aspects of quality individually. For reasons of time and logistical constraints, this thesis will not examine the economic aspects of healthcare embodied by efficiency and optimality, nor the acceptability, legitimacy or equity of healthcare that are better examined at

a population level. The concerns expressed by healthcare leaders, discussed in chapter 1, relate to the efficacy of EGS services, due to lack of research and development of treatments, and, in particular, the effectiveness of healthcare for EGS patients.

Box 2.1: Components of healthcare quality

Efficacy

The ability of the science and technology of healthcare to bring about improvements in health when used under the most favourable circumstances.

Effectiveness

The degree to which attainable improvements in healthcare are, in fact, achieved.

Efficiency

The ability to lower the cost of care without diminishing the maximum achievable improvement in health

Optimality

The balancing of improvements in health against the costs of such improvements

Acceptability

Conformity to the wishes, desires and expectations of patients and their families

Legitimacy

Conformity to social preferences as expressed in ethical principles, values, norms, mores, laws and regulations

Equity

Conformity to a principle that determines what is just and fair in the distribution of healthcare and its benefits among members of the population

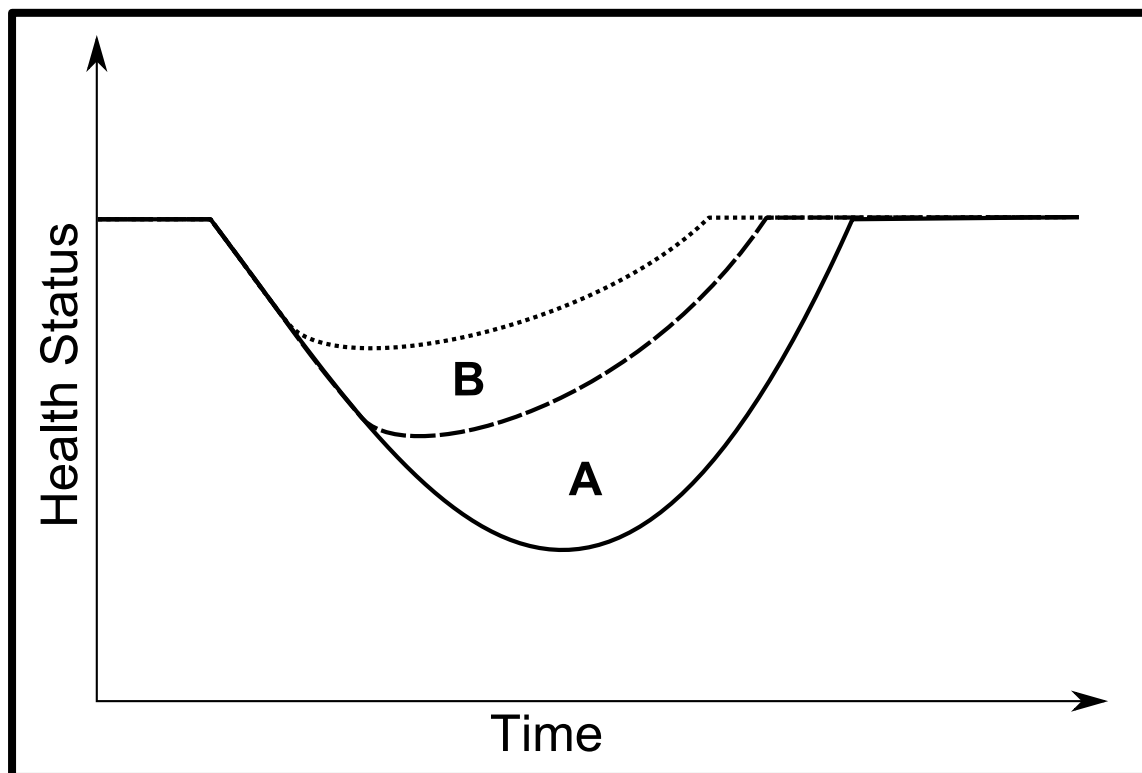
Adapted from (Donabedian, 2003)

The effectiveness of healthcare is the difference between perfect care and the care that is actually delivered and is summarised in Fig. 2.1. Unfortunately this model of healthcare quality often suffers from a lack of information. The most efficacious healthcare may be unknown and, once treatment has started, the course of the illness without care can only be estimated. In addition, there are often no defined measures of health status to measure effectiveness against. These deficiencies are gradually being reduced through clinical and epidemiological studies, of which this thesis is a small part.

Effective healthcare requires two vital components: healthcare providers must, firstly, provide appropriate care for the condition suffered by the patient and, secondly, provide that care in a

flawless manner. This concept is often summarised as “doing the right thing right” (Blumenthal, 1996). This “technical” effectiveness of care will form the basis for the measurement of quality of EGS services in this thesis.

Figure 2.1: Graphical representation of the efficacy and effectiveness of healthcare



(in a self-limiting disease). Solid line indicates course of disease without treatment, dotted line represents best quality care – the efficacy of healthcare. Dashed line represents the care to be measured. The effectiveness of healthcare is equivalent to $A/A+B$. In other words effectiveness is the proportion of the maximum possible health status improvement that is actually achieved (adapted from (Donabedian, 2003)).

The quality of healthcare can be measured for a number of reasons. The most obvious reason is for quality improvement however, when analysed closely, quality improvement has several facets.

Firstly, it is crucial to be able to compare current practice to a gold standard, in other words to measure effectiveness. Secondly, it is useful, when the most efficacious form of care is unknown, to be able to compare institutions with one another. This form of quality measurement then allows best practice from the highest performing units to be disseminated throughout the healthcare

system. Finally, quality measurement allows us to evaluate the impact of any changes in practice that are implemented. Without this vital step we would have no way of knowing whether our intervention was having any effect: “...we can only be sure to improve what we can measure” (Darzi, 2008).

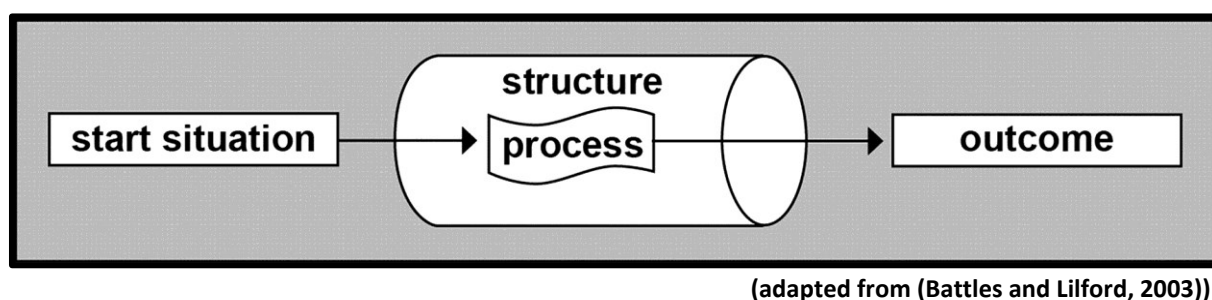
Beyond quality improvement, measurement of quality is increasingly used to manage payment to healthcare providers, often by withholding payment for poor quality care (NHS Institute for Innovation and Improvement, 2012). The monitoring of some aspects of healthcare is required by regulatory agencies, for example the mandatory reporting of “never events” both in the United Kingdom (UK) and the United States of America (USA). Other measurements of quality may be routine within an organisation, such as the waiting time for elective operations or bed occupancy figures. Finally, as is the case in this thesis, measurement of quality may be prompted by problems identified on either a local or health system level. Having identified why healthcare quality may be measured it is necessary to decide what to measure.

2.2. How can we measure quality?

Healthcare is hugely diverse and has a vast variety of settings, personnel, diseases and patients. Attempting to measure the quality of every aspect of healthcare, even within a small institution, would be impossible. It is therefore necessary to concentrate efforts on those areas likely to provide the most useful window onto the system we wish to assess. In a seminal paper in 1966 Donabedian proposed three approaches to assessing the quality of healthcare that remains the pre-eminent model for assessing quality of care (Donabedian, 1966). Donabedian suggested that quality of healthcare could be measured in terms of the structure within which care is provided, the process of delivery of care itself, and the outcomes of care for the patient or population (Fig 2.2). Alternatives to the use of the “structure, process and outcome” model are limited but include Lord Darzi’s Next Stage Review, which describes the measurement of clinical effectiveness, safety and patient experience (Darzi, 2008) and population measures of healthcare quality such as the USA Institute for

Healthcare Improvement's "whole system measures" of quality (Martin et al., 2007b). These alternatives are however really only a complement to the "structure, process, outcome" model, which is overwhelmingly the most widely used in assessing the effectiveness of healthcare and is the one that will be used in this thesis.

Figure 2.2: Graphical representation of the structure, process and outcome model



2.2.1. Structure, process and outcome

The structure, process and outcome model is worthy of some further discussion to clarify its meaning, strengths and weaknesses. Structure relates to the conditions under which care is provided. This included the material resources such as facilities and equipment, human resources, including the number and qualification of personnel and organisational characteristics, for example the systems for organisation of staff, methods of paying for care and the presence of teaching or research (Donabedian, 2003). Structure can be thought of as everything that is fixed for two patients having treatment for the same disease at the same time in the same institution. The process of care, conversely, can be considered to be everything that is variable for the same two patients: the diagnosis, treatment, rehabilitation and education, all of which are usually provided by professional clinical staff (Donabedian, 2003). Finally, outcomes are the changes in individuals that can be attributed to healthcare, including changes in health status, knowledge, satisfaction and future behaviour (Donabedian, 2003). Figure 2.2 graphically depicts the structure, process and outcome model. Each of the three facets of the structure, process and outcome model has advantages and

disadvantages and provides a slightly different viewpoint on the quality of the care being assessed. A combination of all three is likely to provide the most comprehensive review of the quality of the healthcare being assessed.

It is widely accepted that the environment in which healthcare is delivered affects the behaviour of both staff and patients and therefore the quality of care delivered (Donabedian, 2003). Structural variables have been widely used to examine the quality of care in elective surgery. Variables such as hospital and surgeon volume, surgeon sub-specialty training and high nurse-to-bed ratios have all been shown to correlate with surgical outcomes (Birkmeyer et al., 2004). Structural variables are attractive as quality measures as they are easily observable, readily documented and only change relatively slowly (Donabedian, 2003). Unfortunately there is little evidence of the effect of many structural variables on healthcare outcomes. In addition this evidence can only be gathered through observational studies, rather than controlled trials, which makes it difficult to rule out confounding as a cause of significant relationships between structure and outcome (Birkmeyer et al., 2004). Structural variables are also difficult to change if they are found to be lacking; a centre with low procedure volume cannot easily turn itself into one with high procedure volume. Finally, structural variables reflect population markers of quality between institutions and are somewhat removed from actual patient care (Birkmeyer et al., 2004). Structure is therefore a useful but imperfect marker of quality.

Process measures are routinely used as measures of quality in clinical audit and have become particularly important in the management of chronic diseases (in which the outcome is often remote from the process by a number of months or years). In elective surgery the use of thromboprophylaxis against deep venous thrombosis is one of the best characterised relationships (National Institute for Health and Clinical Excellence, 2010). Process measures directly reflect the care given to the patient and so are widely accepted as measures of quality by clinical staff and patients (Birkmeyer et al., 2004). Processes are also very sensitive in detecting differences in care between institutions; outcome measures are confounded by the variability between patients

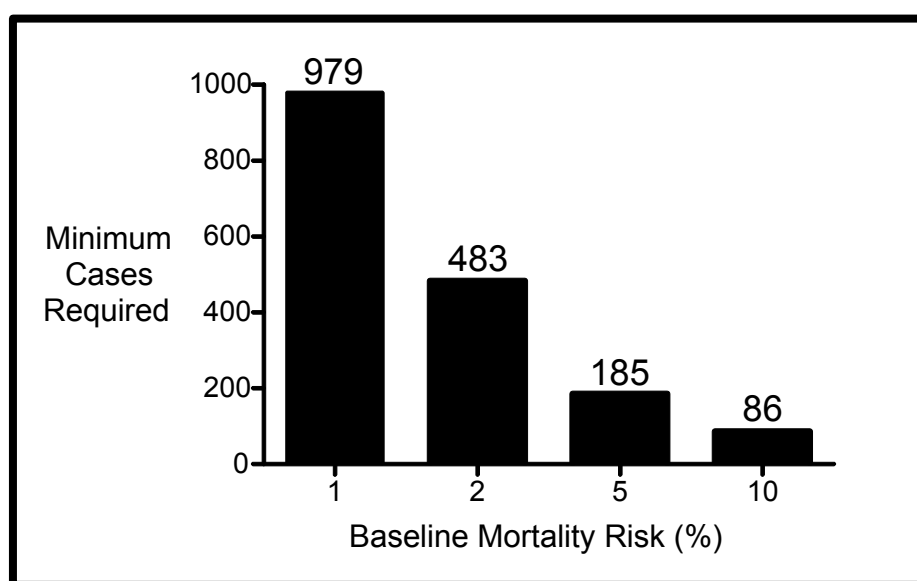
whereas process measures have been shown to discriminate accurately between high and low performance units (Mant and Hicks, 1995). Process measures are also readily actionable if found to be of poor quality and improvements in process advance the outcomes for all institutions, not just those with the worst outcomes (Lilford et al., 2007). There are an increasing numbers of processes which have high-quality evidence from multiple randomised, controlled trials linking them with improved outcomes, often with a large magnitude of effect. Unfortunately there are also many processes for which we have limited or no evidence of their effect on patient outcomes and this is a particular problem in EGS. Other disadvantages of processes in measuring quality include the difficulty in knowing which processes are suitable for which patient (patients with a bleeding diathesis should not, for example, always be given thromboprophylaxis) and the relative laboriousness of collecting data on the process of care for individual patients (Birkmeyer et al., 2004).

The USA Institute of Medicine, in their landmark report “To Err is Human” defined three dimensions of quality that affect the structure and process of care (Kohn et al., 1999). These are that healthcare should be safe, it should be consistent with current medical knowledge, and it should meet patients’ and relatives’ values and expectations. This thesis will primarily focus on the second dimension but elements of both safety and patient satisfaction will be discussed.

Data on outcomes have long been a staple of surgical quality assessment. Mortality, morbidity, recurrence rates and length of stay are familiar to all surgeons and are considered the mainstay of quality monitoring by many due to their immediate applicability to patient care. In addition the measurement of outcomes on its own has been shown to improve the quality of care by raising awareness amongst clinical staff (Khuri et al., 2002). Unfortunately outcome measures also have a number of disadvantages. The main disadvantage is in dealing with uncommon outcomes such as mortality after elective surgery. As the risk of mortality falls the number of cases required to show a statistically significant difference between providers rises (Fig. 2.3). Many hospitals and almost all surgeons do not perform enough cases of each type to aggregate a sufficient number of cases to

analyse. This results in the inability to draw meaningful conclusions within a short timeframe which leads to a delay between the delivery of care and the availability of outcome measures of quality. In this time period the system of healthcare is likely to have evolved, rendering the assessment of quality increasingly unhelpful (Birkmeyer et al., 2004).

Figure 2.3: Graph to show minimum number of cases required at individual hospitals to identify a statistically significant doubling of baseline mortality risk



(adapted from (Birkmeyer et al., 2004))

A second problem with outcome measures is one of attribution (Donabedian, 2003). Attribution refers to the fact that, while outcomes may vary between individuals it is difficult to know whether this is as a result of differences in the care they received or differences in the patient's medical, genetic and psychological make-up. This means that outcome measures must be standardised for variability in patients; this process is known as case-mix adjustment. Many methods of case-mix adjustment have been developed but the best surgical example is that of the National Surgical Quality Improvement Program (NSQIP) amongst Veteran's Affairs hospitals in the USA (Khuri et al., 1998). While case-mix adjustment can go some way to limiting the problems of attribution, none of

the adjustment methods account perfectly for the inherent variability in patients. A final problem with outcome measurement, which has been alluded to already, is the temporal separation between the desired outcome and the care that is being measured. A good surgical example is 5-year survival rates following cancer surgery which, by the time they are available, no longer reflect the care currently being given by a surgeon or provider. Of course, the longer the interval between the delivery of care and the desired outcome, the greater the chance for factors other than the quality of healthcare to affect the variable being measured (Donabedian, 2003).

It is clear that assessment of the quality of healthcare structure, process and outcome all have strengths and weaknesses and therefore the best way to build a comprehensive picture of quality is to examine a combination of facets. This thesis will examine all three approaches to measuring quality of care in EGS in order to build as complete an assessment of quality as possible.

2.2.2. Sources of data on quality of care

Medical casenotes have been a mainstay of quality and safety research in healthcare. Large casenote review studies such as the Harvard Medical Practice Study (Brennan et al., 1991), the Quality in Australian Health Care Study (Wilson et al., 1995) and similar casenote review studies in the UK (Vincent et al., 2001, Neale et al., 2001) have served to increase the visibility of quality and safety in healthcare. These studies led directly to influential reports such as *To Err is Human* (Kohn et al., 1999) and *An Organisation with a Memory* (Department of Health, 2000), which brought quality of care to the attention of the public and the medical profession as a whole. Despite the success of these studies, the assessment of casenotes is not without its own disadvantages. One major problem when assessing the quality of care is the quantity of information that is missing from casenotes. This is due, in part, to the fact that it is not necessary to record all the information we would like to have for quality monitoring purposes in a record that is solely for clinical use. It stands to reason therefore that a retrospective examination of casenotes that were not initially intended for quality assessment results in significant deficiencies in the data available. In addition, medical casenotes are widely accepted to be frequently incomplete or inaccurate (Donabedian, 2003). Completion of medical

records varies by the location of care, out-patient records being worse than in-patient records and episodes of care across multiple sites causing particular confusion (Donabedian, 2003). In the worst cases records are simply lost in the ever-growing libraries of physical casenotes, where electronic medical records have yet to be instituted. Examinations and tests performed with negative or normal results are often not recorded and there is little information about the quality of the interaction between patient and healthcare professional. Inaccuracies in casenotes are usually due to simple clerical error but the temptation to omit the details of adverse events or embarrassing oversights in an era of frequent litigation is ever present (Donabedian, 2003). Inaccuracies can also be found due to observer bias; healthcare staff may not all interpret the same findings identically and therefore case records may be different for two patients with identical symptoms and signs but separate clinical staff (Donabedian, 2003).

An alternative to the examination of casenotes is the direct observation of care. Direct observation is much more time consuming than the assessment of case records but it is likely to produce far richer and more detailed information. A mixture of direct observation and contemporaneous case record review has been used with some success in the assessment of surgical care (Olsen et al., 2007).

Observation is superior to record review because data on structure or process is collected by the researcher directly, rather than the second-hand information gathering of record review.

Observation is however subject to the Hawthorne effect, in which the patients and staff being observed alter their behaviour because the observer is present (Landsberger, 1961). Video recording is also being increasingly widely used as a method of quality assessment, particularly in simulated settings (Arora et al., 2011). Surgery lends itself to this form of observation as it is conducted in a fixed position, though there are a number of ethical issues surrounding the use of video observation with real (as opposed to simulated) patients.

As a result of the relative inefficiency of direct observation of care alternative methods of data collection have been sought. The first of these is the questioning of both staff and patients regarding the type and quantity of care delivered. This may take the form of closed questioning using

questionnaires and surveys or more qualitative interview studies. Patients are increasingly asked about the care they have been given and an entire branch of quality monitoring dealing with patient reported outcome measures (PROMS) has been developed. While patients may not always be in a position to offer an educated opinion on the technical quality of care, PROMS continue to be widely used in the NHS to assess the quality of the interactions between staff and patients (Darzi, 2008). Qualitative interview studies are a good way of eliciting staff and patient's opinions about a clinical service and the factors that they believe improve or impair quality.

A final, and increasingly popular data source for monitoring quality, are administrative databases. Increasing computerisation of the management of healthcare has resulted in the creation of large electronic databases containing records of admissions, deaths, diagnoses and patient demographics. These databases often contain millions of records, which allows sophisticated risk-adjustment of case-mix to be performed. Robust risk-adjustment then allows separate units or even surgeons to be compared in a way that was not previously possible. These databases have revolutionised the study and use of patient outcomes as quality measures, particularly in surgery, which has led the way in this field. Indeed, the use of administrative data has been so successful that dedicated databases such as NSQIP have been developed specifically for quality monitoring purposes (Khuri et al., 1998). These large databases and risk-adjustment techniques have alleviated some of the problems with outcome measures described in the previous section as they allow amalgamation of cases to ensure sufficient numbers for statistical analysis. As has been previously alluded to however, risk-adjustment is imperfect and the accuracy of data in many databases is often questioned. The results of these statistical analyses must therefore be treated with caution.

Mirroring the structure, process and outcome model, data sources for investigating the quality of healthcare have advantages and disadvantages. The best way to ensure a thorough assessment of quality in an acceptable timeframe is to use a mixture of data sources, choosing the most appropriate for each area under investigation.

The thesis will focus on the efficacy and effectiveness of care for EGS patients, using the Donabedian model to assess quality of care. This will involve an investigation of structural factors relevant to EGS, such as staffing, operating theatres, critical care and radiology; the process of care, including diagnosis, resuscitation and post-operative care; and outcomes in terms of mortality, length of stay and readmission rate. To ensure the most comprehensive assessment of quality possible, this thesis will assess the structure, process and outcomes of EGS using a variety of methods and data sources.

Before embarking on this type of assessment of quality it is necessary to have a clear understanding of previous attempts to examine quality of care in EGS and this will be the subject of the next chapter.

3. CURRENT LITERATURE ON QUALITY OF CARE IN EMERGENCY GENERAL SURGERY

As discussed in Chapter One, the volume of research on quality of care in EGS is relatively small. Whilst there are reasonable bodies of research on popular single topics, such as endoscopic stenting for large bowel obstruction or same admission laparoscopic cholecystectomy for cholecystitis, overall, the research coverage is limited. This paucity of previous research is largely due to lack of interest from both clinicians and funders of research (Association of Surgeons of Great Britain and Ireland, 2012). Nevertheless, it is important to have a clear understanding of previous attempts to measure quality in EGS before beginning new investigations. This chapter will present a limited search of the literature with a narrative discussion based on the principles of measurement of quality of care discussed in the previous chapter.

3.1. Search strategy

Searching the quality literature is not straightforward because authors use a myriad of different terms to describe their work. Many of the search terms used retrieve very large numbers of irrelevant articles and, in addition, much research focuses on single diseases and is not generalisable to the rest of EGS. Research into EGS as a whole is limited, partially because it is more complex to perform than that for a single disease state and partly because EGS patients are heterogeneous and difficult to generalise. The primary endpoint of this search was therefore papers measuring efficacy or effectiveness of structure, process or outcome for EGS as a whole. Secondary endpoints were articles that describe either a single structure, processes, or outcome for multiple diseases or those that described multiple structures, processes or outcomes for a single disease.

Ovid SP was used to search the titles and abstracts of articles in the MEDLINE, Embase and PsycINFO databases between 1st January 1990 and 20th April 2014. The search was limited to 1990 to avoid the inclusion of articles that are no longer applicable to current practice. In addition, similar searches

were performed in Google Scholar and the Cochrane Library. These results were supplemented by hand searches of the grey literature, which included reports from NICE, SIGN and NCEPOD, the use of the Pubmed “related articles” feature and search of the references of included articles. Papers dealing solely with the treatment of paediatric patients (considered to be patients under the age of 16 or no longer in full time education) were excluded as the system of care for these patients is usually markedly different to that for adults. For clarity, this review will focus on EGS as provided by the UK NHS and similar healthcare systems. Articles assessing the quality of care in developing nations (broadly considered to be those outside North America, Europe and Australasia) were excluded as the type of care provided differs significantly from that in “Western” countries. Case reports and conference abstracts were also excluded. The full search strategy is detailed in Figure 3.1.

Figure 3.1: Search strategy for quality of care in emergency general surgery

Search Term	Hits	Combined with “OR”	Combined with “AND”	Limits applied: -Humans -English language -1990 to current -De-duplicated
Emergenc*	557,020	)		
Urgent	90,139	) 651,911	)	
Lifesaving	5,655	)		
Life-saving	15,429	)		
Surgery	1,829,521	)		
Surgical	1,578,655	) 3,315,801	) 9,310	) 4,090
Operation	667,519	)		
Quality	1,426,006	)		
Safety	709,696	) 2,067,432	)	
Structure AND Process AND Outcome	4,128	)		

Ovid SP was used to search titles and abstracts.

The search strategy used “Structure AND Process AND Outcome” as a composite search term. This was done because the use of these terms individually retrieved in excess of 5 million articles. If

included like this, the eventual search would have retrieved 11,232 articles. It was considered that this was an excessive number to hand-search and therefore the composite search term was used to reduce numbers, without significantly weakening the search. None of the papers cited in the results but only found using reference lists or the “related articles” function in Pubmed would have been uncovered using this wider search. Similarly, the papers by Faiz et al. were not found using the search strategy above, however the only suitable word in the papers’ titles and abstracts to have them included would be “Mortality”. Including “Mortality” as a search term results in over 32,000 references retrieved by the search.

Figure 3.2: Search results and classification of retrieved articles

	Number of articles excluded	Remaining articles included
Articles retrieved		4090
Exclusions on titles and abstracts		
Not general surgery	3210	880
Elective surgery only	489	391
Paediatric population only	24	367
Developing world only	20	347
Exclusions on full text		
Single disease	222	125
Single process of care only	34	91
Intra-operative care only	22	69
Inclusions from reference lists and “related articles”	37	106

Titles and abstracts of the articles retrieved by the search were downloaded to Endnote v6.0.1 (Thompson Reuters, New York, USA) and these were reviewed to see if they were relevant to quality and safety in emergency general surgery. A flow chart for reference selection can be found as Figure 3.2. The remaining references were reviewed in full text version and considered for inclusion. The remaining studies covered the entire gamut of emergency general surgery and consisted of editorials, single centre cohort studies, multi-centre outcomes studies using large datasets and many other article formats. As such these studies could not be formally quality assessed because no

quality assessment criteria exist for many of these types of articles and because quality assessment primarily looks for risk of bias in randomised controlled trials, of which there was only one in the literature review and this was stopped early. For similar reasons a systematic amalgamation of data between studies (such as in meta-analysis or formal systematic review) was not possible. In addition, few studies actually addressed the same research questions as one another, a prerequisite for data synthesis. Due to these limitations the remaining 106 articles were assimilated and presented as a narrative review. Not all articles have been referenced in the text as all possible topics have not been covered. Suitable examples have been cited for each statement made and all relevant articles included where data is reported.

3.2. Results of literature search

Improvements in outcome for EGS admissions are the ultimate goal for all who work in this field and, without an understanding of current performance, a detailed examination of underlying structure and process is difficult to put into perspective. For this reason this literature review, and the rest of this thesis, will consider the outcomes of EGS in the first instance, followed by an exploration of the structural and process factors that may explain or contribute to these outcomes.

3.2.1. Emergency general surgery outcomes

Mortality is the most frequently utilised outcome measure for EGS. This is appropriate for this high-risk group of patients as death rates are high enough to provide a useful data for most high-risk EGS diagnoses. Morbidity is also widely used but is limited by the lack of standardised definitions for many complications, the difference between post-operative atelectasis (lung base collapse without infection) and chest infection/pneumonia being a classic example. There is some debate over the use of length of stay and readmission rate for EGS patients. In many cases, length of stay is dependent on the social circumstances and rehabilitation of the patient rather than the speed with which they recover from their disease (Mamidanna et al., 2010). While the readmission of EGS patients is often unwarranted, there are a number of conditions, for example small bowel

obstruction secondary to adhesions, in which successful non-operative management can be followed by a relapse within the 30 day period that is normally considered inappropriate. A final problem with the currently available data on EGS outcomes is that the majority of it is based on data sets that use an operation or group of operations as inclusion criteria. This approach only includes patients that surgeons have selected to undergo an operation and therefore is not necessarily an accurate representation of the outcomes for all EGS admissions.

The most frequently examined group of EGS patients is those who required an emergency colorectal resection. These operations are a sub-group of emergency laparotomies and are performed for obstruction, perforation, bleeding or ischaemia of the colon as a result of various disease processes. This is a useful group of patients to focus on because mortality for these procedures is high and they remain relatively common.

NHS Hospital Episode Statistics (HES) data demonstrates a 30-day, in-hospital mortality of 14.3% for patients undergoing emergency colorectal resection between 1996 and 2007 (Faiz et al., 2010b).

This compares favourably with mortality from the American National Surgical Quality Improvement Project (NSQIP) hospitals of 15.4% between 2005 and 2007 (Ingraham et al., 2010a) (Table 3.1).

Though this data has not been rigorously risk-adjusted, these papers suggest that the discrepancy in outcomes between the UK and USA in terms of elective mortality does not extend to emergency operations (Bennett-Guerrero et al., 2003). NSQIP participating hospitals are self-selecting and therefore the outcomes described by this program may not accurately reflect the outcomes of all hospitals in the USA (Almoudaris et al., 2011a). In addition, NSQIP only samples a selection of operations at each hospital and excluded some more minor procedures entirely, which may increase bias further (Khuri et al., 1998). In contrast, HES includes all hospitals in England and so avoids this selection bias. Post-operative complications are very common following emergency colorectal resection, occurring in almost half of patients (Ingraham et al., 2010a). Median length of stay in hospital is between 14 and 23 days, depending on diagnosis and the 28-day readmission rate is

between 6 and 14% (Faiz et al., 2010b)(Table 3.1). Survival at one year is similarly poor, with nearly 30% of patients dying within 12 months of their operation (Faiz et al., 2010b).

It is well recognised that age is a risk-factor for poor outcome following EGS operations and this is true for colorectal resections, where mortality is nearly 25% in patients over 70 years of age, rising to over 30% in those over 80 (Mamidanna et al., 2012). Length of stay and readmission rates do not seem to differ markedly from younger patients but mortality at 1 year for those over 70 years is 43% (Mamidanna et al., 2012).

Ingraham et al. examined outcomes for all EGS operations, though this includes large numbers of more minor procedures such as appendicectomy and abscess drainage (Ingraham et al., 2011a). This study of NSQIP data found an overall mortality of 6% and morbidity of 20% for EGS procedures compared to 1% and 9% respectively for elective operations (Table 3.1). The same group looked at similar operations in patients over 65 years of age and found a relative risk of death in those over 65 of 2.3 times, compared to the rest of the population (Ingraham et al., 2011c).

Table 3.1: Outcomes for emergency general surgery in published literature

Authors	Data Source	Patient Group	30-Day Mortality	Morbidity	Median Length of Stay (days)	Readmission Rate
Faiz et al. (2010a)	HES 2001-2005	Colorectal Resections	15.50%	-	-	-
Faiz et al. (2010b)	HES 1996-2007	Colorectal Resections	2.5-35.2%	-	14-23	6.4-14.1%
Ingraham et al. (2010a)	NSQIP 2005-2007	Colorectal Resections	15.40%	48%	-	-
Ingraham et al. (2011a)	NSQIP 2005-2008	All EGS Operations	5.80%	19.80%	-	-
Saunders et al. (2012)	Emergency Laparotomy Network 2010-2011	Emergency Laparotomy	14.90%	-	11	-

The studies included in this table are all those that report EGS outcomes at a population level
HES Hospital Episode Statistics; NSQIP National Surgical Quality Improvement Program; EGS Emergency General Surgery

A final method of defining high-risk EGS patients has been to examine patients undergoing emergency laparotomy. This procedure, which involves opening the abdominal cavity, usually through a midline incision, encompasses all colorectal resections but also includes diagnostic exploration of the abdominal cavity and the majority of other intra-abdominal operations such as repair of perforated gastric or duodenal ulcer and other small bowel operations. Of note, appendicectomy and hernia repairs do not usually require a laparotomy. The NHS Emergency Laparotomy Network has recently completed a prospective audit of laparotomies in the NHS (Saunders et al., 2012). This study included 1941 patients from 35 self-selecting hospitals. 30-day mortality was 15% and median length of stay was 11 days (Table 3.1). For patients over 80 30-day mortality rose to 24%, which compares favourably with a reported mortality of 48% for patients over 75 having a laparotomy in a single centre in 1996 (Cook et al., 1997), suggesting that mortality (or patient selection) may have improved over time.

Additional measures of EGS outcome include the assessment of patient reported outcome measures (PROMs) and measurement of the cost effectiveness of healthcare. Unsurprisingly, given the lack of outcome data for EGS, investigation of these areas did not reveal any robust evidence to date. Both PROMs and cost effectiveness research are suitable topics for future study in emergency general surgery.

3.2.1.1. Variability in outcomes

Though outcomes for high-risk EGS operations are similar between studies, a recurring theme is variability in outcomes between providers. This concern has been prompted by the findings of recent NCEPOD reports, detailing sub-optimal care (Findlay et al., 2011) and a large study of medical and surgical emergency admissions that demonstrates an in-hospital mortality odds ratio of 1.10 for patients admitted at the weekend (Aylin et al., 2010). Variability, particularly in risk-adjusted mortality for EGS patients between hospitals, is a key concern of both the Association of Surgeons and the Royal College of Surgeons (Association of Surgeons of Great Britain and Ireland, 2012, Royal

College of Surgeons of England, 2011a). These reports describe a “greater than two-fold variation in relative risk of 30-day mortality (risk-adjusted) after non-elective lower GI procedures between trusts in the North West Strategic Health Authority” but no reference to the study containing this data is given. Faiz et al. examined outcomes for emergency colorectal surgery between 2001 and 2005 and found similar variability between providers (Faiz et al., 2010b). Out of 166 NHS trusts, 11 exceeded 2 standard deviations (SD) above the mean risk-adjusted 30-day mortality and 4 were more than 3 SD greater. This is not however many more outliers than can be found for similar analyses of elective colorectal surgery (Almoudaris et al., 2013).

Studies from the USA using NSQIP data have also demonstrated variability in outcomes between institutions but have found no consistent pattern of outlying providers in emergency vs elective colorectal surgery (Ingraham et al., 2011a), between different EGS operations (Ingraham et al., 2011a) or between elderly and young groups of patients (Ingraham et al., 2011c). This lack of a consistent pattern of high mortality and low mortality outlying institutions casts doubt on the idea that there are “good” and “bad” providers that either excel or fail for all groups of patients. Nevertheless, there is reasonable evidence for differences in structure and processes of care between institutions and it is likely that the risk-adjustment used to correct for the variability between patients is not sufficiently accurate and so systematic differences between institutions are lost in the “noise” of patient variability. The following sections will investigate the evidence for some of these differences in structure and process, try to identify best practice and examine the degree of variability in practice.

3.2.2. Structure of care for emergency general surgery

Detailed guidelines for the structure of EGS care in the NHS have recently been published (Royal College of Surgeons of England, 2011a). Though these guidelines provide explicit standards for units admitting EGS patients they are dependent on a rather limited evidence base. In addition, there is little evidence of the current rate of adherence to these standards within the NHS. There are a multitude of structures that contribute to the treatment of EGS patients and it would be impossible

to cover them all in this review. Patients are likely to come into contact with the emergency, radiology, operating theatre, anaesthesia and critical care departments as well as the surgical team and their wards. This section of the review will summarise the evidence for a selection of the best researched structural components of the EGS service.

3.2.2.1. Consultant staffing for emergency general surgery

The overwhelming majority of research publications on the structure of EGS deal with the working patterns of consultant surgical staff. The RCS standards do not nominate a preferred working pattern but do state that all EGS services should be consultant-led and ideally consultant-delivered, that consultants should be free of elective commitments, available at all times for telephone advice and available on-site within 30 minutes (Royal College of Surgeons of England, 2011a). Several working patterns have been proposed to address these standards, which are difficult to fulfil in a traditional “on-call” system, in which the consultant performs their emergency work in addition to their elective commitments. The first of these systems is a “consultant-of-the-week”, in which consultants are free from elective commitments and cover emergency admissions for either a half or whole week. Surgeons have demonstrated a reduction in length of stay and readmissions with this system in a pre-post study, admittedly in conjunction with other improvements to the EGS service (Western et al., 2011). Just over half of surgeons responding to a recent ASGBI survey were working a consultant-of-the-week pattern but more than 40% continued to have elective responsibilities whilst covering the EGS service (Association of Surgeons of Great Britain and Ireland).

Alternatives to the consultant-of-the-week model have been proposed, primarily in the USA. These include the development of an “acute care surgeon” sub-speciality that treats trauma and emergency general surgery patients. These surgeons are generally based in dedicated units treating trauma and EGS patients with limited input from sub-specialised elective surgeons. There is some evidence that this model of care can improve local outcomes, at least in emergency colon surgery (Moore et al., 2011). However, while the development of specialist trauma centres in the USA has

undoubtedly improved trauma care, trauma centres on their own do not seem to have improved EGS outcomes in NSQIP hospitals (Ingraham et al., 2011b).

A third alternative staffing model is that of a dedicated emergency surgeon or “hospitalist” (Maa et al., 2007, Sorelli et al., 2008). The emergency surgeon is responsible for all daytime emergency surgery as well as the day-to-day care of patients but is covered by either other emergency surgeons or their sub-specialty colleagues outside normal working hours. This is similar to the acute care surgeon model in many ways but without the responsibility for trauma patients. This type of consultant staffing has been shown to reduce length of stay and costs while increasing daytime operating and reducing time to theatre (Maa et al., 2007, Sorelli et al., 2008, Suen et al., 2014). Unfortunately, as with almost all studies of structure, these were simple pre-post designs without controls and so it is difficult to know what proportion of the stated improvements were actually due to the intervention in question. In addition, this model raises questions about the ongoing experience of surgeons covering the out-of-hours service, who may only be called on to perform emergency operations a few times per year.

There are clear recommendations that senior surgeons running the EGS service need to be relieved of their elective duties and there are a number of staffing patterns that allow this (Martin et al., 2007a). About half of surgeons appear to be meeting this standard already but this may be impractical in smaller hospitals with few surgeons and limited numbers of emergency admissions. It may be that increasing centralisation of surgical services, including EGS, accelerate this change in the future.

3.2.2.2. Additional infrastructure factors

The driving force behind centralisation of elective surgical care, particularly in vascular and cardiac surgery, was the finding that units that performed more operations had better outcomes (Holt et al., 2007). This finding has been attributed to the fact that large specialised centres are more used to treating patients requiring complex surgery and can provide a more robust and specialised service.

Examination of 30-day and 365-day mortality for emergency colorectal surgery using HES data has not demonstrated a volume-outcome relationship for EGS (Faiz et al., 2010b). It is likely that the majority of hospitals are already above the minimum threshold of high-risk EGS operations at which low volume begins to affect outcomes.

In 2005 the UK Department of Health produced a document recommending emergency assessment units to combat the problem of emergency patients scattered in varying wards around the hospital depending on bed availability (Department of Health, 2005). Admission to the first available bed frequently leads to patients housed on inappropriate wards, where staff do not have appropriate experience of either the disease or the treatment plan. The 2007 NCEPOD report into emergency admissions identified that, while 60% of hospitals had a surgical assessment unit, about 7% of patients were admitted to an inappropriate ward (Martin et al., 2007a). NCEPOD recommended that “Following the initial assessment and treatment of patients admitted as an emergency, subsequent inpatient transfer should be to a ward which is appropriate for their clinical condition; both in terms of required specialty and presenting complaint” and this recommendation has been echoed by the recent RCS standards. Surgical admissions units have been shown to alleviate pressure from A&E departments by diverting general practitioner referrals and have demonstrated equivalent time to treatment, however their effect on outcomes for EGS in the NHS is unknown (Mohamed and Mufti, 2005).

In terms of the supporting services for EGS, the RCS standards call for 24 hour access to theatres, intensive care, and interventional radiology sufficient to support the anticipated EGS workload (Royal College of Surgeons of England, 2011a). While these standards are sensible goals, there is little evidence of the extent to which hospitals currently adhere to these standards and even less evidence that improving access to these services will actually improve patient outcomes.

The availability of operating theatres for EGS has long been a contentious topic. Emergency operating has been addressed in several reports from NCEPOD. “Who Operates When” was the first of these reports, published in 1997 and it demonstrated a large number of operations being

performed out of hours, often by unsupervised junior members of staff due to lack of availability of daytime operating space, not because of clinical need (Campling et al., 1997). This study led to the introduction of NCEPOD operating lists; operating lists that are dedicated to emergency operating during daytime working hours. The most recent NCEPOD report demonstrates that 72.5% of hospitals now have a dedicated daytime NCEPOD list but also show that 16.8% of hospitals do not have out-of-hours emergency operating (Findlay et al., 2011). It is not clear whether the reductions in out-of-hours operating produced by NCEPOD lists has resulted in patients with clinical need for urgent or immediate operations being inappropriately delayed until daylight hours. Despite these objective improvements in operating theatre provision, access to operating theatres for EGS is still considered inadequate by 55% of surgeons (Association of Surgeons of Great Britain and Ireland, 2009). The introduction of a dedicated emergency operating list has been associated with a reduction in time to theatre, a reduction in hospital stay and improved surgeons' job satisfaction, however only in a single-site, pre-post study (Stupart et al., 2013, Heng and Wright, 2013).

Consultant surgeon and anaesthetist presence at high-risk emergency operations is recommended by NCEPOD and the RCS. The initial NCEPOD report in 1997 demonstrated that daytime attendance was 54% by consultant surgeons and 56% by consultant anaesthetists (Campling et al., 1997). By 2003 this had risen to 66% and 62% respectively (Cullinane et al., 2003) and in 2011 NCEPOD found that 98.9% of high-risk operations had an appropriate grade of surgeon and 95.3% had an appropriate grade of anaesthetist (Findlay et al., 2011). In contrast to this, the recent network audit of emergency laparotomies has shown that during the daytime only 81% of these high-risk operations have a consultant surgeon present and 75% have a consultant anaesthetist present. In the evening this falls to 68% for surgeons and 55% for anaesthetists and after midnight just 62% for consultant surgeons and 41% for consultant anaesthetists (Saunders et al., 2012). It is not clear which study methodology is producing the more accurate results or how these staffing differences affect the outcomes from these operations.

The intensive care unit (ICU) is a critical adjunct to surgery for EGS patients. Clarke et al. have shown that, in a single centre, patients who have laparotomies and are subsequently treated in intensive care appear to have better risk-adjusted outcomes than those who return to ward care post-operatively (Clarke et al., 2011). Access to ICU beds in NHS hospitals is frequently limited, especially given the unpredictable nature of EGS case volume. Eighty percent of hospitals responding to a recent NCEPOD report had a critical care unit but despite this 44% of surgeons describe transferring 2 or more patients out of their hospital for critical care support each year (Findlay et al., 2011, Association of Surgeons of Great Britain and Ireland, 2009). These findings are however at odds with the emergency laparotomy network's recent assertion that "there was little evidence of a disparity between the availability of critical care resources after emergency laparotomy and the perceived clinical need" (Saunders et al., 2012). Though guidelines for the construction of ICUs suggest that 12% of acute beds should be critical care beds, differing hospital systems and changing healthcare practices over time mean that a set number of ICU beds per hospital is not necessarily practical (The Intensive Care Society, 1997). It is not clear how increasing provision of ICU would affect EGS outcomes.

The RCS standards call for 24 hour access to both diagnostic and interventional radiology. Survey of surgeons shows that 96% have access to 24 hour CT scanning but only 71% have adequate access to CT reporting out-of-hours (Association of Surgeons of Great Britain and Ireland). Similarly, while 95% of surgeons have interventional radiology available during working hours, this falls to 44% outside these times. In addition, the service offered is not comprehensive for 36% of surgeons during the daytime and 79% out-of-hours (Association of Surgeons of Great Britain and Ireland). Though radiology services out-of-hours are not all-inclusive it is unclear whether access to a comprehensive service 24 hours a day would actually improve patient outcomes and what the cost implications of this would be. It is likely that the overwhelming majority of hospitals do not have a sufficient number of patients requiring interventional radiology to make 24 hour provision at every hospital practical or necessary. It may be that "hub and spoke" models of care with extended services provided at a single central hospital will develop as care becomes increasingly centralised.

This brief review of the evidence base supporting some of the structural elements of the EGS service demonstrates the lack of empirical data and conflicting reports of service provision that standards and guidelines are based on. We have little evidence for the efficacy of assessment units, increased access to operating theatres, intensive care and interventional radiology. This is in part due to the difficulty in quantifying the improvement due to a single structure change when so many confounding factors exist. Fortunately, when examining the process of care, controlled studies to demonstrate the effect of interventions are possible.

3.2.3. Processes of care for emergency general surgery

The process of care for EGS patients is highly variable depending on the severity of the illness and the disease process responsible. Intra-operative processes such as the use of the World Health Organisation's Safe Surgery Saves Lives checklist (Weiser et al., 2010) will not be covered in detail in this review because these processes have been studied in much more depth than the peri-operative care that is the focus of this thesis and are often identical to those of high-risk elective surgery. Peri-operative processes for EGS patients include the initial work-up, admission, investigations and diagnosis, followed by the initiation of any non-surgical treatment and pre-operative assessment and optimisation. On-going post-operative care and the teamwork and coordination that are common to all phases of care for EGS patients will also be examined. An extensive review of every individual process of care would be a thesis in its own right and therefore this section of the review will only describe processes that are applicable to the majority of EGS patients and for which there is a significant evidence base.

Efforts to measure the reliability with which these processes are performed will also be examined.

The concept of reliability has been adapted for use in medicine from industry, in particular from systems engineers designing complex industrial applications in which process failures must be minimised. Reliability in healthcare has been defined by the Institute for Healthcare Improvement (IHI) as "failure-free operation over time" (Resar, 2006) and this is an aspect of quality in which healthcare is a long way behind. The majority of healthcare processes run at between 50% and 90%

reliability, a level unthinkable in industry where failure in processes typically occur on 0.001% of occasions. Of course many industrial processes are identical time after time, whereas every patient is different. Nonetheless process reliability in healthcare, where it is measured, is often poor.

Remarkably few EGS processes have robust empirical evidence specific to this group of patients. The best researched field is that of the treatment of sepsis and the key processes are defined in the surviving sepsis guidelines (Dellinger et al., 2008). These include immediate resuscitation of septic patients, appropriate investigations to identify the source, early intravenous antibiotics and control of the source of infection as soon as possible after resuscitation (Dellinger et al., 2008). A recent meta-analysis of studies examining the use of the surviving sepsis guidelines has demonstrated an odds ratio for survival of 1.7 in favour of the guidelines (Chamberlain et al., 2011). The processes that make up the surviving sepsis care bundle form a major part of the RCS guidelines for the care of high risk surgical patients (Royal College of Surgeons of England, 2011b). Unfortunately there is little evidence as to the reliability with which these evidence-based guidelines are applied in the NHS.

Thromboprophylaxis against deep vein thrombosis (DVT) or pulmonary embolism is another process that has been widely researched. Evidence for the efficacy of thromboprophylaxis in elective surgical patients is robust but the evidence in EGS is far less developed. The only randomised controlled trial of prophylaxis in EGS patients was discontinued early but demonstrated a non-significant reduction in DVTs of 65% (Bergqvist et al., 1996). The current National Institute for Health and Clinical Excellence (NICE) guidelines recommend that all acute surgical patients with an inflammatory or intra-abdominal condition should be considered at high risk of thrombosis; this includes essentially all EGS patients. These patients should have mechanical prophylaxis with compression stockings or intermittent pneumatic compression started on admission with the addition of pharmacological thromboprophylaxis for patients without risk factors for bleeding (National Institute for Health and Clinical Excellence, 2010). Two studies, both at single centres, have documented the adherence to these guidelines and this varies markedly between sites (Table 3.2) (McCulloch et al., 2010,

Stevenson et al., 2007). It is this kind of variability in care delivery that may explain some of the differences in outcomes between providers.

Physiological signs play a crucial role in diagnosis and evaluation of EGS patients. The “vital signs” of pulse, blood pressure, temperature, respiratory rate and oxygen saturation allow clinicians to assess the severity of disease and the patient’s response to it. Early warning scores have attempted to amalgamate these signs into a single score that predicts patients at risk of deterioration or in need of intensive care admission. The most frequently used algorithm is the Modified Early Warning Score (MEWS), which was developed in medical patients (Subbe et al., 2001) and has been validated for surgical inpatients (Gardner-Thorpe et al., 2006). It is not clear whether the use of early warning scores improves patient outcomes in EGS but both NICE and NCEPOD have recommended their universal use (Findlay et al., 2011, National Institute for Health and Clinical Excellence, 2007). Both NCEPOD and one independent single centre study (McCulloch et al., 2010) have examined the adherence to these policies and found similar reliability of about 70%.

Reliability of a number of other processes has been investigated in studies examining multiple processes of care for EGS patients (Table 3.2). Unfortunately the majority of reliability research is conducted under the guise of local audit and therefore not published. Work that does make it into the literature tends to be from single sites and only assesses the reliability of single processes. This makes it difficult to get a good idea of the actual variability in practice between EGS units.

Stevenson et al. have demonstrated that it is possible to improve adherence to selected processes of care using a brief questionnaire and generalised feedback (Stevenson et al., 2007). Reliability can be improved even further by issuing detailed job descriptions to surgical staff to clarify their roles and responsibilities. The longevity of the improvements following such an intervention is unknown. An alternative approach to improving processes of care in EGS is the use of quality improvement techniques derived from industry (Nicolay et al., 2012). McCulloch et al. have demonstrated improvements in process reliability using a “lean” intervention, which consists of process mapping, simplification and streamlining of processes, increasing failure visibility and completing Plan-Do-

Study-Act (PDSA) cycles of improvement (McCulloch et al., 2010). In this study lean was associated with significant improvements in process completion that persisted for 10 months after the project was complete. Two processes that were not subject to the lean intervention did not improve in the same time-period but there were no formal control sites in this study.

Table 3.2: Process reliability in emergency general surgery patients

Process	Source of data			
	McCulloch et al. 2010	Stevenson et al. 2007	NCEPOD report 2007 (Martin et al. 2007)	NCEPOD report 2011 (Findlay et al. 2011)
Correct use of thromboprophylaxis	35%	73%	-	-
Correct recording of medications/allergies	47%	75%	-	-
Use of early warning vital signs score	68%	-	-	74%*
Adequate doctor-nurse communication	57%	-	-	-
Correct recording of fluid balance	89%	-	-	94%*
Proper use of alcohol hand gel	23%	-	-	-
Correct use of venous site infection protocol	46%	-	-	-
Correct recording of blood test results	-	88%	-	-
Consultant review within 24 hours	-	-	76%	-
No delay in obtaining investigations	-	-	95%#	-
Admission to an appropriate ward	-	-	92%#	94%*
Clear handover of clinical care	-	-	93%#	-
Appropriate frequency of clinical review	-	-	93%#	-
Appropriate frequency of vital signs assessment	-	-	92%#	-
Adequate consent obtained	-	-	-	77%*
Timely surgery performed	-	-	-	80%

***combined high-risk EGS and elective general surgical patients; #combined medical and surgical emergency admissions**

All processes of care are subject to the teamwork of the healthcare professionals delivering them.

The quality of teamwork has been shown to influence surgeons' technical performance in the operating theatre (Hull et al., 2012) and to affect the outcomes of major surgery (Mazzocco et al.,

2009). The care of EGS patients is a high-pressure and time-limited team enterprise and, though there is little direct evidence of an effect of teamwork on EGS process and outcomes, it is highly likely that such an effect exists, given the weight of evidence in healthcare and other high-reliability organisations (Patterson et al., 2004). Teamwork is crucial in decision making, organisation and execution of healthcare processes (Youngson and Flin, 2010), all of which play a large role in the treatment of EGS patients. Communication plays a significant role in teamwork and around 20% of in-hospital adverse events are attributed to communication breakdowns (Gawande et al., 2003, Greenberg et al., 2007).

A key example of teamwork's effect on the process of care in EGS is found in shift handover between teams of surgeons or nurses. Reduction of working hours for doctors has increased the number of shift changes and hence the number of handovers and opportunities for failure. The effect of teamwork on the quality of handover has been demonstrated in research related to this thesis (Symons et al., 2012). This study demonstrated strong correlation between the quality of teamwork and the overall quality of surgical shift handover. Robust handover is vital for high-quality EGS care as failures at this crucial stage has a knock-on effect on the rest of the processes delivered to the patient.

Very few processes in EGS are initiated, performed and completed by a single individual and those that are often require cooperation and communication with the patient. As a result of this, teamwork between healthcare professionals looking after EGS patients has the ability to affect almost all processes of care. High quality teamwork is therefore vital, both within and outside handover, to maximise the effectiveness of EGS care.

3.3. Conclusion

This literature review provides a flavour of the level of evidence available for the efficacy and effectiveness of EGS care. There are quite good data on outcomes for EGS patients that undergo operations but almost none that reflect all EGS admissions. Mortality and morbidity for emergency

colorectal resection and emergency laparotomy are high and outcomes for elderly patients are particularly poor. Given that this is the most rapidly growing section of the population in the UK, these figures are a cause for concern. There is some evidence of variability in outcomes and, though differences in outcomes appear large, it is difficult to demonstrate that statistical variability between units is any worse than that found in elective surgical care.

Detailed guidelines on the optimal structure of care for EGS have recently been published (Royal College of Surgeons of England, 2011a) but they are largely based upon expert opinion. Multiple staffing patterns for senior surgeons have been proposed but none are clearly better than the others in terms of patient outcomes. Access to emergency assessment units, operating theatres, intensive care and radiology services are all recommended but there are conflicting reports on the current availability of almost all of them and no good evidence that universal access is likely to improve outcomes.

There are a small number of EGS processes with good evidence that they improve outcomes; these including the surviving sepsis guidelines and thromboprophylaxis. Many others such as administration of routine medications and obtaining adequate consent are part of standard care. Nevertheless, there is some evidence of wide variations in the reliability of many of these processes and evidence that adherence can be markedly improved using simple interventions. Though not strictly a process of care, there is an increasing body of evidence that teamwork and communication between healthcare professionals plays a key role in the effectiveness of EGS care by maximising the performance of all team members.

The evidence base for EGS structure, process and outcome is limited and has some obvious areas of deficiency. This thesis will attempt to fill some of these holes and draw together a coherent picture of current quality of care in emergency general surgery in England.

4. AIMS OF THESIS

4.1. Current understanding of emergency general surgery

The previous chapter assessed the available evidence on quality of care in emergency general surgery. Though some areas of EGS are well researched, notable gaps in the literature can be identified. Research into EGS outcomes is largely limited to patients who undergo operations; very little data is available for all admissions or for those patients who have non-operative treatment. Whilst there appears to be some variability in outcomes for patients that have operations it is not clear whether this is down to patient selection or actual differences in performance.

There is a small amount of evidence that newer working patterns have beneficial effects for both patients and staff but this is limited to single centre pre-post studies without controls. Though guidelines have been produced recommending levels of provision for radiology, operating theatre and critical care services, there is little evidence of how changes in these facilities affect patients' outcomes.

Small numbers of care processes for EGS patients have robust evidence linking them to patient outcomes. Reliability of these processes varies between studies and there is little research that compares process completion between institutions. A very large number of processes of care have little to no empirical evidence base and expert opinion plays a large role in many treatment strategies. Inevitably, expert opinion varies somewhat and this may lead to further variability between, or within, EGS units.

4.2. Aims

The aim of this thesis is to use the Donabedian structure, process and outcome framework to investigate quality of care in emergency general surgery in the English NHS. Specific aims are to:

Background

- 1) Gather further background information on the underlying problems in EGS by conducting interviews with staff with experience in treating EGS patients

Outcomes

- 2) Investigate the outcomes of EGS admissions using Hospital Episode Statistics data.
 - In particular examine the outcomes for all EGS admissions, not just those who have surgery, and assess the patient factors that predict poor outcomes.
- 3) Identify any variability in outcomes for EGS admissions between hospital trusts.

Structure

- 4) Investigate variability in structure between NHS hospital trusts using publicly accessible data from the Department of Health.
- 5) Use risk adjusted HES outcomes and structural data to assess which structural factors predict good or bad performance for NHS Trusts.

Process

- 6) Use evidence synthesis and expert opinion to develop a core list of fundamental processes of care for admission of EGS patients
- 7) Use this list to assess adherence to processes of care for EGS patients in NHS institutions and examine variability between multiple sites.
- 8) Utilise direct observation of the process of care for EGS patients to develop an understanding of the type and frequency of process failures in the emergency surgical patient pathway.

Background

5. EXPERT OPINION ON THE QUALITY OF CARE IN EMERGENCY GENERAL SURGERY

5.1. Introduction

The preceding chapters have discussed the relative paucity of research into quality of care in EGS. Whilst the majority of this literature suggests that quality in EGS is poor, there is little empirical evidence that this is actually the case. EGS is a complex service involving many interconnected disciplines and therefore identifying the underlying issues that impair the quality of care can be difficult using simple quantitative research. To develop a comprehensive understanding of quality of care in EGS it is necessary to appreciate the problems that clinical staff face on a day-to-day basis.

This study aimed to explore systematically the problems encountered in the treatment of EGS patients, utilising the experience of the multidisciplinary team who have day-to-day experience of the hospital systems involved. This qualitative study will allow us to identify and prioritise issues in emergency general surgical care for further study.

A formal semi-structured, in situ interview technique was used because it can provide greater breadth and insight into the complex interactions that take place in healthcare than would be possible using a questionnaire or structured interview study (Fontana and Frey, 2000).

5.2. Aims

- Investigate clinical staff's opinions on the quality of care delivered by the EGS service.
- Investigate the interviewee's perception of the function of the EGS service and the deficiencies in that service, with particular reference to the structure and process of care.
- Identify areas that staff consider suitable for potential safety and quality improvements in emergency surgery.

5.3. Methods

5.3.1. Setting

An interview study with qualitative, content analysis, based at an urban university teaching hospital between January and May 2010. All interviews were performed in private, within the hospital, by two interviewers. The researchers for all interviews were a male surgeon with a background in patient safety research (the author) and a female psychologist with experience in surgical safety research.

Ideally an interview study such as this would be conducted using acknowledged experts in the field. Unfortunately, and especially at the time at which this study was conducted, there were few such experts within the NHS (assuming expertise is based on publication in peer reviewed journals, which is also debatable). An additional consideration was the inclusion of a nursing perspective in these interviews. Nursing “experts” are even more difficult to identify and may not be able to reflect practice in many different institutions. As a result, the participants for this study were limited to experienced clinical staff within the institution that the research was conducted. In this way a representative group of staff could be sampled and equal numbers of interviewees from each professional group included. Participants were selected using purposive sampling (Marshall, 1996), in which interviewees are selected to ensure that a range of professions and working environments are represented in the study population. Potential interviewees were approached in-person, briefed on the nature and goals of the study and guaranteed anonymity and confidentiality. Ethical approval to conduct the study as part of a larger emergency surgery quality improvement project was provided by the local research ethics committee.

5.3.2. Interviews

Researchers used a standardised semi-structured interview question guide (Appendix A). This guide was developed based on the review of the literature on safety and quality in emergency surgery conducted in Chapter 3 and by discussion within the research team. After development the

interview guide was validated for both content and face validity, firstly by discussion between the study researchers themselves and subsequently by conducting a pilot interview with an anaesthetic registrar, who was not a participant in the study itself.

Each interviewee was asked to give an anonymous example of an EGS case in which there was an error or adverse event and to describe the outcome. Participants were also questioned on the problems they regularly experienced in providing emergency surgical care, the improvements that they would recommend and any incidents that they had experienced in information transfer and communication. The questions that each interviewer asked were fixed throughout. Interviewees were prompted for further information to complete or expand their answer to each question where necessary.

5.3.3. Data analysis

Interviews were digitally recorded and professionally transcribed. A sample section of each transcription was checked against audio files by the interviewers to ensure accuracy. Interview transcriptions were imported into NVIVO qualitative research software (v8, QSR International, Melbourne, Australia) and analysed for common themes between interviews using the constant comparative technique (Glaser and Strauss, 1967). This technique involves assimilation of interviews and development of a theme coding strategy, usually by multiple investigators and in this case by the two interviewers. The coding strategy was finally applied independently to all interviews by both researchers, who used the NVIVO software package to highlight sections of transcript corresponding to one or more themes. Formal inter-rater reliability analysis is not possible with this type of qualitative analysis but coding was compared between the two raters and disagreements were resolved by consensus. Results were formulated by examination of the transcript segments coded to each theme and illustrative quotes were taken from these highlighted transcript segments.

Analysis of these interviews indicated that no new themes were introduced by the latter participants, a situation known as theme saturation (Marshall, 1996), and therefore further interviews were not pursued.

5.4. Results

There were eighteen study participants, equally divided between registrar and consultant level surgeons, theatre and intensive care based anaesthetists and theatre and ward based nurses (Table 5.1). All participants approached agreed to be involved in the study. Mean interview duration was 36 minutes and ranged from 17 to 68 minutes. All participants completed all interview questions.

Table 5.1: Profession, gender and experience of interviewees

		Time in Current Role	
Profession	Sub Group	Sex	(Years)
Surgeon	Consultant	M	6
		M	6
		M	2
	Registrar	M	6
		F	3
		M	1
Anaesthetist	Intensive Care Consultant	M	9
		M	8
		M	4
	Theatre Consultant	M	10
		F	4
		M	3
Nurse	Ward	M	10
		F	8
		F	8
	Theatres	F	17
		F	8
		F	5
Mean: 6.6			

Interview themes identified by the coding strategy fell into one of three broad categories; Structure, for example staffing levels and hospital layout; Process, such as failure to recognise sick patients and delayed diagnosis; and Teamwork, including leadership, coordination and communication between team members, between teams and with patients (Figure 5.1).

Figure 5.1: Major themes that interviewees considered contribute to failures during emergency surgical admissions.

Structure	Process	Teamwork
<ul style="list-style-type: none"> • Access to critical care beds • Access to theatres • Staffing levels • Hospital environment 	<ul style="list-style-type: none"> • Diagnosis • Recognition of unwell patients • Prioritisation 	<ul style="list-style-type: none"> • Communication <ul style="list-style-type: none"> o Within teams o Between teams o With patients • Leadership • Coordination • Handover

5.4.1. Structure

Structural factors play a large role in errors and adverse events in healthcare (Calland et al., 2002, Vincent et al., 2004) but evidence base for the optimum structure of an EGS service is limited, as discussed in Chapter 3. Interestingly, structural factors were not often mentioned as root cause of error by participants but as a general annoyance of their everyday work patterns. A variety of structural factors were discussed by interviewees including access to critical care beds, access to operating theatres, staffing levels and the layout of the hospital itself.

5.4.1.1. Access to critical care beds

Lack of access to intensive care and HDU beds was a recurring theme of the interviews, discussed by 14 participants. A small number of physical beds and problems recruiting and training nursing staff were common themes. Anaesthetists, in particular, felt that the care of surgical high dependency patients fell between the intensive care team and the surgical team, with neither having satisfactory “ownership” of units and patients. One participant gave an interesting opinion on planning for emergency admissions and the difficulty in being both efficient and flexible:

“...invariably it’s capacity in ICU that’s the issue ... it’s just about trying to make sure that you’ve got some wiggle room all the time ... there are inefficiencies that people cling to because they create flexibility in the system so that we know we can deal with the unexpected.”

Intensive Care Anaesthetist

Current political focus in the NHS is based on increasing efficiency but, as this quote demonstrates, small inefficiencies allow the system to adapt to the variable demand that emergency care places on it. This is the case for hospital beds and theatre space as well as for critical care.

5.4.1.2. Access to emergency operating theatre space

Ten participants, including five of the six surgeons, identified difficulty getting operating theatre space as a cause of delays. Surgical registrars in particular complained of difficulty organising emergency operations, especially for less urgent cases such as abscesses. Afternoon and evening emergency operating lists were seen as being particularly problematic because overrunning elective work and lack of staff can lead to a cascade of delays. Participants noted that some cases booked onto the emergency operating list were actually elective cases that had been cancelled due to lack of

time on their original list. These procedures may delay less urgent emergency operations, increasing the length of hospital stay for such cases.

5.4.1.3. Staffing Levels

Staffing levels were mentioned by twelve participants as a regular problem. A lack of staff seemed to affect both doctors and nurses. Interviewees felt that, in most cases, staff muddled through these issues and coped with the staff available. The majority of staff shortages occurred out of hours and did not regularly affect the care of elective patients and therefore these staffing issues were often not given high priority by hospital management. Participants described units with a high turnover of nursing staff that developed a poor reputation within the hospital. This then made it very difficult to recruit nurses to these positions.

5.4.1.4. Hospital Environment

The hospital environment was discussed by nine interviewees as a factor in delays and waste of staff time, both in terms of the location of departments and also the location of patients around the hospital due to shortage of beds. Anaesthetists in particular highlighted difficulties in moving patients around the hospital for radiological investigations, to theatres and so on. All interviewees recommended theatres and critical care to be in close proximity to one another and for A&E and imaging departments to be close together. Participants felt that having these departments spread out leads to delays and risks when moving unwell, potentially unstable patients. Surgeons were concerned about the spread of EGS patients across multiple wards due to bed shortages.

Participants felt that patients on non-surgical wards had less good outcomes than those on dedicated surgical wards and that there is a risk of losing patients due to regular patient movement from ward to ward. This is reflected in the recommendations of the recent NCEPOD emergency admissions report which suggest all patients are admitted to a suitable ward and that patient transfers are minimised (Martin et al., 2007a).

5.4.2. Process

5.4.2.1. Diagnosis

Incorrect or delayed diagnosis was often cited as a problem, especially in the sickest patients.

Intensive care anaesthetists in particular recognised this as a problem and trauma patients were identified as being at high risk as less obvious injuries may be missed by clinicians focussing on more major injuries. Inaccurate interpretation of imaging, especially overnight, was highlighted as one of the causes of misdiagnosis but CT scanning was also advocated by some participants as a way of verifying diagnoses. Participants suggested that incorrect diagnoses usually only increased the patient's length of stay, however occasionally it was "critical".

5.4.2.2. Recognition of sick patients

Recognition of sick patients and appropriate escalation of care was identified by interviewees as a serious problem, especially by senior anaesthetists. Fifteen participants identified this as an issue and the three who did not were all theatre nurses:

"I mean identifying sick patients is actually, most of the time, quite simple, we just have to believe the vital signs ... I remember when I was a medical SHO, counting an asthmatic patient's respiratory rate which was 50, believing that that was impossible and writing down a different number."

Intensive Care Anaesthetist

Participants felt that junior doctors were often poorly supported but also failed to involve their senior colleagues at an early enough stage of patient's care. This may be because they feel that they can't be seen to be unable to cope or because they lack the experience to identify sick patients at all.

Ward nurses felt that there were too many grades of doctors, each handing responsibility only one level up the chain. This may lead to multiple reviews and long delays in treating acutely unwell patients. Several interviewees cited shorter working hours and the European Working Time Directive for a perceived reduction in the experience of junior medical staff and therefore an inability to recognise sick patients sufficiently early.

5.4.2.3. Prioritisation

Participants' opinions on the relative priority given to elective and emergency patients varied across the group. All agreed that life threatening emergencies took priority, however "urgent" cases often needed to wait for theatre time. There was an overall feeling that the institution prioritised elective surgery over emergency surgery and that staff would be taken away from the emergency theatre to staff elective ones if necessary:

"everybody focuses on getting the elective lists done, to the point where sometimes, they're doing elective cardioversions and we're trying to do proper emergency laparotomies and it's 'no, no, you have to wait until the cardioversions have been done.'"

Surgical Registrar

5.4.2.4. Handover

Handover was another area where there was a perceived weakness and propensity for error. It was discussed by nine participants, including five of the six surgeons. Some interviewees felt that this had been exacerbated by increased shift-working amongst junior doctors, which increased the number of handovers required. Several surgeons gave examples of handover errors or omissions and

identifying which patients to handover was generally perceived to be a greater risk than the handover itself. Participants explained that EGS patients were often spread around the hospital on a number of different wards, which made nursing involvement in handover impractical. Written handover was also identified as a point of weakness both following operations, for example in theatre notes and medication charts, and for ward patients from their normal doctors to the weekend team.

“...it should be handed over and it should be clear to everybody and if there are any queries they should, you know, investigate it, read the notes and read the operation note and do all the right things. But sometimes things aren't in the right place. Sometimes things aren't handed over. Assumptions are made.”

Surgical Registrar

5.4.3. Teamwork

All but one interviewee had discussed teamwork as a cause of error prior to the interview question on this topic, suggesting that problems in this area were a common occurrence.

5.4.3.1. Communication

Inadequate communication was the most frequent cause of errors and adverse events in EGS described by the interviewees and it was discussed by all participants. Communication failures between staff members were perceived to be common and occurring within the surgical team as well as between teams. The majority of the communication failures described were of verbal communication, particularly between nurses and doctors or between different speciality teams.

Participants generally felt that communication was of variable quality both in an elective and emergency setting. Communication failures occurring within the immediate team were discussed by

fifteen interviewees. Participants felt that communication between doctors and nurses could be improved:

"I suppose it's this divide that seems to be there between doctors and nurses, you know, it's an invisible thing but it seems to be there, you know, you hit this plastic and nobody can sort of, go through it..."

Ward Nurse

Friction between doctors and nurses may develop because of the very different roles they fulfil and the different cultures of the two professions. Ward nurses complained of conflicting instructions from multiple doctors for three reasons. Firstly, medical staff rarely read previous entries in the casenotes, especially when giving verbal instructions; secondly, these instructions may not be documented; finally, communication between doctors within a team can be impaired because their various tasks mean that they are physically separated and not all team members are fully up to date with all patient plans at all times.

Nine interviewees, including all surgical registrars and four out of six nurses perceived a problem with written communication as discussed above and in the handover section of these results. Incomplete or absent consent forms occasionally cause problems and written documentation of plans for patients was sometimes poor.

Communication failures within the wider hospital multidisciplinary team were mentioned by nine of the twelve ward based staff but only one theatre based anaesthetist and no theatre nurses, possibly because the theatre teams are more self-contained, and have less need to liaise with teams in the wider hospital than the surgical teams do. In spite, or perhaps because of this, communication regarding emergency operating lists was considered to be particularly problematic. This was in part because identifying and contacting the people responsible was difficult. For this reason interviewees

described cutting corners to make the system work more efficiently but simultaneously increasing the risk to the patient.

Communication between staff and EGS patients was also seen to be problematic and was mentioned by all participants, though the consequences of error in this area were less severe. Several participants felt that staff to patient communication for surgical emergencies was more involved than in an elective setting because they were less prepared, often unwell and regularly in a life threatening situation. One participant highlighted particularly difficult situations:

“...there are two different areas where you get a problem, one is where people are given unrealistically favourable expectations of outcome from surgery...The other one is where the patient doesn’t want the operation that they clearly need.”

Intensive Care Anaesthetist

Participants felt that doctors may approach communication with EGS patients in a routine fashion, not appreciating the importance of this event to the patient. Communication problems between staff and patients about the timing of emergency operations were frequently described. Emergency operating lists usually prioritise based on clinical need but either patients did not understand the prioritisation system or they had not had it explained to them.

5.4.3.2. Leadership

All interviewees, with the exception of two ward nurses, described poor or absent leadership as a cause for errors and adverse events, particularly in a crisis situation.

“...when there are a number of senior people the communication may break down because you're not quite sure who the team leader is”

Theatre Anaesthetist

A number of clinicians gave examples of poor leadership that they had experienced. An overall lack of leadership was also considered to be a common occurrence. More senior doctors expressed the opinion that junior doctors sometimes did not take responsibility for their patients and conversely more junior staff felt that they lacked the authority or ability to effect change within the organisation. Short rotations for junior doctors also act as a disincentive to make changes even when a system is clearly inefficient or unsafe. In situations in which clinical leadership was lacking, twelve participants felt that apathy quickly took over and this often resulted in delays:

“...often in hospitals, there's not a culture of 'Let's go and help them out.' There's a culture of, you know, 'I'm not getting involved. It's not my problem.'”

Surgical Registrar

5.4.3.3. Coordination

Coordination of personnel and resources was seen to be crucial to the immediate management of surgical emergencies and was covered by thirteen interviewees. Participants described difficulties getting emergency patients seen by the appropriate staff, for example as part of a pre-operative workup or initial patient treatment. This relates, in part, to the difficulties in communication between teams described in section 5.4.3.1.

Coordination of team members for procedures requiring multiple personnel also causes problems and can lead to delays:

“...everybody runs and when you get there, if you look at the statistics you've got to wait 30 minutes, 40 minutes, an hour for the surgeon or anaesthetist or someone before you actually start. So you are held up in theatre for an hour and you could have ... utilised the staff and organised the staff better”

Theatre Nurse

Participants discussed problems coordinating facilities, particularly in the light of increasing demands for efficiency.

5.4.4. Training

Training and simulation were frequently brought up by interviewees as a way of reducing error, particularly for staff new to the hospital or department. Training was discussed by 17 interviewees and five participants advocated multidisciplinary team training over and above role specific training. The necessity for robust induction for new junior doctors was emphasised, especially as individual posts are increasingly short.

A number of participants discussed the fast turnover of junior doctors as they move from one speciality to another and from hospital to hospital. This rapid turnover makes formation of good teams difficult and reduces familiarity between teams that regularly communicate with each other. It also reduces junior doctor's exposure as they are usually protected by more senior staff during the early part of each post. Simulation training using all members of the healthcare team was also recommended and nurses in particular advocated multidisciplinary training as a way of improving teamwork.

"I don't think we should be doing any sort of crisis training that doesn't involve multidisciplinary training because we having been doing simulations here now for over seven years, what comes out quite clearly is if you do single speciality training, it veers very much towards technical skills. You can talk about non-technical but it's interesting, it doesn't...it doesn't pervade quite the same way. Whereas if you have multidisciplinary teams, it's amazing, you'll see every cliché, you know, every disaster occurs."

Theatre Anaesthetist

5.5. Discussion

Using semi-structured, in situ interviews, this study has assessed the attitudes and beliefs of the surgical multidisciplinary team in relation to the vulnerabilities and risks in the care of emergency surgical patients. Three overarching themes emerged from the interviews and the causes of error described fit well with the Donabedian paradigm of quality in healthcare (Donabedian, 1966).

Participants described problems with the local structure and environment, with the process of care and with teamwork, all of which interconnect and affect each other and the overall outcome for patients.

Structural factors were regularly mentioned as a cause of sub-optimal care by participants but clinical staff rarely perceive the structure of care to be remediable, at least individually. Very few participants recommended changes to the structure of care; they appeared to consider it out of their control and the prevailing attitude was one of "making do" with the structure available.

Access to critical care facilities, particularly high dependency unit beds was sometimes difficult.

Access to operating time in theatre and delays incurred due to the sub-optimal hospital environment

were also perceived to be a problem by participants. Issues with staffing levels for doctors, nurses and operating department staff were highlighted by interviewees.

In contrast to the structural issues highlighted, interviewees felt strongly about many process issues and were more engaged in trying to remedy problems in this area. Incorrect or delayed diagnosis and failure to recognise sick patients featured regularly as causes of error, particularly from intensivists and other senior anaesthetists, probably because they are the professional group most frequently exposed to the aftermath of this type of error. Theatre nurses did not identify recognition of sick patients as a cause of error but, unlike the other staff in this study, they do not work in a ward environment. Diagnosis and recognition of sick patients are key to the initial treatment of emergency surgical patients and so the fact that interviewees singled these processes out as vulnerable to error is concerning.

Prioritisation between elective and emergency patients was sometimes difficult according to participants and some described an institutional culture that has a preference for elective patients despite all interviewees expressing the importance of priority for emergency surgery. Surgeons in particular were concerned about the robustness of handover. Handovers between doctors and between nurses rely heavily on all the aspect of team skills mentioned by the participants and so, not surprisingly, are prone to error. A separate study into teamwork in surgical shift handover, conducted concurrently with the research in this thesis, has identified strong correlation between the quality of teamwork skills and the completeness of handover (Symons et al., 2012).

Poor teamwork was the most frequently mentioned cause of errors and adverse events in emergency general surgery. Participants illustrated problems as a result of poor communication, leadership and coordination. Communication issues were the most frequently discussed failure mode and included written and verbal communication between staff as well as from staff to patients. Written communication appeared to be most important to surgical registrars and nurses, perhaps reflecting their increased use of this type of communication compared to other participants. Staff based outside the operating theatre perceived problems with communication between teams,

however this was only an issue for one theatre anaesthetist and no theatre nurses, possibly because there is limited communication by these staff outside the immediate theatre team.

Interviewees described the importance of good leadership, not only in terms of averting adverse events, but also to ensure efficiency and productivity and to avoid delays. Lack of a shared mental model between team members, leading to delays, was a common theme.

Overall, participants felt that failures in teamwork skills were the greatest threat to patient safety in emergency general surgery. It was particularly noticeable that the examples provided by interviewees were mainly between professional groups, rather than within the same team and one of the error reduction strategies proposed by participants was multidisciplinary team training. Team training in healthcare has evolved from the Crew Resource Management (CRM) training used in aviation and is becoming increasingly popular (Cooper and Taqueti, 2004). Team training has been shown to develop teamwork skills but improvements in patient outcome have not yet been demonstrated (Weaver et al., 2010, Nagpal et al., 2010b).

A recurring theme of the interviews was the brevity of junior doctor rotations. This adversely affects the development of teams themselves and complicates communication between teams due to lack of familiarity. In addition junior doctors, who should be the catalyst for changes in the process of care, have no incentive to initiate improvements because they will not see any benefit (Pronovost, 2011).

The great majority of surgical safety research to date has been conducted in the operating theatre however intra-operative errors were barely mentioned by the interviewees in this study. Far greater concern was raised about the quality of admission and on-going ward care, particularly with respect to acutely unwell patients. It is clear that further research into the safety and quality of care for EGS patients during the admission and ward phases of care is warranted.

5.5.1. Limitations

This study was conducted at a single site and therefore it is difficult to ascertain whether these are universal problems or specific to the hospital in question, however many participants had experience of multiple hospitals, both in the NHS and in other countries. Many, if not all of the problems discussed here will be familiar to those providing emergency surgical care in the NHS and they echo the anecdotal reports published elsewhere (Association of Surgeons of Great Britain and Ireland, 2007). Sampling of interviewees was not random, however it was very important to get a variety of viewpoints by including many different members of the multidisciplinary team and this is an accepted methodology for qualitative research such as this (Marshall, 1996). Interviewees were approached in person by the interviewers and most were known to one or other of the interviewers in advance. This may have biased the results and some interviewees may have felt obliged to participate based on their previous experience of working with the research team. Staff that felt obliged to participate (despite an opt-out being provided) may have given biased responses.

5.6. Conclusion

This systematic investigation of system failures in emergency general surgery has identified problems with the environment that this care is provided in, with clinical processes and with teamwork skills. The qualitative nature of this study has provided great insight into the issues faced by the clinical team treating EGS patients and highlighted a number of areas for further study. In particular, the effect of NHS Trust structure on outcomes will be investigated in Chapter 8; the performance of basic processes of care, including diagnosis, will be examined in Chapter 10; and the role that communication failures and delays have in the aetiology of process failures will be discussed in Chapter 11.

Investigation of the structure and process of care on a large scale however, requires patient outcomes to benchmark against. In order to do this the following chapters will discuss EGS outcomes in the NHS.

Outcomes

6. INTRODUCTION TO HOSPITAL EPISODE STATISTICS

Patient outcomes are the yardstick by which hospitals and individual clinicians are most frequently compared, particularly in the lay press. To patients and their clinicians the individual's outcome is crucial. As such, outcomes are a particularly important part of the quality of healthcare and, if there were fewer confounding factors, we might not need to measure any other aspect of quality at all. Unfortunately, as discussed in Chapter 2, the patient's age, co-morbidities, sex and the severity of the disease process all play a part in determining outcome. This makes assessment of outcomes difficult and requires data on large numbers of patients and sophisticated statistical techniques to unravel the extent to which outcome can be attributed to any particular factor. The use of this type of data to assess outcomes is the subject of this section of the thesis.

6.1. Measurement of outcomes

Measurement of outcomes requires collection of data on individual patients. As discussed, because patients are very variable, reliable measurement of outcomes requires large numbers of patients to be included in any outcomes data set so that valid conclusions can be drawn. There are a number of ways that this type of data can be collected, with advantages and disadvantages to each. This chapter will describe the data source used in this thesis and discuss the pros and cons of potential alternatives.

6.2. What are Hospital Episode Statistics?

Hospital Episode Statistics (HES) is a data warehouse containing details of all admissions to NHS hospitals in England (Hospital Episode Statistics, 2010). It includes details of all inpatient episodes from 1989 onwards and has information on about 14 million admissions per year. Each admission in HES is a single record or 'spell', divided up into 'episodes' of care, each under a named consultant. For example a patient spell might be divided into an episode under the care of a surgeon and

another in intensive care. HES records contain demographic and diagnostic information, procedures and operations performed during each episode in the patient's stay as well as outcome data regarding in-hospital death and length of stay for the whole spell.

Demographic information on patient age, gender and ethnic origin is available, as well as the postcode in which they live and the treating NHS Trust. In addition to this basic information a number of additional data fields are derived, based on the core data set. For example, the Carstairs index of deprivation is calculated based on the patient's home postcode, divided into population weighted quintiles (Carstairs and Morris, 1989). This index has been validated for use in surgical database research and has been widely applied to HES data (Hole and McArdle, 2002, Faiz et al., 2009). The data available to our research group keeps the Carstairs score but removes the original postcode to aid anonymity.

Diagnostic information in HES uses the International Classification of Diseases 10th revision (ICD-10) system to populate a primary diagnostic code and up to 13 secondary diagnosis codes. Secondary diagnosis codes are used for pre-existing co-morbidities as well as complications that develop during a patient's hospital stay. The Charlson index of co-morbidity is a weighted index that takes account of the number and severity of comorbidities to aid stratification and risk adjustment of longitudinal studies (Charlson et al., 1987). This index is calculated using the secondary diagnostic codes from HES and has also been validated for use in surgical patient groups (Charlson et al., 1994). While much useful information can be derived from the administrative data in HES, the database does not contain any clinical information on stage or severity of disease.

Operations and procedures in HES are classified according to the Office for Population, Census and Surveys classification of surgical operations and procedures, fourth revision (OPCS-4). There are up to 12 operative or procedural codes per record and date of intervention is available for each one. HES also contains data on the mode of admission (elective vs non-elective) and the destination on discharge.

Data is collected by individual hospitals and submitted to a central repository called the Secondary Uses Service. The Secondary Uses Service takes snapshots of their database each month and these are uploaded to HES. At the end of each financial year the data is refreshed to incorporate any changes made by providers and the years' data is finalised. Data years in HES run from the 1st April to 31st March, mirroring trusts' financial years. Once the end of year data refresh is performed HES data is fixed (Hospital Episode Statistics, 2010).

6.3. Data quality

Data submitted to HES inevitably contains errors as it is created by coders at individual institutions. Whilst the quality of data submitted to HES has improved year by year (The Audit Commission, 2010), it is necessary to perform both automated and manual cleaning of the data. Automated cleaning looks for common and obvious data errors and tries to correct them. For example, records in which a patient's date of birth is recorded as being prior to 1st January 1885 have this date changed to 'invalid'. Automated cleaning also adds several fields to each record based on existing data. For instance this includes addition of Strategic Health Authority based on postcode and 28-day readmission if the same patient has another record in the database within 28 days of discharge. Manual cleaning deals with more complicated changes to the data such as remapping obsolete ICD-10 or OPCS-4 codes or, for example, where NHS trusts have merged or split (Hospital Episode Statistics, 2010). Manual cleaning is also used to identify and remove duplicate records.

Unfortunately, even after cleaning, the data in HES is not perfect. Coders at individual institutions must convert clinical notes of variable quality into reproducible codes with a minimum of errors. Standards for clinical coding are maintained by a structured programme of training and exams for coders and through regularly updated coding guidance (NHS Connecting for Health, 2012). Quality of coding at NHS trusts is regularly checked by The Audit Commission, who have found that the quality of coding has improved over time (The Audit Commission, 2010). In 2007 the average number of clinical coding errors at NHS trusts was 16 percent. In 2010 this was found to have fallen to 11

percent and the discrepancy between the best and worst trusts had also reduced (The Audit Commission, 2010).

Fortunately the most useful and important pieces of information are those that are most likely to be coded correctly. In-hospital mortality is the most reliable statistic and has been shown to be over 99 percent accurate (Holt et al., 2012). Accuracy of the primary diagnostic code has improved from 74 percent to 96 percent following the introduction of 'Payment by Results' by the Department of Health in 2002 (Burns et al., 2012). Payment by Results is a system of reimbursement for NHS Trusts based on the diagnosis and complexity of each patient treated (Department of Health, 2011). Accuracy of coding for procedures and operations has remained static at about 84 percent according to a recent systematic review (Burns et al., 2012), however The Audit Commission data suggests that accuracy is improving in this field as well, up to 90 percent accurate in 2009/10 (The Audit Commission, 2010).

6.4. Alternatives to Hospital Episode Statistics

HES is a comprehensive administrative database that can be used for outcomes research in England but it is subject to limitations of accuracy described above and lacks any clinical data. Unfortunately there are limited alternatives to its use. There are a number of voluntary, disease specific registries such as the National Bowel Cancer Audit that could be used to generate data on emergency surgery, with the advantage of the addition of some relevant clinical data such as stage of disease. This data set has however demonstrated variable reporting of emergency status, which would prevent its use for analysis of the patients needed for this thesis (National Bowel Cancer Audit, 2010). In addition it has been shown that those units that submit data to voluntary registries have significantly better outcomes than those that do not (Almoudaris et al., 2011a) and therefore the use of a voluntary submission dataset for outcomes research may introduce bias.

Clinical datasets with rigorous sampling of inpatient workload have been developed, the main example being the National Surgical Quality Improvement Project (NSQIP), initially developed by the

Veterans Affairs healthcare group in the United States and subsequently taken up by the American College of Surgeons (Khuri et al., 1998). This database consists of a sample of patients undergoing operations at each hospital and data is collected by trained nursing staff. Significant volumes of clinical data on severity and acuity of disease are recorded and this has allowed accurate risk-adjustment of patient outcomes. The introduction of NSQIP resulted in a 27% reduction in mortality for major surgery in Veterans Affairs hospitals within six years of its inception (Khuri et al., 2002) and is now used by more than 400 hospitals in the United States alone. Unfortunately there is no equivalent to NSQIP in the UK. The majority of datasets that include clinical information are limited to single site studies, though development of multicentre audits of, for example, emergency laparotomy are under development (Saunders et al., 2012).

The biggest problem faced by researchers interested in clinical outcomes in EGS is the exclusion of patients who don't have an operation from data sets such as NSQIP. This introduces a large element of bias because surgeons do not all have the same criteria for offering patients an operation. Risk-averse surgeons or hospitals will appear to have very good outcomes as they only operate on very fit patients. Conversely those surgeons or hospitals offering operations to borderline candidates may seem to have very poor outcomes. Outcomes for patients having operative treatment are unlikely to reflect outcomes for all EGS patients admitted to a hospital. For this reason it is important to assess outcomes for EGS based on all admissions to hospital, rather than just those who have an operation.

The only data on EGS in the UK that avoids bias due to either voluntary submission or patient selection is HES and therefore, despite its limitations in terms of accuracy and lack of clinical information, it remains the most useful data set available for the study of emergency surgery in the UK. HES was therefore the data set of choice when trying to examine variability in EGS outcomes for this thesis.

The following chapters will describe selection of a suitable cohort of patients for the study of EGS outcomes. Selection of such a group will allow investigation of the patient demographics presenting

to the EGS service, analysis of the patient specific variables that affect outcomes and assessment of the performance of included NHS Trusts compared to one another.

7. OUTCOMES AND VARIABILITY IN OUTCOMES FOR EMERGENCY GENERAL SURGICAL ADMISSIONS

7.1. Introduction

Chapter 6 has discussed the appropriateness of Hospital Episode Statistics (HES) for analysis of EGS outcomes in England as well as the paucity of suitable alternatives for EGS research. While HES lacks clinical data to risk adjust the severity of patient's condition it does have the advantage of including all admissions to NHS Trusts in England. This chapter will describe the selection of an appropriate cohort of EGS patients and the results of a study of mortality, length of stay and readmission rates for these patients. Finally, risk-adjusted outcomes data will be used to examine the performance of NHS Trusts compared to one another.

7.2. Methods

Data for this study was obtained from the Dr Foster Unit at Imperial College London, which is part of the Centre for Patient Safety and Service Quality. In addition to the supervisors of this thesis, this study was performed in collaboration with Professor Paul Aylin and Dr Alex Bottle from the Dr Foster Unit and supervised by Mr Omar Faiz from the Department of Surgery and Cancer at Imperial College. All data manipulation, analysis and interpretation was performed by the author with technical assistance from Mr Alex Almoudaris. Professor Aylin, Dr Bottle and Mr Faiz provided supervision and assistance in data interpretation.

This study was approved under Section 251 of the NHS Act 2006 by the National Information Governance Board for Health and Social Care and by the South East Research Ethics Committee.

7.2.1. Selection of EGS cohort for investigation

HES has approximately 14 million finished admission episodes per year of which about 5 million are emergencies (Hospital Episode Statistics, 2010). These episodes are split across all ICD-10 codes and include adults and children. To make sense of this data it was necessary to define a cohort of patients that represent EGS so that their outcomes could be investigated.

A time period for the date of discharge of 1st April 2000 to 31st March 2010 was chosen for the study because 2009-10 was the last year for which a full data set was available and because a 10 year data series would provide a useful volume of data to examine without becoming unmanageably large. In addition, starting the study period in 2000 avoided the worst of the coding inconsistencies that occurred before this point in time. Year of discharge, rather than admission, was used to determine inclusion because this is the original data field in HES and therefore has better accuracy than a derived admission date.

The study population was limited, in the first instance, to adult patients presenting as an emergency. Adults were defined as patients with an age of ≥ 18 years on the day of admission. The emergency code in HES covers a number of different admission types, including GP referrals, admission from hospital clinics and self-presentation to an emergency department. As such it can be better described as 'non-elective' however, for the purposes of this study the emergency code was the only practical way to differentiate between elective and emergency patients. This approach to selection of emergency admissions in HES has been widely used and published (Aylin et al., 2010, Faiz et al., 2010b).

Selection of ICD-10 diagnostic codes for inclusion was performed in stages. Diagnoses assigned for the first diagnostic field of the first episode of each spell were the only ones used to determine inclusion or exclusion. This was done to ensure that only patients admitted with EGS diagnoses were included in the study cohort and so that those who developed, for example, bowel ischaemia, while an inpatient were not considered. Subsequent episodes of care within the same spell were however

used to identify patients that had had intra-abdominal operations at some point during their hospital stay.

The primary outcome measure used in this study was mortality because this is the most relevant outcome for doctors and patients and because it is the most reliably coded outcome in HES (Holt et al., 2012). To facilitate the study of variable mortality rates it was necessary to exclude diagnoses with a low risk of death to avoid large amounts of confounding data and an unmanageably large data set. Low-risk diagnoses with a 30-day, in-hospital mortality rate of less than 5% were therefore excluded, based on published definitions of high-risk surgery (Pearse et al., 2006, Royal College of Surgeons of England, 2011b).

The aim of this study was to investigate the care of those patients that routinely present to the EGS service for first line treatment and therefore diagnoses that occasionally require surgery but more routinely present to another speciality (for example, upper gastrointestinal haemorrhage, which is usually treated by physicians) needed to be excluded. This was done by examining the “main speciality” code, which describes the primary speciality of the treating consultant for each episode. Diagnoses for which less than 35% of patients had been seen by general surgery as the main speciality for one of their inpatient episodes were excluded. This cut-off was determined by discussion between the author and the supervisor for this analysis (Omar Faiz) and based on a level that balanced the inclusion of diagnoses that mandate surgery (largely perforation of hollow organs) with the exclusion of diagnoses that are generally not treated by surgeons, such as upper gastrointestinal bleeding.

ICD-10 is split into groups of diagnoses by region of the body. EGS primarily deals with diagnoses confined to the abdominal cavity and organs. As discussed in Chapter 1, this thesis has not considered vascular, urological, gynaecological or trauma diagnoses and therefore ICD-10 codes for abdominal conditions cover the vast majority of the remaining EGS workload. To simplify the analysis in this study, only codes in the abdominal diagnoses section of ICD-10 were considered for inclusion. Examination of data from other sections of the ICD-10 coding scheme would have required

the assessment of many millions of cases, with little likelihood of finding any other high volume diagnoses that fulfil the criteria laid out above.

The final criterion applied to the data set was based on the NHS trust at which treatment was conducted. A large number of non-acute NHS trusts had a small number of EGS cases assigned to them in HES. These included mental health and social care trusts as well as ambulance trusts and sub-specialty hospitals dealing with, for example, paediatrics, orthopaedic surgery, neurology and women's services. Clearly these trusts are not comparable to large general acute trusts and therefore data relating to all trusts with less than 500 admissions over the study period (50 per year, approximately 1 case per week) were excluded.

7.2.2. Operative interventions in emergency general surgery

Office of Population, Census and Surveys classification of operations and procedures, version 4 (OPCS-4) is used by HES to record the operations each patient has undergone during their inpatient stay. There are a maximum of 12 possible entries per episode of care. OPCS-4 codes corresponding to intra-abdominal operations were used to identify patients that had had intra-abdominal operative treatments during any of the episodes of their inpatient stay. The OPCS-4 codes considered to represent intra-abdominal operations were developed based on discussion between the author and the supervisor for this section of the thesis (Omar Faiz) and can be found in Appendix B.

7.2.3. Statistical analysis

As discussed in Chapter 2, logistic regression is a statistical methodology used to determine the independent contribution of variables such as age and sex to the risk of mortality. The results of this logistic regression can then be used to "risk adjust" the mortality for a group of patients, such as those treated at a specific NHS trust, in order to compare their mortality with a group of patients treated at a different trust. In this way the influence of the variables used in the logistic regression model can be accounted for, even though one trust might have treated many more men, or much older patients than the other.

A binomial logistic regression was performed using categorical, patient specific variables to examine 30-day in-hospital mortality. Continuous variables to be included in the model were divided into categories based on original HES data. For example, Charlson index of co-morbidities was divided into two categories, those with a score of zero to two and those that scored three or more. Similarly, patients were divided into age ranges from 18-59, 60-69, 70-79 and 80 and over. These values were chosen aiming for a rough doubling of crude mortality between each group and to ensure groups with approximately even numbers of patients in each. Univariate logistic regression was performed for each variable to assess its suitability for inclusion in the multivariate model, with a cut-off of $p=0.10$ as a maximum limit. Logistic regression was performed using the backwards likelihood ratio method as this is least likely to result in variables being incorrectly discarded from the final model (Field, 2009).

All statistical analyses were performed using IBM SPSS Statistics v.19 (IBM Corporation, Armonk, New York). Funnel plots were created using tools available from <http://www.erpho.org.uk/topics/tools/funnel.aspx> using a normal approximation to the Poisson distribution for control limits. Funnel plots are a graphical method of representing performance data in healthcare (Mayer et al., 2009).

7.3. Results

The inclusion and exclusion criteria resulted in a cohort of 367,796 patients representing high-risk EGS admissions. A final list of included ICD-10 codes, with similar inclusion and exclusion data can be found in Table 7.1. Appendix C details all excluded abdominal ICD-10 codes, with accompanying 30-day, in-hospital mortality and the proportion of patients treated by a surgeon.

For ease of analysis and to aid comprehension of the data, included ICD-10 diagnoses were amalgamated into logical groups; these included hernia diagnoses, various causes of bowel obstruction and problems with gastrointestinal (GI) ulcers (Table 7.1).

Table 7.1: Included diagnostic codes and inclusion criteria

ICD-10 Code and Diagnosis	Number of Cases	30-Day In-Hospital Mortality (%)	Proportion Treated by Surgeons (%)
Gastrointestinal Ulcers			
K25.1 Gastric ulcer, acute with perforation	1254	23.60%	89.63%
K25.2 Gastric ulcer, acute with both haemorrhage and perforation	166	32.53%	64.46%
K25.5 Gastric ulcer, chronic or unspecified with perforation	3995	19.85%	92.82%
K25.6 Gastric ulcer, chronic or unspecified with both haemorrhage and perforation	373	31.10%	64.88%
K26.1 Duodenal ulcer, acute with perforation	3815	19.34%	92.69%
K26.2 Duodenal ulcer, acute with both haemorrhage and perforation	470	31.06%	72.34%
K26.5 Duodenal ulcer, chronic or unspecified with perforation	13397	19.81%	93.29%
K26.6 Duodenal ulcer, chronic or unspecified with both haemorrhage and perforation	1156	30.62%	73.70%
K27.1 Peptic ulcer, acute with perforation	189	39.15%	78.31%
K27.2 Peptic ulcer, acute with both haemorrhage and perforation	24	58.33%	41.67%
K27.5 Peptic ulcer, chronic or unspecified with perforation	687	37.41%	82.97%
K27.6 Peptic ulcer, chronic or unspecified with both haemorrhage and perforation	83	50.60%	59.04%
K28.0 Gastrojejunal ulcer, acute with haemorrhage	37	5.41%	45.95%
K28.1 Gastrojejunal ulcer, acute with perforation	23	13.04%	100.00%
K28.2 Gastrojejunal ulcer, acute with both haemorrhage and perforation	9	33.33%	77.78%
K28.3 Gastrojejunal ulcer, acute without haemorrhage or perforation	18	11.11%	55.56%
K28.5 Gastrojejunal ulcer, chronic or unspecified with perforation	99	21.21%	95.96%
K28.6 Gastrojejunal ulcer, chronic or unspecified with both haemorrhage and perforation	10	60.00%	40.00%
K28.7 Gastrojejunal ulcer, chronic without haemorrhage or perforation	25	12.00%	36.00%
K28.9 Gastrojejunal ulcer, unspecified without haemorrhage or perforation	220	5.00%	49.55%
Hernias			
K40.0 Bilateral inguinal hernia with obstruction without gangrene	736	6.79%	94.16%
K40.1 Bilateral inguinal hernia, with gangrene	44	13.64%	93.18%
K40.4 Unilateral or unspecified inguinal hernia, with gangrene	604	13.74%	96.03%
K41.0 Bilateral femoral hernia, with obstruction, without gangrene	253	10.67%	91.30%
K41.1 Bilateral femoral hernia, with gangrene	40	22.50%	97.50%
K41.3 Unilateral or unspecified femoral hernia with obstruction without gangrene	11584	8.20%	97.03%
K41.4 Unilateral or unspecified femoral hernia, with gangrene	1123	11.93%	96.88%
K42.1 Umbilical hernia with gangrene	759	7.91%	95.78%
K43.0 Ventral hernia with obstruction, without gangrene	11518	5.74%	96.30%
K43.1 Ventral hernia with gangrene	592	15.20%	97.47%
K44.0 Diaphragmatic hernia with obstruction, without gangrene	1247	11.31%	68.08%
K44.1 Diaphragmatic hernia with gangrene	141	12.77%	39.01%
K45.0 Other specified abdominal hernia with obstruction without gangrene	1280	12.58%	93.91%
K45.1 Other specified abdominal hernia with gangrene	141	17.02%	92.91%
K46.0 Unspecified abdominal hernia with obstruction without gangrene	1006	12.72%	89.46%
K46.1 Unspecified abdominal hernia with gangrene	88	12.50%	95.45%
Bowel Ischaemia			
K55.0 Acute vascular disorders of intestine	12919	49.40%	79.67%
K55.1 Chronic vascular disorders of intestine	892	30.83%	77.47%
K55.8 Other vascular disorders of intestine	261	16.48%	48.28%
K55.9 Vascular disorder of intestine, unspecified	6694	46.82%	75.49%

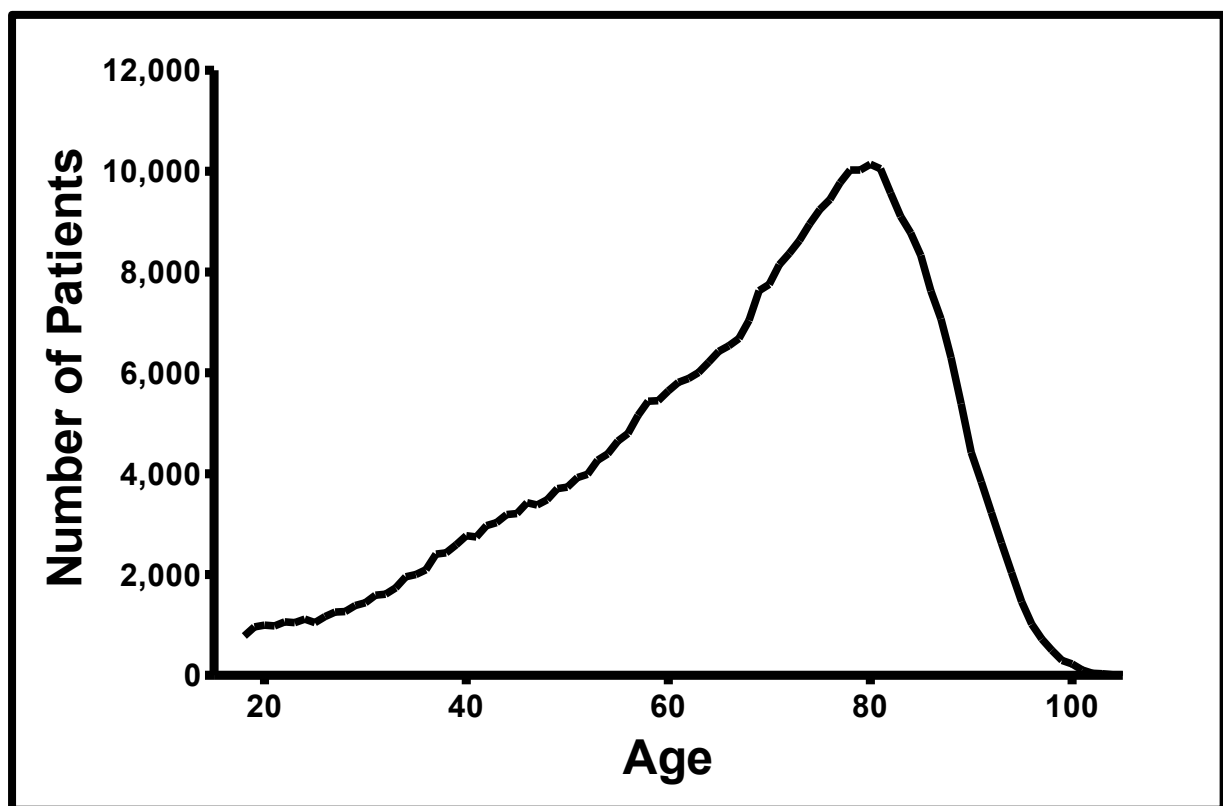
Bowel Obstruction			
K56.0 Paralytic ileus	995	14.27%	61.01%
K56.1 Intussusception	837	5.14%	88.89%
K56.2 Volvulus	20726	10.57%	92.08%
K56.3 Gallstone ileus	1888	10.17%	91.58%
K56.4 Other impaction of intestine	7950	5.17%	69.71%
K56.5 Intestinal adhesions [bands] with obstruction	34944	5.50%	96.03%
K56.6 Other and unspecified intestinal obstruction	90048	11.77%	85.41%
K56.7 Ileus, unspecified	1264	7.28%	79.27%
Diverticulitis			
K57.0 Diverticular disease of small intestine with perforation and abscess	1170	17.52%	89.91%
K57.2 Diverticular disease of large intestine with perforation and abscess	17593	16.50%	94.55%
K57.4 Diverticular disease of both small and large intestine with perforation + abscess	781	18.82%	94.11%
K57.8 Diverticular dis of intestine part unspecified with perforation and abscess	5956	25.13%	88.80%
Disorders of Peritoneum			
K65.0 Acute peritonitis	13311	20.71%	66.76%
K65.8 Other peritonitis	2421	18.92%	55.18%
K65.9 Peritonitis, unspecified	9949	41.85%	52.07%
K66.1 Haemoperitoneum	1550	15.61%	64.77%
K66.8 Other specified disorders of peritoneum	836	7.78%	71.41%
K66.9 Disorder of peritoneum, unspecified	151	11.26%	71.52%
Liver and Biliary Conditions			
K76.2 Central haemorrhagic necrosis of liver	5	20.00%	80.00%
K76.3 Infarction of liver	55	49.09%	47.27%
K76.8 Other specified diseases of liver	2881	6.46%	54.08%
K80.3 Calculus of bile duct with cholangitis	8872	5.37%	59.68%
K82.0 Obstruction of gallbladder	417	5.76%	61.15%
K82.2 Perforation of gallbladder	1534	17.41%	93.55%
K82.3 Fistula of gallbladder	132	10.61%	80.30%
K83.0 Cholangitis	14271	8.45%	44.15%
K83.1 Obstruction of bile duct	21360	6.80%	50.64%
K83.2 Perforation of bile duct	84	9.52%	90.48%
Miscellaneous Diagnoses			
K22.3 Perforation of oesophagus	1008	26.39%	55.75%
K31.0 Acute dilatation of stomach	181	10.50%	71.27%
K31.1 Adult hypertrophic pyloric stenosis	2595	10.25%	59.19%
K31.5 Obstruction of duodenum	1177	7.56%	56.84%
K31.6 Fistula of stomach and duodenum	158	7.59%	81.65%
K59.3 Megacolon, not elsewhere classified	1916	13.20%	79.75%
K59.8 Other specified functional intestinal disorders	3106	7.69%	74.50%
K63.0 Abscess of intestine	1384	7.15%	90.46%
K63.1 Perforation of intestine (non-traumatic)	13872	46.17%	83.19%
K63.4 Enteroptosis	144	5.56%	60.42%
K63.8 Other specified diseases of intestine	2302	6.13%	72.07%
Total	367,796	15.6%	

ICD-10 International Classification of Diseases, 10th Edition

7.3.1. Overall cohort demographics and outcomes

Of the 367,796 patients in the final study cohort, 167,881 (45.6%) were male and the mean age was 67 years (range 18-105). The age distribution of patients was however skewed towards older age groups and the modal age was 80 years, as shown in Figure 7.1.

Figure 7.1: Age distribution in study cohort



The overall 30-day in-hospital mortality rate was 15.6% and the median length of stay and 28-day readmission rate for patients leaving hospital alive were 8 days and 14.9% respectively (Table 7.2).

The overall rate of operative treatment was 37.4% but this varied widely by diagnostic group. Basic demographics and outcomes for these diagnostic groups are shown in Table 7.2.

Table 7.2: Summary of included ICD-10 diagnostic groups

Diagnostic Groups	Frequency	Median Age (years)	Proportion Male (%)	30-Day In-Hospital Mortality (%)	Median LOS for Survivors (days (IQR))	28-Day Readmission for Survivors (%)	Operative Treatment (%)
Liver and Biliary Conditions	49,611	72	49.7%	7.4	8 (5-14)	14.8	5.1
Hernias	31,156	74	34.1%	8.2	6 (3-12)	10.7	83.1
Bowel Obstruction	158,652	70	46.1%	9.8	6 (3-13)	16.3	26.8
Diverticulitis	25,500	70	40.6%	18.6	13 (8-23)	13.0	63.4
Gastrointestinal Ulcers	26,050	67	54.8%	21.5	9 (6-17)	8.5	80.9
Disorders of Peritoneum	28,218	65	48.8%	27.3	9 (4-16)	18.2	25.7
Miscellaneous Diagnoses	27,843	71	46.7%	28.0	11 (5-21)	16.3	39.9
Bowel Ischaemia	20,766	76	38.8%	47.4	13 (7-23)	14.2	52.5
Total	367,796	71	45.6%	15.6	8 (4-15)	14.9	37.4

LOS Length of Stay; IQR Interquartile Range

Table 7.3: Variation in EGS volume and outcomes between 2000 and 2009

Study Year (1 st April to 31 st March)	Number of Admissions	Number of 30-Day In-Hospital Deaths	30-Day In-Hospital Mortality (%)	Median LOS for Survivors (days)	28-Day Readmission for Survivors (%)	Number of Operations Performed	Proportion of Patients Treated Operatively (%)	Proportion of Operative Patients Dying in Hospital Within 30 Days (%)
2000	31,158	5,286	17.0	8	12.7	12,563	40.3	6.5
2001	31,829	5,561	17.5	9	12.7	12,825	40.3	6.7
2002	33,072	5,762	17.4	8	13.6	13,022	39.4	6.2
2003	34,333	5,778	16.8	8	13.7	13,315	38.8	6.0
2004	35,618	5,956	16.7	8	14.2	13,605	38.2	5.8
2005	37,778	6,004	15.9	8	14.4	14,156	37.5	5.7
2006	38,479	5,827	15.1	7	16.0	13,971	36.3	5.3
2007	39,546	5,732	14.5	7	15.2	14,411	36.4	4.8
2008	41,864	5,819	13.9	7	16.7	14,681	35.1	4.5
2009	44,119	5,758	13.1	7	17.6	14,944	33.9	4.1
Mean	36,780	5,748	15.6	8	14.9	13,749	37.4	5.5

EGS Emergency General Surgery; LOS Length of Stay

This study covers EGS patients from 1st April 2000 to 31st March 2010 and there were significant changes in EGS activity during this time. The number of annual admissions increased by 40% from 31,158 patients in 2000 to 44,119 patients in 2009 (Table 7.2). Despite this increase in admissions, the number of deaths per year remained roughly constant, resulting in a decrease in 30-day in-hospital mortality from 17.0% to 13.1%. Median length of stay for patients leaving hospital alive fell slightly over the study period but this was offset by a rapid increase in readmission rate from 12.7% to 17.6% (Table 7.2). The number of patients undergoing operative treatment rose slightly during the study but not to the same extent that admissions increased. As a result, the proportion of patients treated operatively fell from 40.3% to 33.9% (Table 7.2).

Few EGS patients have palliative operations performed and therefore the vast majority of patients having operations would expect to survive their inpatient stay. The proportion of patients that have an intra-abdominal operation and subsequently die within 30-days of admission fell considerably during the study period from 6.5% in 2000 to 4.1% in 2009.

7.3.2. Risk adjusted mortality

Multiple logistic regression was performed for 30-day in-hospital mortality with age, diagnostic group, Charlson co-morbidity score, discharge year, Carstairs social deprivation score and patient gender as the potential categorical variables. The final logistic regression model is shown in Table 7.4.

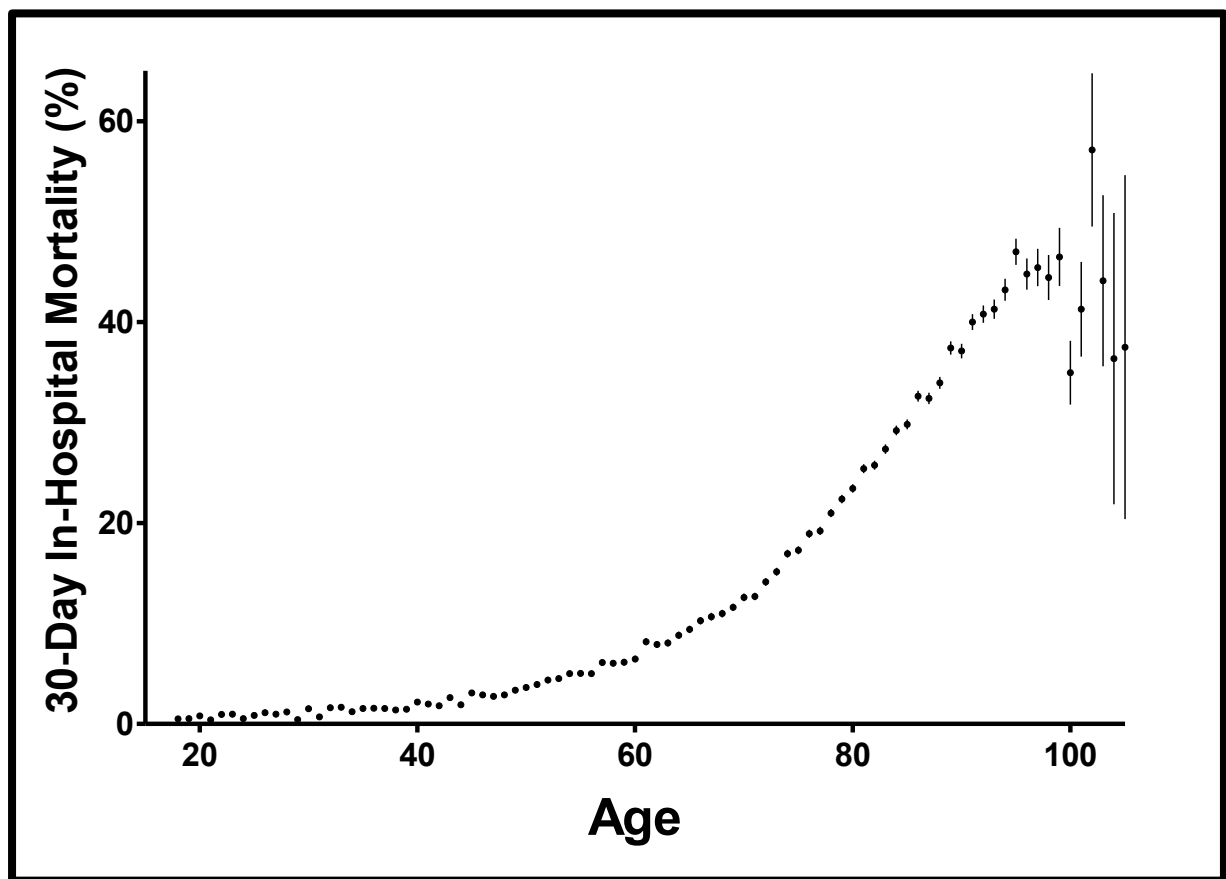
Table 7.4: Logistic regression model for 30-day in-hospital mortality

Variable	Significance	Odds Ratio (95% C.I.)
Age (years)		
<60		1
60-69	<0.001	2.91 (2.78-3.04)
70-79	<0.001	5.92 (5.69-6.16)
>79	<0.001	14.77 (14.21-15.34)
Diagnostic Group		
Liver & Biliary Conditions		1
Hernias	0.037	1.06 (1.00-1.12)
Bowel Obstruction	<0.001	1.49 (1.43-1.55)
Diverticulitis	<0.001	3.58 (3.41-3.77)
Gastrointestinal Ulcers	<0.001	4.87 (4.64-5.12)
Miscellaneous Diagnoses	<0.001	6.04 (5.77-6.32)
Disorders of Peritoneum	<0.001	6.90 (6.59-7.23)
Bowel Ischaemia	<0.001	12.44 (11.87-13.03)
Charlson Score		
0-2		1
>2	<0.001	2.61 (2.56-2.67)
Discharge Year		
2009		1
2008	<0.001	1.12 (1.07-1.17)
2007	<0.001	1.19 (1.14-1.24)
2006	<0.001	1.34 (1.28-1.40)
2005	<0.001	1.41 (1.35-1.47)
2004	<0.001	1.54 (1.48-1.61)
2003	<0.001	1.60 (1.53-1.67)
2002	<0.001	1.64 (1.57-1.71)
2001	<0.001	1.68 (1.61-1.76)
2000	<0.001	1.65 (1.58-1.73)
Carstairs Score		
1		1
2	<0.001	1.07 (1.03-1.10)
3	<0.001	1.12 (1.08-1.16)
4	<0.001	1.20 (1.16-1.24)
5	<0.001	1.22 (1.18-1.27)
Unassigned	0.018	1.52 (1.09-2.13)
Gender		
Male		1
Female	<0.001	1.22 (1.20-1.25)
All variables had univariate probability <0.001		
C.I. Confidence Interval		

Increasing age had the greatest independent effect on mortality and this is further illustrated by the increase in crude mortality as age rises (Figure 7.2). Different diagnoses had highly variable mortality and the degree of co-morbidity was also a significant predictor of patients' 30-day in-hospital mortality. In line with the cohort demographics, year of discharge and patient gender had significant

effects on mortality. Patient deprivation, in the form of Carstairs scores, was also an independent predictor of mortality.

Figure 7.2: Crude mortality as patient age increases

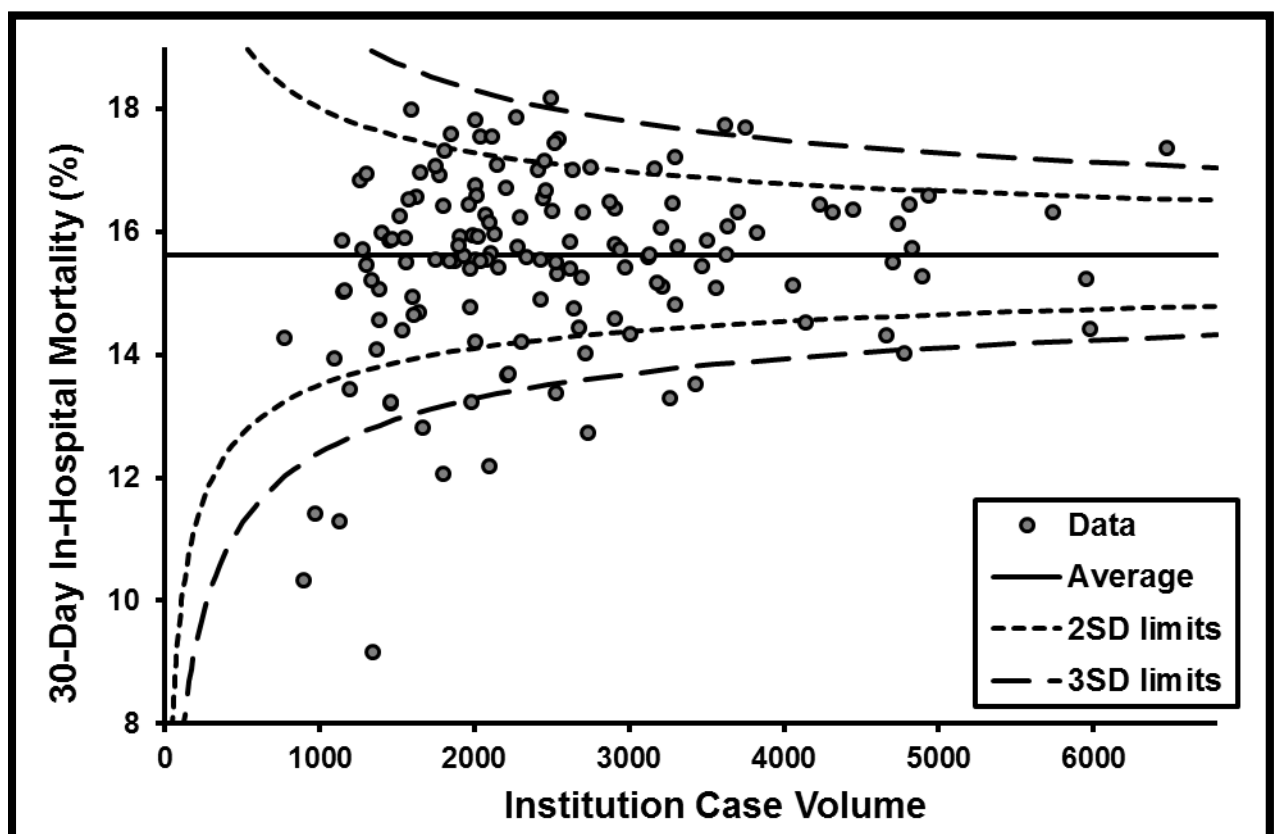


Error bars represent 95% confidence intervals

As mentioned above, the logistic regression model shown here can also be used to differentiate between the mortality of different groups of patients. This is done by assigning a probability of death to each patient, based on the variables used in the model, and comparing this to the observed mortality rate. This allows the derivation of a mortality rate for each group of patients as though all groups had a similar composition with respect to the variables in the logistic regression model. In this study NHS trusts have been used to define groups of patients and this allows us to assess the 30-day in-hospital mortality for each trust, had all trusts treated similar groups of patients. The results

of this analysis are shown in Figure 7.3. Risk adjusted mortality for NHS trusts ranged from 9.2% to 18.2%, a near doubling of risk adjusted mortality between best and worst performing trust. There were four NHS trusts more than three standard deviations (SD) above the mean, considered to be high mortality outliers, and twelve trusts more than 3 SD below the mean, considered to be low mortality outliers. At 2 SD there were 14 high mortality outliers and 24 low mortality outliers. Given the 145 NHS trusts included in this study, one would expect a total of 7 outlying trusts at 2 SD and none at 3SD.

Figure 7.3: Risk adjusted mortality for NHS trusts in England 2000-2009



SD Standard Deviation

7.3.3. Other outcome measures

Similar logistic regression analyses were performed for both length of stay and readmission rate.

This was done by changing the dependent variable from 30-day in-hospital mortality to patients with

an extended length of stay, beyond the 3rd quartile of length of stay duration for all survivors, and to patients readmitted within 28 days of discharge. These logistic regressions excluded all patients who died in hospital and results are shown in Tables 7.5 and 7.6.

Table 7.5: Logistic regression model for extended length of stay

Variable	Significance	Odds Ratio (95% C.I.)
Age (years)		
<60		1
60-69	<0.001	1.70 (1.65-1.74)
70-79	<0.001	2.30 (2.24-2.36)
>79	<0.001	3.24 (3.16-3.32)
Diagnostic Group		
Liver & Biliary Conditions		1
Hernias	<0.001	0.67 (0.65-0.70)
Bowel Obstruction	<0.001	0.89 (0.87-0.92)
Diverticulitis	<0.001	3.09 (2.97-3.20)
Gastrointestinal Ulcers	<0.001	1.73 (1.66-1.80)
Miscellaneous Diagnoses	<0.001	2.34 (2.25-2.43)
Disorders of Peritoneum	<0.001	1.67 (1.61-1.74)
Bowel Ischaemia	<0.001	2.58 (2.46-2.70)
Charlson Score		
0-2		1
>2	<0.001	1.48 (1.46-1.51)
Discharge Year		
2009		1
2008	0.073	1.03 (1.00-1.07)
2007	<0.001	1.10 (1.06-1.14)
2006	<0.001	1.09 (1.05-1.13)
2005	<0.001	1.24 (1.20-1.29)
2004	<0.001	1.30 (1.26-1.35)
2003	<0.001	1.36 (1.31-1.41)
2002	<0.001	1.37 (1.32-1.42)
2001	<0.001	1.39 (1.34-1.44)
2000	<0.001	1.26 (1.22-1.32)
Carstairs Score		
1		1
2	<0.001	1.08 (1.05-1.11)
3	<0.001	1.13 (1.10-1.16)
4	<0.001	1.21 (1.17-1.24)
5	<0.001	1.27 (1.23-1.31)
Unassigned	0.034	1.37 (1.03-1.82)
Gender		
Male		1
Female	<0.001	1.27 (1.25-1.29)

All patients with a length of stay in the 4th quartile were considered to have had an extended length of stay

All variables had univariate probability <0.001

C.I. Confidence Interval

Increasing age, comorbidities and social deprivation were all independent predictors of extended length of stay. Female patients and those admitted in earlier years of the study were also more likely to have an extended stay. Of the diagnostic groups, diverticulitis was the strongest predictor of extended length of stay.

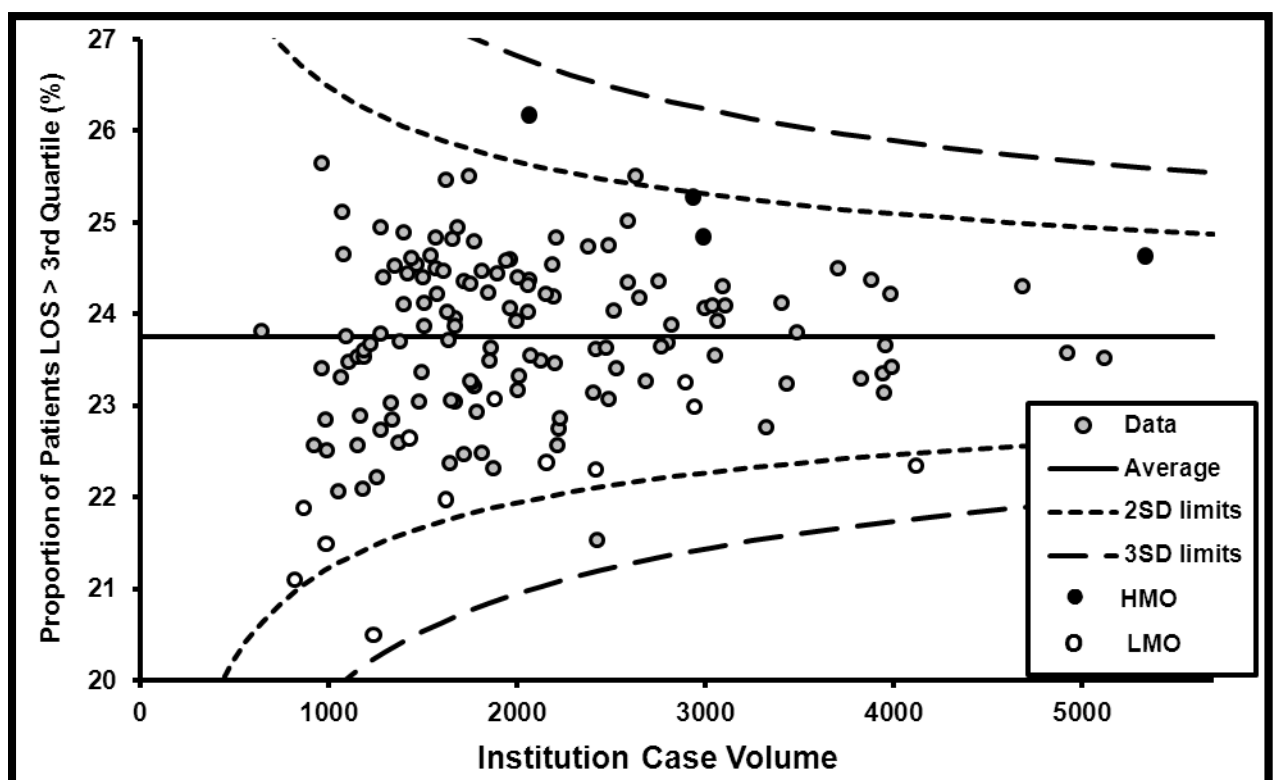
Table 7.6: Logistic regression model for 28-day readmission

Variable	Significance	Odds Ratio (95% C.I.)
Age (years)		
<60		1
60-69	0.531	1.01 (0.98-1.04)
70-79	0.685	0.99 (0.97-1.02)
>79	<0.001	1.07 (1.04-1.10)
Diagnostic Group		
Liver & Biliary Conditions		1
Hernias	<0.001	0.72 (0.69-0.76)
Bowel Obstruction	<0.001	1.17 (1.13-1.20)
Diverticulitis	<0.001	0.90 (0.86-0.95)
Gastrointestinal Ulcers	<0.001	0.57 (0.53-0.60)
Miscellaneous Diagnoses	<0.001	1.15 (1.09-1.20)
Disorders of Peritoneum	<0.001	1.26 (1.20-1.32)
Bowel Ischaemia	0.303	0.97 (0.91-1.03)
Charlson Score		
0-2		1
>2	<0.001	1.39 (1.36-1.42)
Discharge Year		
2009		1
2008	0.006	0.95 (0.91-0.98)
2007	<0.001	0.85 (0.82-0.89)
2006	<0.001	0.92 (0.88-0.95)
2005	<0.001	0.82 (0.78-0.85)
2004	<0.001	0.81 (0.78-0.85)
2003	<0.001	0.79 (0.76-0.82)
2002	<0.001	0.78 (0.75-0.82)
2001	<0.001	0.73 (0.70-0.76)
2000	<0.001	0.73 (0.70-0.76)
Carstairs Score		
1		1
2	0.812	1.00 (0.97-1.04)
3	0.039	1.04 (1.00-1.07)
4	<0.001	1.09 (1.06-1.13)
5	<0.001	1.15 (1.11-1.18)
Unassigned	0.535	0.89 (0.63-1.28)
Gender		
Male		1
Female	<0.001	0.93 (0.91-0.95)
All variables had univariate probability <0.001		
C.I. Confidence Interval		

Age appeared to make little difference to readmission rate until patients reach 80 years of age, at which point readmissions increased significantly. Increased comorbidities, male gender and higher levels of social deprivation also significantly predicted readmission within 28 days. Rates of readmission increased significantly over the study period and GI ulcers and hernias were the diagnostic groups least likely to require further inpatient treatment.

Figure 7.4 and 7.5 demonstrate funnel plots of risk adjusted extended length of stay and readmission rates for NHS Trusts in the study. Those trusts that were high and low mortality outliers in the 30-day in-hospital mortality logistic regression are highlighted to identify correlation between the different outcome measures.

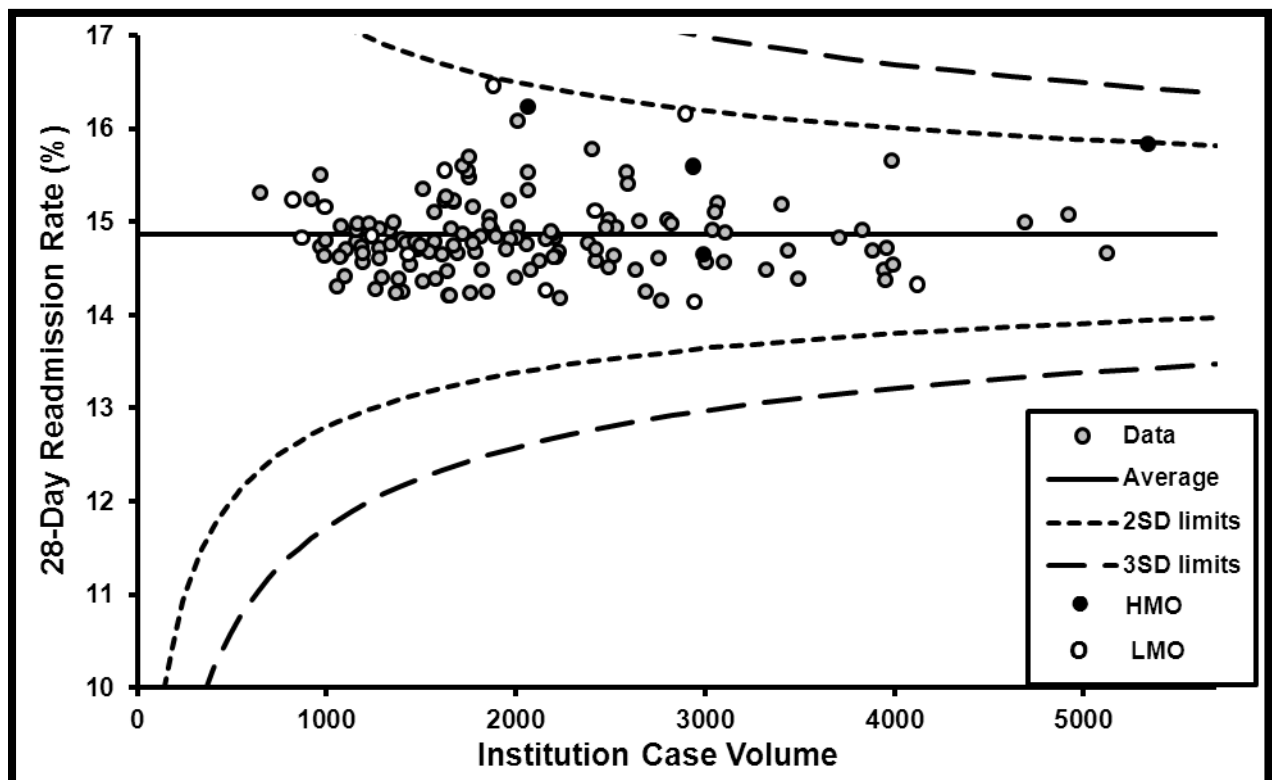
Figure 7.4: Risk adjusted extended length of stay for NHS trusts in England 2000-2009



LOS Length of Stay; SD Standard Deviation; HMO High Mortality Outlying NHS Trust; LMO Low Mortality Outlying NHS Trust

No NHS trusts had an outlying extended length of stay rate above the 3 SD limit. There were two NHS trusts with a rate of extended length of stay above the 2 SD cut-off, of which, one was also a high mortality outlier. Similarly, there were three NHS Trusts that had a low rate of extended length of stay beyond the 2 SD limits and 2 of these were also low mortality outliers. There was a significant positive correlation between Trusts' risk adjusted 30-day in-hospital mortality and their risk-adjusted proportion of patients with an extended length of stay (Pearson's $r = 0.826$, $p > 0.001$)

Figure 7.5: Risk adjusted 28-day readmission rate for NHS trusts in England 2000-2009



SD Standard Deviation; HMO High Mortality Outlying NHS Trust; LMO Low Mortality Outlying NHS Trust

Risk adjusted 28-day readmission rates were very similar across all NHS trusts and there were no outliers at either 2 or 3 SD limits. There was no correlation between risk-adjusted 30-day in-hospital mortality and readmission rates for NHS Trusts (Pearson's $r = -0.037$, $p = 0.660$)

“Failure to rescue” is a marker of quality for elective surgical care and corresponds to the proportion of patients that suffer a post-operative complication that go on to die (Silber et al., 1992, Ghaferi et al., 2009). As such it is analogous to the proportion of emergency surgical patients that have an operation but subsequently die in hospital. Almoudaris et al. have recently computed failure to rescue for NHS Trusts in England for colorectal surgery between 2000 and 2008 (Almoudaris et al., 2011b). There was a significant positive correlation between NHS Trusts’ failure to rescue following colorectal surgery in this study and Trusts’ proportion of patients having operative treatment for high-risk EGS diagnoses and subsequently dying in hospital (Pearson’s $r = 0.286$, $p > 0.001$).

7.4. Discussion

This study is the first to examine EGS outcomes using the admission diagnosis as the inclusion criteria, as opposed to studies that only include patients who have operative treatment. This distinction has allowed a more robust assessment of EGS outcomes, avoiding bias due to patient selection for operative intervention by EGS teams. Whilst there are undoubtedly a few diagnoses that were not included in this study that require emergency general surgical intervention (most notably some cancers and skin/soft tissue infections), these conditions present to a wide variety of different clinicians and so their outcomes do not necessarily represent the quality of care delivered by surgeons. In addition, very few meet the 5% mortality cutoff applied to this study. The inclusion criteria used here enabled the selection of a cohort of patients regularly treated by surgeons and allowed the outcomes of high-risk EGS care to be assessed.

Despite the differences in patient selection, the overall crude mortality rate in this study of 15.6% is remarkably similar to those in studies of EGS patients undergoing operation in both the UK (Faiz et al., 2010b) and the USA (Ingraham et al., 2010b). The mean age of the study cohort of 67 years was not surprising but the high modal age of 80 demonstrates that the high-risk EGS diagnoses studied are particularly common in old age. This may, in part, explain the excess of female patients in the

study as they are the more numerous sex in this age bracket (There are 70% more women than men over the age of 80 years in England and Wales based on 2011 census data (Office for National Statistics, 2012)). There was an excess of female patients in the hernia cohort. It is likely that this was because this diagnostic group included femoral hernias with either obstruction or gangrene but only included inguinal hernias with gangrene. This discrepancy was due to the low mortality of inguinal hernias with obstruction alone. Female patients also predominated in the bowel ischaemia group, possibly because this is primarily a disease of old age; the median age of patients with bowel ischaemia was 76 years. Unsurprisingly, GI ulcers were more common in males and the hernia and ulcer groups had the highest rates of operative intervention, in excess of 80%. Readmission rates were generally high, though it is unclear whether these readmissions were for the same or different conditions. The diagnostic groups with the highest rates of operative intervention, GI ulcers and hernias, had the lowest rates of readmission, presumably due to successful surgery to resolve the problem.

The variations in volume and outcome by year of discharge are striking and the underlying causes of these variations are not completely clear. Between 2000 and 2009 there was a 42% increase in the number of admissions in the diagnoses studied, from 31,000 to 44,000 patients per year. Similar increases in emergency department attendances and emergency admissions have been noted in the HES dataset and have been largely ascribed to an increase in admissions with a zero day length of stay (Jones, 2009). In this study there were only 12,580 admissions with a length of stay of zero days and, of these, 42% died in hospital, suggesting that an increase in short admissions has not affected this study unduly. The UK population is getting older and larger. There was an increase in population of 3.7 million and the proportion of the population over the age of 65 rose from 15.9% to 16.5% between 2001 and 2011 (Office for National Statistics, 2012). In addition the readmission rate for all types of emergency admissions rose during the study period (Jones, 2009). These changes will have led to an increased incidence of hospital admission for the diagnoses studied but they are not sufficient to explain the magnitude of the rise in admissions found. The most likely explanation for

the remaining rise in the admission rates between 2000 and 2009 is the increased accuracy of coding over time. This study has only examined the diagnoses with highest mortality and therefore excluded, for example, uncomplicated hernias, GI ulcers and diverticular disease. In the early years of the study, many patients with incarcerated or gangrenous hernias and perforated ulcers or diverticular disease may have been incorrectly coded into uncomplicated diagnoses. As the accuracy of coding has increased over time, and partially due to the increased tariff from the Payment by Results system offered by the more complex codes, more patients with serious pathology have been correctly coded into the more complex diagnoses and therefore appeared in the later years of this study. As a result of these changes caution must be applied when examining trends in high-risk EGS diagnoses over time.

Between 2000 and 2009 30-day in-hospital mortality fell from 17.0% to 13.1%. Due to the increase in admissions, the absolute number of deaths remained roughly constant, and the number of operations performed rose only slightly. On first inspection this would suggest that the additional admissions in the latter years of the study period were likely to have been fit patients without severe disease and that mortality has remained roughly constant. There is however some evidence that outcomes have improved, manifested by the slightly reduced length of stay and the significant reduction in mortality of those patients undergoing operation. During the time period studied there were significant improvements in imaging, intensive care and selection of patients for operation and these are manifested in the reduced proportion of patients undergoing operative treatment (40.3% to 33.9%) and the reduced proportion of patients undergoing operation that die in hospital (6.5% to 4.1%). As few EGS patients have palliative operations, the proportion of EGS patients that have an intra-abdominal operation but do not leave hospital alive could therefore be considered a marker of surgical outcome in EGS. The large reduction in this proportion from the beginning to the end of this study suggests that the quality of care for operative treatment in EGS, at least in terms of mortality outcome, has improved between 2000 and 2009. 28-day readmission rate increased sharply over the

study period from 12.7% to 17.6% and this reflects trends across the whole of NHS emergency inpatient care (Jones, 2009).

Logistic regression modeling for 30-day in-hospital mortality has demonstrated the importance of patient age and admission diagnosis in predicting mortality. The ongoing problems associated with the aging UK population are highlighted by the high mortality of diagnoses common in older patients, even when the effect of age is adjusted for.

Age group and diagnosis had the greatest effect on length of stay but diagnostic group and year of discharge had the greatest effect on 28-day readmission rate. The GI ulcer and hernia repair diagnostic groups had significantly low odds ratios for readmission and this is likely due to the effective surgical treatments available for these conditions.

There was significant variability in risk-adjusted 30-day in-hospital mortality between NHS Trusts and a two-fold increase in mortality between best and worst performing trust. This finding corroborates the assertions of the surgical societies discussed in Chapter 3 (Royal College of Surgeons of England, 2011a, Royal College of Surgeons of England, 2011b, Association of Surgeons of Great Britain and Ireland, 2012). The underlying causes of this variability in risk-adjusted mortality between NHS Trusts will be explored further in the following chapter.

There were no significant outlying NHS Trusts for either risk adjusted extended length of stay or 28-day readmission rate at 3 standard deviations, suggesting a much greater degree of uniformity between trusts for these metrics. NHS Trusts performed similarly for 30-day in-hospital mortality and extended length of stay but the risk of readmission did not correlate with mortality. As discussed for the raw data on these metrics, it seems likely that mortality and length of stay have improved somewhat over time and are perhaps outcomes that can be influenced by the varying quality of patient care between NHS Trusts and over time. Conversely, rising readmission rates appears to be more reflective of a societal trend, influenced by patient's changing expectations of healthcare,

particularly for elderly dependent patients, and therefore unaffected by differences in the quality of surgical care received (Jones, 2009). As a result, there is little difference in risk-adjusted readmission rate between NHS Trusts.

7.4.1. Limitations

Justification of the diagnostic codes included within this study is merited. Mortality of greater than 5% has been proposed as a cut-off for high-risk status in previous publications (Royal College of Surgeons of England, 2011b, Pearse et al., 2006). The bundle of diagnostic codes used in this study reflects high-risk EGS admissions that are likely to include many of the sickest patients admitted to NHS hospitals. These patients require rapid, high-quality care and, as such, provide a suitable population for the investigation of EGS outcomes. Notable exceptions to the diagnostic bundle include acute pancreatitis (mortality 4.4%) and acute appendicitis (mortality 0.5%).

This study is subject to a number of limitations. Research using administrative data sets such as HES is reliant on the accuracy of the information that these databases contain. HES has been shown to be reliable for primary diagnostic and procedure codes (Burns et al., 2012) as well as for 30-day in-hospital mortality (Holt et al., 2012). In particular, mortality coding has been shown to be more than 99% accurate (Holt et al., 2012). Changes in the accuracy and completeness of coding may limit the interpretation of changes in outcomes over time. As an administrative database, HES does not contain information about patient physiology or severity of disease on presentation and this potentially makes risk adjustment insensitive.

7.5. Conclusion

This study has investigated the outcomes for high-risk EGS patients in the NHS in England and has highlighted the high mortality associated with these conditions. The old age of the majority of patients makes successful treatment particularly difficult and this is likely to get worse in future

years as the UK population ages. There appear to have been some improvements in mortality and length of stay during the study period, particularly in terms of post-operative mortality, though changes in coding practices make the magnitude of these changes difficult to quantify. There does appear to be significant variability in mortality between NHS Trusts for high-risk EGS diagnoses and the following chapter will investigate the structural factors that may underlie these differences in greater detail.

Structure

8. EFFECT OF NHS TRUST RESOURCES ON RISK ADJUSTED OUTCOMES

8.1. Introduction

Analysis of emergency general surgery HES data in Chapter 7 demonstrated significant variability in outcomes between NHS Trusts. In particular, 30-day in-hospital risk adjusted mortality doubled between best and worst provider. The Donabedian paradigm suggests that these differences must be caused by either the structure of care at these hospitals or the process of care delivered to patients.

Very little national data are available on the process of care at individual NHS Trusts but some data are available on trust's facilities and infrastructure. The aim of this chapter is use the HES dataset described in Chapter 7 and publicly available Department of Health (DoH) data to examine the effect of variation in NHS trusts' structure on 30-day risk-adjusted mortality.

8.2. Methods

Data on NHS trusts' structure was obtained from the DoH's performance data and statistics website (Department of Health, 2012). Annual, and in some cases quarterly, data were available for trusts' bed occupancy percentage, number of operating theatres, intensive care unit (ICU) and high dependency unit (HDU) bed numbers, and the number of CT scans and non-obstetric ultrasound scans performed. In addition, the number of acute and general inpatient beds per trust per year was also available. A further structural variable that could be determined from the original HES data was the number of EGS admissions per hospital bed, a surrogate for the Trust's workload.

Structural variables were collated and, with the exception of bed occupancy percentage, rationalised to give values proportional to the number of acute and general beds in the trust that year.

Infrastructure variable per hospital bed for each year, or part of a year, were then averaged over the 10 year study period, to produce the most accurate possible indication of trust's structure between

2000 and 2009. Where trusts merged during the study, their structure was accounted for separately in the years prior to merger but summed (or averaged for bed occupancy) for final analysis. This was done because HES data is only available under the merged NHS Trust code and not for the initial, unmerged trusts. There was a small quantity of missing data (0.3% of 8700 data points) which was excluded from the analysis: for example, some trusts only had data for a variable for nine out of ten years and therefore an average was taken over 9, rather than 10 years.

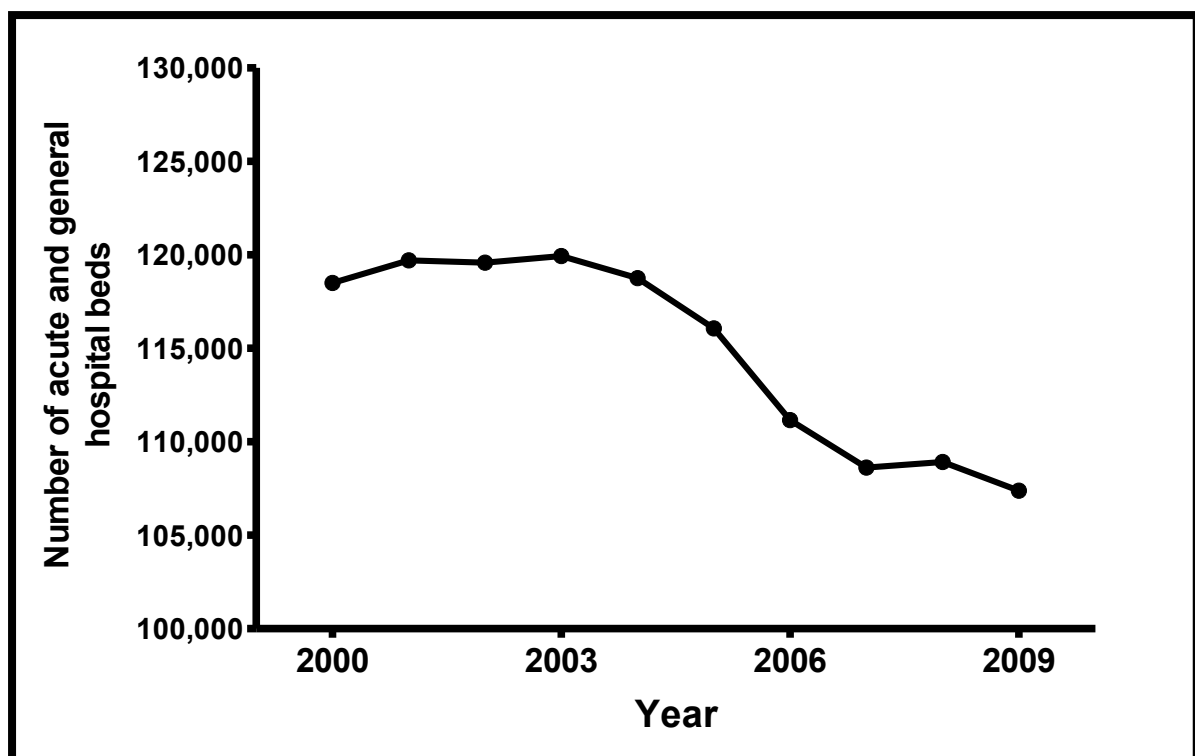
Having determined the provision of each structural variable at each NHS Trust during the study period, the next stage of the study was to examine how these variables affected patient's outcomes. For this study 30-day in-hospital mortality was used as the target endpoint as this was the outcome that best demonstrated variability between NHS Trusts in Chapter 7 and it is also the outcome of greatest interest to clinicians and patients. To allow the use of categorical logistic regression analysis, NHS Trusts were divided into thirds based on each structural variable and patients were assigned to a high, middle or low tercile based on the Trust in which they were treated. Structural variables with a p value of <0.10 on unadjusted analysis were then added into the multiple logistic regression model developed in Chapter 7 (Field, 2009). To examine differences in the provision of infrastructure between high and low mortality outlying hospitals, the trusts identified in Chapter 7 as mortality outliers at 2 standard deviations from the mean were compared. There were 14 high mortality outliers (HMOs) and 24 low mortality outliers (LMOs) from the 145 NHS trusts included in this study. The independent samples t-test was utilised for the comparison of means.

8.3. Results

8.3.1. Changes in NHS infrastructure 2000-2009

There were significant changes in the provision of infrastructure across the NHS in England during the study period. There was a 10% reduction in the number of inpatient beds from 120,000 to 107,000 over the study period and this occurred predominantly between 2003 and 2007 (Fig. 8.1).

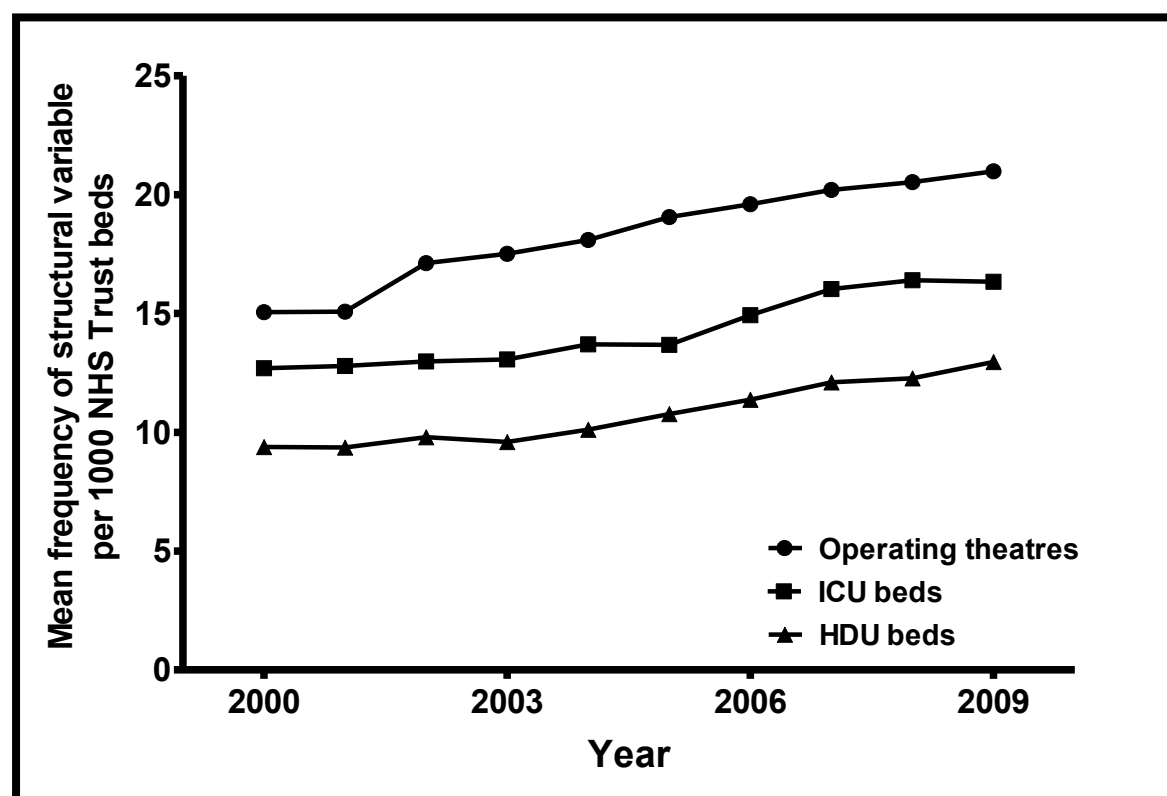
Figure 8.1: Number of acute and general hospital beds in the NHS in England



Conversely, the provision of operating theatres and critical care facilities increased markedly. There was a 28% increase in the number of operating theatres, 19% increase in the number of ICU beds and 28% increase in the number of HDU beds. Coupled with the decrease in the number of hospital beds, these changes resulted in large increases in the relative quantity of these infrastructure elements per hospital bed (Fig. 8.2). There was a 39% increase in the number of operating theatres

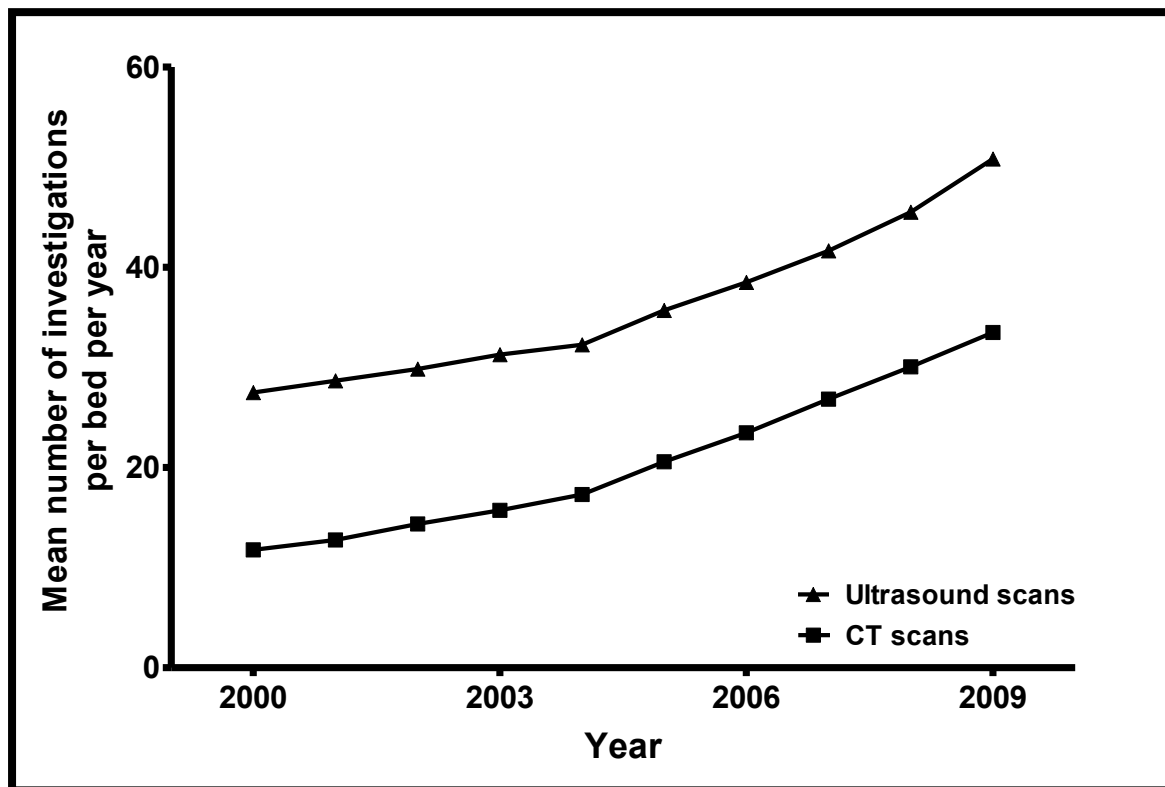
per 1000 trust beds, a 29% increase in the number of ICU beds per 1000 trust beds and a 38% rise in the number of HDU beds per 1000 trust beds (Fig. 8.2).

Figure 8.2: Provision of theatres and critical care facilities per inpatient bed



Utilisation of CT and ultrasound scanning increased very rapidly during the decade studied. There was a 156% absolute increase in the number of CTs, which resulted in a 185% increase in CT scans per inpatient bed per year. Similarly there was a 66% rise in the total number of non-obstetric ultrasounds performed, an 85% increase per bed per year (Fig. 8.3).

Figure 8.3: Number of imaging investigations per inpatient bed per year



8.3.2. Effect of structural variables on risk adjusted mortality

All seven structural variables had p values ≤ 0.10 on unadjusted analysis and so were added to the patient specific variables used for risk adjustment in Chapter 7. This produced a second, extended risk adjustment model, which demonstrates the independent effect of structural variables on 30-day in-hospital mortality (Table 8.1).

Table 8.1: Multiple logistic regression model for 30-day in-hospital mortality, including patient and structural variables (continued overleaf)

Predictor	Unadjusted p value	Multiple Logistic Regression Model (Odds Ratio (95% CI))	p value
Patient Variables			
Age	<0.001		
<60		1	
60-69		2.89 (2.76-3.02)	<0.001
70-79		5.86 (5.63-6.09)	<0.001
≥80		14.60 (14.06-15.17)	<0.001
Diagnosis	<0.001		
Liver and biliary conditions		1	
Hernia with obstruction or gangrene		1.05 (1.00-1.11)	0.076
Bowel obstruction		1.49 (1.43-1.55)	<0.001
Perforated diverticulitis		3.57 (3.40-3.75)	<0.001
Gastrointestinal ulcer		4.87 (4.63-5.11)	<0.001
Miscellaneous diagnoses		6.06 (5.79-6.35)	<0.001
Peritonitis		6.99 (6.67-7.33)	<0.001
Ischaemic bowel		12.50 (11.93-13.11)	<0.001
Co-morbidities	<0.001		
Charlson score ≤2		1	
Charlson score >2		2.61 (2.56-2.67)	<0.001
Year of discharge	<0.001		
2009		1	
2008		1.12 (1.08-1.18)	<0.001
2007		1.19 (1.14-1.24)	<0.001
2006		1.34 (1.29-1.41)	<0.001
2005		1.40 (1.34-1.47)	<0.001
2004		1.54 (1.48-1.61)	<0.001
2003		1.60 (1.53-1.67)	<0.001
2002		1.64 (1.56-1.71)	<0.001
2001		1.68 (1.61-1.76)	<0.001
2000		1.65 (1.58-1.73)	<0.001
Social deprivation	<0.001		
Carstairs score 1 (least deprived)		1	
Carstairs score 2		1.06 (1.03-1.10)	0.001
Carstairs score 3		1.12 (1.08-1.15)	<0.001
Carstairs score 4		1.19 (1.15-1.23)	<0.001
Carstairs score 5 (most deprived)		1.23 (1.19-1.28)	<0.001
Carstairs score unassigned		1.50 (1.07-2.11)	0.018
Sex	<0.001		
Male		1	
Female		1.22 (1.19-1.25)	<0.001
Structural Variables			
Admissions per hospital bed	<0.001		
Fewest tercile (1.7-3.0)		1	
Middle tercile		0.97 (0.94-1.00)	0.022
Most tercile (3.7-5.8)		0.96 (0.93-0.99)	0.016
Bed Occupancy %	<0.001		
Lowest tercile (76.9%-84.8%)		1	
Middle tercile		0.98 (0.95-1.01)	0.145
Highest tercile (88.4%-94.8%)		1.06 (1.03-1.09)	<0.001
Theatres per 1000 hospital beds	<0.001		
Fewest tercile (8.3-15.7)		1	
Middle tercile		1.01 (0.99-1.04)	0.344
Most tercile (20.5-29.8)		1.10 (1.06-1.13)	<0.001

CI Confidence Interval; ICU Intensive Care Unit; HDU High Dependency Unit; CT Computed Tomography; USS Ultrasound Scan.

Table 8.1: Continued

Predictor	Unadjusted p value	Multiple Logistic Regression Model (Odds Ratio (95% CI))	p value
ICU beds per 1000 hospital beds	<0.001		
Fewest tercile (4.9-10.6)		1	
Middle tercile		1.03 (1.00-1.05)	0.065
Most tercile (14.4-53.7)		0.84 (0.81-0.87)	<0.001
HDU beds per 1000 hospital beds	<0.001		
Fewest tercile (1.2-8.0)		1	
Middle tercile		0.93 (0.90-0.95)	<0.001
Most tercile (11.9-32.7)		0.96 (0.93-0.99)	0.006
CT scans per bed per year	<0.001		
Fewest tercile (8.7-17.6)		1	
Middle tercile		0.98 (0.95-1.01)	0.185
Greatest tercile (22.4-37.6)		0.86 (0.83-0.89)	<0.001
USS per bed per year	<0.001		
Fewest tercile (18.4-31.9)		1	
Middle tercile		1.05 (1.02-1.08)	<0.001
Greatest tercile (39.2-67.8)		1.02 (0.99-1.05)	0.178

CI Confidence Interval; ICU Intensive Care Unit; HDU High Dependency Unit; CT Computed Tomography; USS Ultrasound Scan.

Admission to a trust in the highest tercile for institutional intensive care bed provision (Odds Ratio (OR) 0.84, 95% Confidence Interval (CI) 0.81-0.87, $p<0.001$) and high dependency bed facilities (OR 0.96, 95% CI 0.93-0.99, $p=0.006$) as well as the highest tercile for CT usage (OR 0.86, 95% CI 0.83-0.89, $p<0.001$) were all associated with significantly reduced mortality (Table 8.1). There was also a lower odds ratio for mortality at NHS Trusts in the tercile with the most high-risk EGS admissions per hospital bed (OR 0.96, 95% CI 0.93-0.99, $p=0.016$). Conversely, treatment at NHS Trusts in the highest tercile for bed occupancy (OR 1.06, 95% CI 1.03-1.09, $p<0.001$) or operating theatres per 1000 hospital beds (OR 1.10, 95% CI 1.06-1.13, $p<0.001$) were independent predictors of mortality (Table 8.1).

8.3.3. Infrastructure differences between high and low mortality outlying trusts

Structural differences between the HMO trusts and LMO trusts, identified in Chapter 7, were assessed to investigate the potential underlying causes of the variability in risk-adjusted mortality.

There was no significant difference in the institutional number of admissions per bed, bed occupancy, number of operating theatres or high dependency beds per 1000 hospital beds between high and low mortality outlying trusts (Table 8.2). LMO trusts had a significantly greater number of intensive care beds per 1000 trust beds (Table 8.2, Fig. 8.4). In addition, LMO trusts made significantly greater use of computed tomography and ultrasound scanning than HMO trusts during the study period (Table 8.2, Fig. 8.5).

Table 8.2: Organisational differences between high and low mortality outlying NHS Trusts

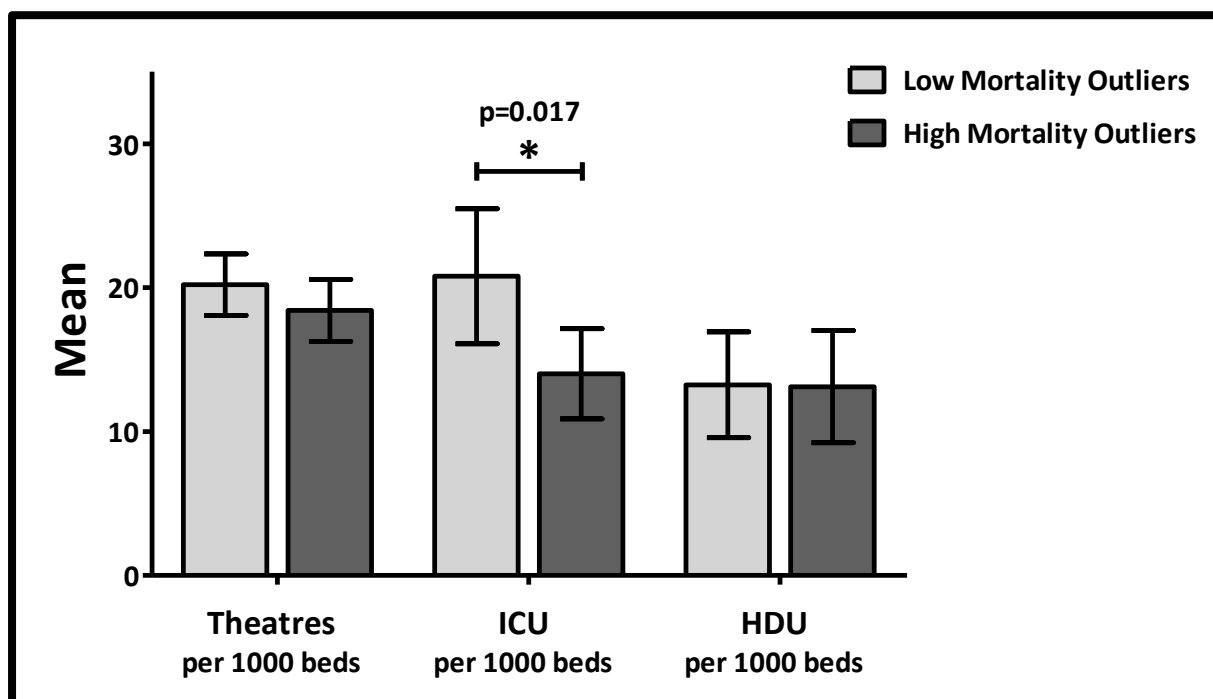
Organisational Factor	LMOs Mean (SEM)	HMOs Mean (SEM)	t	Mean Difference	95% CI of Difference	P value
EGS admissions per trust bed	2.95 (0.16)	3.04 (0.18)	-0.33	-0.08	-0.59 to 0.43	0.745
Bed occupancy (%)	87.1 (0.8)	85.9 (1.2)	0.85	1.18	-1.63 to 3.99	0.400
Operating theatres per 1000 beds	20.2 (1.0)	18.4 (1.0)	1.15	1.79	-1.37 to 4.95	0.258
Intensive care beds per 1000 beds	20.8 (2.3)	14.0 (1.4)	2.51	6.76	1.30 to 12.23	0.017*
High dependency beds per 1000 beds	13.2 (1.8)	13.1 (1.8)	0.05	0.13	-5.36 to 5.61	0.963
CT scans per bed per year	24.6 (1.2)	17.2 (1.0)	4.26	7.38	3.87 to 10.90	<0.001***
USS per bed per year	42.5 (2.5)	30.2 (1.6)	4.16	12.33	6.31 to 18.34	<0.001***

Independent samples t-test for significance

*** p<0.001, * p<0.05

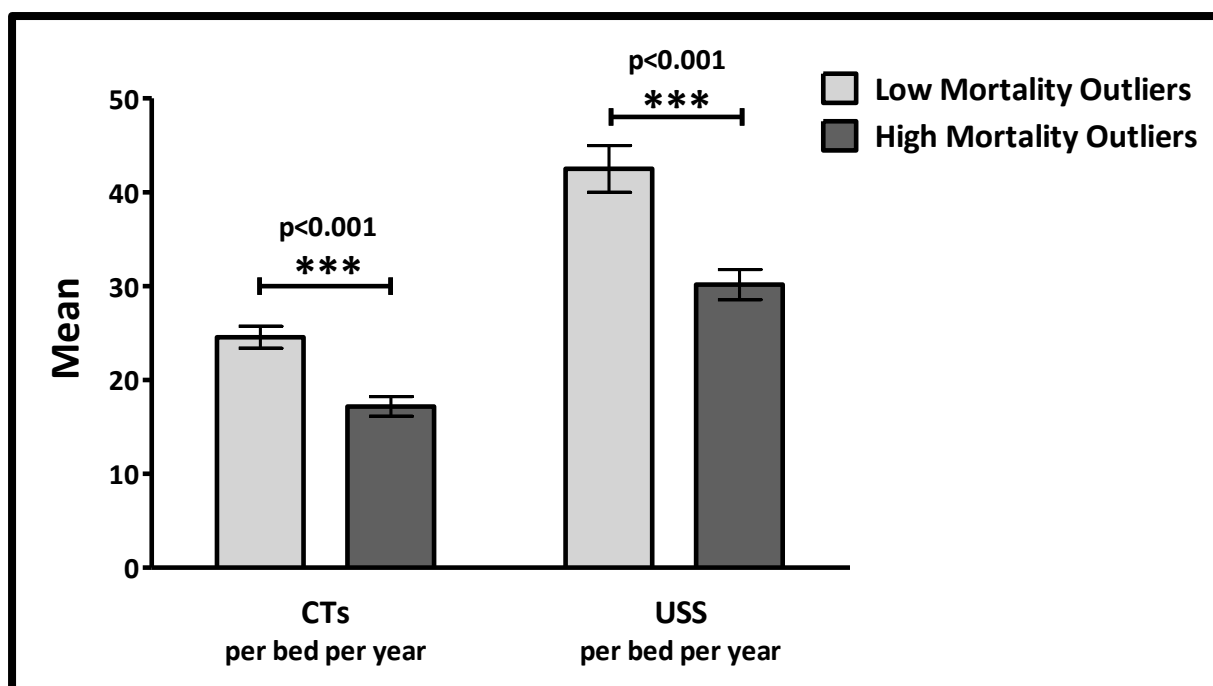
LMO Low Mortality Outlier; HMO High Mortality Outlier; SEM Standard Error of Mean; CI Confidence Interval; EGS Emergency General Surgery; CT Computerised Tomography; USS Ultrasound Scan

Figure 8.4: Graph of hospital operating theatre and critical care provision for high and low mortality outlying NHS trusts



Mean (95% confidence interval) resources 2000-2009, independent-samples t-test: * $p < 0.05$
 ICU Intensive Care Unit; HDU High Dependency Unit

Figure 8.5: Graph of imaging usage for high and low mortality outlying NHS trusts



Mean (95% confidence interval) resources 2000-2009, independent-samples t-test: *** $p < 0.001$
 CT Computed Tomography, USS Ultrasound Scan

8.4. Discussion

A significant reduction in mortality risk was observed at trusts lying within the highest tercile for both ICU and HDU bed provision as well as CT scan usage. Patients treated at NHS Trusts in the highest tercile for number of operating theatres and with the highest bed occupancy demonstrated worse outcome than those treated in the remaining trusts. In addition to the findings of this logistic regression, there were significant organisational and resource differences when assessing the structure of high mortality and low mortality outlier institutions. LMOs had significantly more ICU beds and performed significantly more imaging investigations than HMOs.

The significant contribution of structural variables to the risk of mortality suggests that essential resources, such as critical care and radiology services, may contribute to the overall quality of emergency surgical care provision in the NHS. This theory is supported by the greater provision or use of these facilities at LMO trusts when compared to HMO trusts. These findings support the theory that better resourced NHS Trusts are associated with higher quality of care for high-risk EGS patients.

The findings of this study suggest that the increase in the numbers of critical care beds and imaging usage in the NHS is likely to have improved patient outcomes and may, in part, explain the improvements in mortality over the study duration found in Chapter 7. Future work in this area should attempt to corroborate these findings using alternative data sources. The results demonstrate that an increase in the number of operating theatres per trust bed does not appear to reduce mortality. This result contradicts the assertions of the interviewees in Chapter 5 however, it may be that access to theatre for these high-risk cases is not difficult, whereas theatre access is much more problematic for low risk EGS cases such as appendicitis and abscesses. It seems unlikely that excess operating theatres actually cause harm but it may be that this infrastructure variable has reached a saturation point, at which further increases make no difference to high-risk EGS patients' mortality. Future studies could look at NHS Trusts with high levels of infrastructure provision to try

to determine whether similar saturation points exist for critical care facilities and imaging usage. Finally, similar investigations could be performed to assess the contribution of trust structure to other outcomes for high-risk EGS patients, notably length of stay and readmission rate, which were investigated in the previous chapter.

8.4.1. Limitations

This study was subject to a number of limitations. Structural data for NHS Trusts are only available per trust. While the overall resources in a hospital are likely to reflect the facilities available, there is no way to differentiate between, for example, acute and elective hospital sites within the same NHS Trust. It is not clear that the total trust resources that are available are necessarily reflective of those used to treat EGS patients. The data that was analysed in this study is unable to report on the availability of dedicated emergency surgical operating theatre lists. Neither is it able to distinguish the potential competing resources for critical care beds within trusts or identify the proportion of scans performed specifically on the EGS patient group. As such, caution must be exercised when using overall trust resource availability as surrogates for resource availability for high-risk emergency surgical patients.

A number of NHS Trusts underwent reconfiguration or merger during the time period studied and this may have resulted in varying outcomes before and after these changes. Structural variables such as critical care provision and imaging usage were calculated annually and averaged over the study period to account for organisational change but this dataset cannot account for changes in the process of care as a result of reconfiguration, which may introduce bias into the results. Finally, no data is available on the reliability of hospital's submissions to the Department of Health. It is not known whether this data was verified by hospital visits or peer reviewed and therefore its accuracy is unknown.

8.5. Conclusion

This study has demonstrated that NHS Trust's infrastructure plays a significant role in the mortality of high-risk EGS patients. Improving national standards in emergency general surgery demands that essential hospital resources are optimised at institutions offering these services. However, improvements in infrastructure are only a part of the changes required to maximise the quality of care in emergency general surgery. The following chapters will investigate the process of care for EGS patients and attempt to identify similar areas for improvement.

Process

9. FUNDAMENTAL CARE PROCESSES FOR EMERGENCY GENERAL SURGICAL ADMISSIONS

9.1. Background

The preceding chapters have discussed the outcomes for high risk EGS admissions and examined the way in which structural factors affect these outcomes. Unfortunately there is no equivalent database that documents the suitability and reliability of processes of care for EGS patients between hospitals. Indeed there is limited consensus on which processes actually contribute to improved outcomes, as discussed in Chapter 3. Within the limits of this thesis it is not possible to conduct the type of clinical trial necessary to demonstrate the efficacy of care processes; it is however possible to investigate the effectiveness of care for EGS patients. Whilst there is no national database of process reliability to draw from, it is possible to assess the same processes at multiple hospitals in order to better understand the variability in effectiveness of care between providers.

9.2. Introduction

Emergency patients differ from elective ones because they are acutely unwell at the time of admission to hospital. It is likely that, without treatment, a significant proportion of these patients will continue to deteriorate past a point at which medical intervention can prevent death or serious disability. For this reason it is vital that the process of diagnosis and treatment are provided as soon as possible following admission because delay brings the patient closer to this point of no return. In major trauma scenarios this concept is referred to as the “golden hour” (Lerner and Moscati, 2001) and a similar principle is likely to be true for all emergency admissions, though perhaps without quite the same urgency. The findings of the interview study detailed in Chapter 5 suggested that early identification and treatment of emergency admissions is likely to be an area of weakness in the healthcare system as a result of the junior nature of the staff regularly providing this care and the

time dependent nature of the treatment required. For these reasons, this thesis will focus on the admission phase of care for a quantitative assessment of process reliability in EGS. A more qualitative approach to the investigation of process failures across the whole EGS patient pathway will follow in Chapter 11.

In order to investigate the quality of care provided to EGS patients in the initial stage of treatment it is important to first define this initial stage's duration and identify a gold standard for treatment. Unfortunately the current literature in emergency general surgery (EGS) is not very helpful in this regard, as it is generally focussed on treatments for specific diseases rather than the general principles governing all emergency admissions. Textbooks such as the handbook for the Care of the Critically Ill Surgical Patient (CCrISP) training course for surgical trainees (Anderson, 2003, Olsen et al., 2007) and reports from the National Confidential Enquiry into Patient Outcomes and Deaths (NCEPOD) are more forthcoming but conspicuously lack citations of published scientific studies. In order to make a quantitative analysis of the effectiveness of care for EGS patients it is necessary to define a standard to measure against.

9.3. Aims

As previously mentioned, the quality and quantity of evidence available on which to base standard practice for the initial treatment of emergency surgical admissions is extremely limited. To develop a gold standard we therefore utilised the Delphi consensus methodology to gather expert opinion on fundamental processes applicable to all emergency surgical admissions, avoiding disease specific investigations or treatments.

The aim of this study was to create a list of core processes that should be performed in the initial care of emergency surgical admissions, up to and including the "post-take" ward round. The post-take ward round occurs at the start of each day's work and at this point all patients admitted during the previous 24 hours are seen and discussed. In most hospitals it is led by the consultant that has

been on-call for the preceding day and usually consists of a handover from the night team followed by a ward round by the consultant and his team, who are responsible for the patients' on-going care. This may be the consultant's first contact with the patients admitted in his or her name the previous day and therefore treatment up to this point will often be reviewed and amended as appropriate. We identified the period from admission until the "post-take" ward round as the time period in which initial diagnosis and treatment should be initiated to prevent deterioration of unwell patients. The post-take ward round also provides a convenient and consistent sampling point for studies of otherwise extremely unpredictable emergency admissions.

9.4. Methods

9.4.1. Background to Delphi Process

Delphi is a consensus methodology, commonly used in healthcare for establishing treatment guidelines and setting quality standards (Fink et al., 1984, Jones and Hunter, 1995). It is particularly useful in situations where there is either a lack of, or conflicting evidence available and decisions must be based on expert opinion. In addition, the Delphi methodology does not require group meetings that can be difficult to organise and that are often dominated by a small number of senior participants (Fink et al., 1984).

The Delphi process consists of a series of rounds of anonymous, independently completed questionnaires, in which participants are asked to score their agreement with a number of statements on a Likert scale. Statements are derived from a search of the literature and, where this does not exist, from discussion between researchers and participants. Results of Likert scoring are tabulated and median and interquartile ranges of participants' responses calculated. Statements that have a narrow interquartile range (indicating consensus between participants) and a median score above a predetermined threshold for inclusion in a final list are accepted. Items with a narrow interquartile range and a median below the cut off for inclusion are discarded. Statements without

consensus, based on interquartile range, are submitted, along with any new statements suggested by the respondents, to a further round of questionnaires.

In the second and subsequent rounds of questionnaires the median and range of scores for each item that did not reach consensus in round one are fed back to participants, who are asked to keep or adjust their previous score based on the summary statistics provided. Rounds continue until all items have achieved a sufficiently narrow interquartile range to indicate consensus (Jones and Hunter, 1995). No clear rules exist regarding the numerical value for median or interquartile range that should be used to indicate inclusion and consensus respectively as these will vary based on the size of the Likert scale used, the number of participants, and the controversy of the topic being investigated.

9.4.2. Questionnaire development

Due to the lack of robust evidence for many of the processes performed during the admission of an emergency surgical patient it was necessary to use a variety of sources to develop the initial list of items to be validated by the Delphi process. In this study the results of the pre-existing emergency surgery interviews (Chapter 5) were used to develop an initial catalogue of processes that should be performed for emergency surgical admissions prior to the post-take ward round (Table 9.1).

A traditional literature review across the many potential process topics was also performed (Chapter 3) but yielded disappointingly few references, mainly due to the lack of specific evidence in emergency as opposed to elective surgery. Studies assessing the efficacy of thromboprophylaxis were the most commonly identified however, even in this well researched area, only one randomised controlled trial in emergency surgery was found (Bergqvist et al., 1996) and this had a non-significant result. A search of NICE, SIGN (Scottish Intercollegiate Guideline Network), RCS and ASGBI guidelines as well as NCEPOD reports was performed to retrieve additional information.

Textbooks relevant to the field of emergency surgery were also searched, though a systematic review of these was not performed.

Table 9.1: Sources of data for initial Delphi process list

Process topic	Data Source				
	Interviews	Literature	Guidelines	NCEPOD reports	Textbooks
Initial assessment	X			X	X
Making a diagnosis	X			X	X
Routine blood tests	X				X
Radiology investigations	X			X	X
Formulating a management plan	X			X	X
Documentation				X	X
Senior doctor review	X			X	
Admission to suitable wards	X			X	
Patient transfers				X	
Vital signs monitoring	X		X	X	X
Intravenous access					X
Intravenous fluid resuscitation	X	X	X		X
Analgesia	X		X		X
Antibiotic therapy	X	X	X		X
Thromboprophylaxis	X	X	X		X
Routine pre-admission medications	X				
Urinary catheterisation	X				X
Nasogastric drainage	X				X
Preoperative fasting	X		X		X
Handover	X	X	X	X	

NCEPOD, National Confidential Enquiry into Patient Outcomes and Deaths

A number of guidelines from speciality associations (Dellinger et al., 2008, DeVita et al., 2010, Powell-Tuck et al., 2008, Royal College of Surgeons of England, 2007) and the National Institute for Health and Clinical Excellence (NICE) (National Institute for Health and Clinical Excellence, 2007, National Institute for Health and Clinical Excellence, 2010) were identified and incorporated, covering a number of topics (Table 9.1). These were augmented by NCEPOD report recommendations (Martin et al., 2007a) and textbooks such as the handbook for the Care of the

Critically Ill Surgical Patient (CCrISP) training course (Anderson, 2003, Olsen et al., 2007) as well as discussion between the researchers. The list was also piloted with approximately 10 surgical registrars who were not participants in the study. The majority of NCEPOD recommendations related to the initial assessment of a patient, whereas guidelines mainly dealt with treatment processes. These data sources produced a list of 26 items for the first round of questionnaires (Appendix D).

9.4.3. Setting

The study was conducted between May and June 2010 at the same large, city centre university teaching hospital as our earlier interview study. All participants were approached in person, within the hospital and completed the questionnaires anonymously and without reference to any of the other contributors.

9.4.4. Participants

Delphi methodology requires the participation of “experts” to give opinion in areas in which evidence is lacking or conflicting. It is also recommended that a variety of sources are used to ensure a breadth of views (Fink et al., 1984). As discussed in Chapter 5, experts in emergency general surgery are few and far between, especially at the time that this study was conducted. Use of “experts” based on volume and quality of peer reviewed publications has its own inherent problems and is likely to result in dramatic underrepresentation of nurses in particular. To ensure a breadth of opinions and in order to maintain continuity with the preceding interview study, the same group of contributors were asked to participate in this study (Table 5.1). The participating staff had a mean of 5.9 years’ experience in their existing role, which was considered sufficient to be experienced in the process of care of EGS patients and the potential effect of failures in this care. Theatre nurses were excluded as they have no direct contact with the initial stages of treatment for the majority of emergency surgical admissions and therefore were not considered to have the required expertise to assess processes accurately. After the exclusion of theatre nurses, fifteen interviewees remained

including six surgeons, six anaesthetists and three ward nurses and all agreed to act as participants in this Delphi process.

9.4.5. Procedure

Participants were each given a copy of the first round questionnaire to complete (Appendix D), without reference to each other or other healthcare professionals. This questionnaire asked participants to rate each process on a nine point Likert scale, where 1 was insignificant and 9 was crucial, as to their importance in improving mortality and morbidity for emergency surgical admissions. Participants were also asked to contribute extra processes that had not been considered for the initial questionnaire, to be included in subsequent rounds.

Personalised questionnaires for round two were produced that detailed the median and range of scores for each process that did not reach consensus in round one, as well as the individual participants' original response (Appendix E). This feedback allowed participants to adjust their response to each remaining process and therefore improve consensus, without the inherent bias of a focus group. Two additional processes that were suggested by participants in round one were added to the questionnaires for round two.

9.4.6. Data Analysis

Questionnaire results were entered into an Excel spreadsheet (v2010, Microsoft Corp., Redmond, USA) and summary statistics calculated. A cut-off value for inclusion in the final list of processes was set as a median score of 8 on the nine point (1-9) Likert scale used. Consensus was considered to be achieved once the interquartile range fell below 1.5 for each process.

9.5. Results

All participants completed the entire Delphi process and response rate, both in terms of whole questionnaires and individual items was 100%. Following the first round of questionnaires 20 of the

26 items achieved a consensus opinion, with an interquartile range of 1.5 or less. Of these 20, 16 had a median score of eight or more out of nine, and were therefore included in the final list, and four did not and were discarded (Table 9.2).

The remaining six processes, along with the two suggested by participants during round one were submitted to a second round of questionnaires. Following this round, all items gained a consensus opinion and, of the eight processes, five were included in the final list of included processes and three were discarded (Table 9.2). One of the two processes suggested by participants in round 1 was accepted by the panel and one was rejected. In total, therefore, 21 out of the 28 processes surveyed were accepted by this Delphi.

There were notable differences in the scores allocated by different groups of healthcare professionals, particularly for the processes that were rejected. For example, having a documented plan for oral intake was considered important by nurses (median 8), however doctors did not think it would contribute to better outcomes (median 7). The overall median for this process was 7 and therefore it was rejected. Another example of this was excessive patient transfers, which was given a median score of 9 by nurses in round one but only scored a median of 7 from doctors. This process was subsequently rejected following round two. Similarly, use of thromboprophylaxis was favoured by nurses (median 9) but not doctors (median 7). There were also discrepancies between types of doctors for some processes, for example involvement of a medical team for patients with concurrent illness was considered very important by surgeons (median 8.5) but not by anaesthetists (median 6.5).

Table 9.2: Results of Delphi process

Included Processes	Round One		Round Two	
	Median Score (1-9)	IQR	Median Score (1-9)	IQR
All patients with severe sepsis or septic shock should have blood cultures taken and antibiotics administered within 3 hours of admission (Dellinger et al., 2008).	9	0.5*	-	-
Resuscitation or maintenance with intravenous fluid should be instigated where appropriate (Powell-Tuck et al., 2008).	9	0.5*	-	-
Emergency surgical admissions should be to a ward which is appropriate for their clinical condition in terms of required specialty, level of care and presenting complaint (Martin et al., 2007a).	9	1.0*	-	-
Patients who are bleeding or at risk of bleeding should have a group and save sample taken.	9	1.0*	-	-
A clear treatment plan should be documented in the casenotes (Martin et al., 2007a).	9	1.0*	-	-
A clear handover should be made to the incoming surgical team, including patient name, location, diagnosis and investigations (Martin et al., 2007a, Royal College of Surgeons of England, 2007).	9	1.5*	-	-
By the time of the post-take ward round a preliminary diagnosis should have been made.	8	0.5*	-	-
The initial assessment of patients should include a doctor of sufficient experience and authority to implement a management plan (Martin et al., 2007a).	8	1.0*	-	-
Adequate intravenous access should be secured.	8	1.0*	-	-
Appropriate analgesia should be administered and titrated as necessary.	8	1.0*	-	-
Patients with haemodynamic instability should have a urethral catheter placed to monitor fluid balance.	8	1.0*	-	-
Patients with persistent vomiting and signs of obstruction should have a nasogastric tube placed.	8	1.0*	-	-
Documentation of the first consultant review should be clearly indicated in the casenotes (Martin et al., 2007a).	8	1.0*	-	-
Vital signs observations, including fluid balance, should be recorded in line with the physiological monitoring plan and not less than twelve hourly (DeVita et al., 2010, 2007).	8	1.5*	-	-
Basic bloods (U&E, FBC, CRP where appropriate) should have been performed.	8	1.5*	-	-
Casenotes for patients previously treated at the hospital should be obtained.	8	1.5*	-	-
Casenote entries should be legible, dated, timed and signed (Martin et al., 2007a).	8	2.0	8	0.5†
Patient's allergy status and routine medication should be transcribed onto the medication chart unless contraindicated.	8	2.0	8	1.0†
Patients admitted as an emergency should be seen by a consultant at the earliest opportunity. Ideally this should be within 12 hours and should not be longer than 24 hours (Martin et al., 2007a).	8	2.0	8	1.5†
A clear physiological monitoring plan should be made and documented for each patient (e.g. 4 hourly observations)(2007, Martin et al., 2007a, DeVita et al., 2010).	8	2.0	8	1.5†
Patients with reduced oxygen saturation or PaO ₂ (usually less than 95%) should have supplemental oxygen administered (Anderson, 2003).	-	-	8	0.5†
Excluded Processes	Round One		Round Two	
	Median Score (1-9)	IQR	Median Score (1-9)	IQR
A plan for oral intake should be documented in the casenotes.	7	1.0*	-	-
If a significant concurrent medical illness is apparent then the appropriate medical team should be involved.	7	1.5*	-	-
Appropriate plain radiology should be complete.	7	1.5*	-	-
If NBM, important oral medications should be converted to an alternative route.	7	1.5*	-	-
All suitable patients should have appropriate thromboprophylaxis (2010).	7	2.0	7	1.5†
Excessive transfers both within and outside the hospital should be avoided (Martin et al., 2007a).	7	2.5	7	1.5†
Patient's exercise tolerance and functional status should be clearly documented in the casenotes.	-	-	7	1.5†

IQR interquartile range; U&E urea and electrolytes; FBC full blood count; CRP C-reactive protein; PaO₂ partial pressure of oxygen

* items achieving consensus in round 1, † items achieving consensus in round 2

Some variation in opinion also occurred in processes accepted for the final list, again commonly between doctors and nurses. Doctors considered the teamwork processes of initial assessment by a suitable doctor (median 8 from doctors vs. 6 from nurses), consultant review within 24 hours (median 8 vs. 6) and clear handover (median 9 vs. 8) very important but nurses scored them less highly. Conversely nurses believed that clear, legible documentation would improve outcome but doctors were less sure (median 9 from nurses vs. 8 from doctors).

9.6. Discussion

This study has identified a core list of 21 processes that clinically experienced assessors believe will improve outcome for EGS admissions. This list will allow a quantitative assessment of the effectiveness of care for EGS admissions and may provide the basis for future interventions. Six of the processes in the initial list came from available guidelines or an evidence base for their use in published literature. Of these six, five were accepted by the panel and included in the final list however thromboprophylaxis, with the weight of several randomised controlled trials, meta-analyses and a NICE guideline, albeit predominantly in elective patients, was not accepted. The nurse participants were in favour of this process, possibly because of ward protocols advocating thromboprophylaxis, but doctors were less convinced, perhaps considering that the potential risks of thromboprophylaxis outweigh the benefits in emergency patients.

The initial list of statements included nine recommendations from the recent NCEPOD report on emergency admissions (Martin et al., 2007a). Eight of these processes were accepted by the panel for the final list however “excessive transfers both within and outside the hospital should be avoided” was not. Though nurses, who have first-hand experience of the problems caused by transfers, considered that its implementation would improve outcomes, doctors did not and suggested that it may actually be beneficial when indicated by the patient’s disease or clinical condition. Responses by doctors resulted in this process being rejected.

Differences of opinion were apparent for a number of processes and this was not surprising given the differing backgrounds of the participants. It was not a shock to see that while surgeons are keen on physicians' input for their patients, anaesthetists would much rather manage medical conditions themselves. Nurses scored protocol and documentation processes highly but doctors valued senior doctor involvement and teamwork and this reflects the inherently different cultures of these healthcare professions.

Previous work in this area has confined its process analysis to either the literature or expert opinion alone (Kreckler et al., 2009, Stevenson et al., 2007) and explored a much smaller set of processes than this study encompasses. The use of a comprehensive search strategy and a robust method of process selection have produced a useful and repeatable list of processes on which to base further research.

9.6.1. Limitations

As with any consensus process this Delphi is subject to a number of limitations. The primary limitation is the lack of robust evidence for participants to base their judgements upon. Clearly this is the main reason consensus methods are required in the first place. Secondly the consensus gathering itself is only as good as the panel assembled. There is a risk of deriving "collective ignorance" rather than group knowledge (Jones and Hunter, 1995), however, by including a range of healthcare professionals in the process and ensuring appropriate experience of the panel, this risk has been minimised. This limitation may be illustrated by the exclusion of thromboprophylaxis, against the recommendation of NICE guidelines and current clinical practice, however the panel recommendation is in line with the equivocal literature review on this topic (Bergqvist et al., 1996).

There were varying opinions for a number of processes but the differing occupation of participants ensured a more balanced consensus. It is possible that nursing opinions were underrepresented as there were only three nurses on the panel, however it is not possible to fully balance the groups of

doctors versus nurses and those of anaesthetists versus nurses versus surgeons and therefore a pragmatic approach was taken. As discussed in Chapter 5 (Section 5.5.1) participants were limited to experienced clinical staff at a single institution and many were known to the research team in advance. This may have resulted in bias given the lack of opinion from other NHS hospitals and the fact that some staff may have felt obliged to participate based on their previous encounters with the research team. Published experts in the field of emergency surgery may have weighted responses differently and, should the study be repeated, a wider and more experienced group of participants could be used, especially in view of the development of significantly greater numbers of senior clinicians with a stated interest in emergency general surgery.

A final limitation is the lack of communication and discussion between participants that, while it avoids some personal and professional interests dominating others, does not allow reasoned argument or development of additional ideas.

9.7. Conclusion

This Delphi process used consensus methodology to develop an explicit list of standard processes for the initial treatment of emergency surgical admissions. The following chapter will use the process list developed in this study to make an assessment of the effectiveness of care for EGS admissions in multiple NHS institutions. This list can also be used to audit treatment of EGS admissions, as a checklist intervention to try to improve process reliability and as a training tool for the junior medical staff who usually perform the majority of these processes.

10. ADHERENCE TO FUNDAMENTAL CARE PROCESSES FOR THE ADMISSION OF EMERGENCY GENERAL SURGICAL PATIENTS

10.1. Introduction

The last chapter developed a list of key processes for the admission of emergency general surgical patients. This chapter describes a multicentre study to examine adherence to these processes in the NHS. Chapters 7 and 8 have shown that there is a high degree of variability between NHS trusts in terms of both structure and outcomes. It has been suggested that there is also a high degree of variability in the process of care for EGS patients between NHS institutions but this is difficult to prove due to the lack of robust data on the process of care for EGS patients (Royal College of Surgeons of England, 2011a, Association of Surgeons of Great Britain and Ireland, 2012).

This study aimed to investigate the effectiveness of care provided to EGS admissions by assessing the reliability of fundamental care processes identified in Chapter 9 across multiple hospitals in London and the south-east of England. The study aimed to include a sufficient number of patients per site to demonstrate the presence or absence of variability in the quality of care between hospitals. A final aim was to investigate the effect of process adherence on patient outcomes.

10.2. Methods

10.2.1. Study Design

This chapter describes an observational study of emergency general surgical admission processes. An explicit list of fundamental care processes for newly admitted EGS patients, developed in Chapter 9, was used to assess the effectiveness of care for these patients. Included patients were limited to those with acute abdominal symptoms, including rectal bleeding, because this represents a discreet group of patients that were easily identified by investigators and make up the majority of EGS

admissions. In addition, these patients mirror the basket of diagnoses used to investigate EGS HES outcomes in Chapters 7 and 8. Patients with vascular surgical, trauma, gynaecological or urological diagnoses were excluded and patients under the age of 50 were also omitted from the study. Younger patients were excluded to ensure a cohort of patients with greatest potential to benefit from high quality process of care, to exclude large numbers of patients with non-specific abdominal pain or uncomplicated appendicitis and to maximise the chance of identifying a correlation between fundamental admissions process reliability and outcomes. Patients who died before the post-take ward round were excluded, as were those patients admitted directly to the intensive care unit. ICU patients were excluded because the type and intensity of care provided to these patients differs markedly from that available on an open ward. As a result of this, process of care adherence is not easily comparable between patients in these different locations.

Patients were identified for inclusion in the study at the “post-take” handover, in the morning following their admission. Basic demographic data, including time and date of admission and time from admission to review by a surgeon were collected from the casenotes. Following the post-take ward round, adherence to the 21 processes defined by the Delphi process in Chapter 9 were assessed as either performed correctly, not applicable or not performed. In addition to the original 21 processes, the use of thromboprophylaxis was also assessed, despite its omission from the original Delphi list. This was done because of the strong research evidence in favour of its use and NICE guidance that prophylaxis should be used in “acute surgical admission with inflammatory or intra-abdominal condition”, which covers all the patients in this study (National Institute for Health and Clinical Excellence, 2010). Finally, a second data collection was performed, at which point additional information was collected from the patient’s discharge summary regarding final diagnosis, procedures and operations performed, length of stay and morbidity or mortality.

10.2.2. Participants

Participating hospitals and local collaborators were identified through the London Surgical Research Group (LSRG (www.lsrp.co.uk)). The LSRG is a collaborative group of surgical trainees that perform and support clinical surgical research in London and south-east England. The study was advertised to members through the LSRG's internal communications and potential collaborators identified themselves to the author.

Suitable sites were chosen for inclusion and collaborators provided with study literature and training in the use of data collection sheets. Collaborators obtained permission to perform the study from the local NHS Trust audit department and the consultant in charge of emergency general surgery. The study protocol was discussed with all collaborators and amendments made where necessary.

10.2.3. Data collection and analysis

There was a single data collector at each site and therefore collection of data on consecutive patients was not possible. To counteract potential inclusion bias, on days in which patients were included in the study, all suitable patients were recruited. The data collection proforma used for the study can be found as Appendix F. Following discussion with the National Research Ethics Service helpdesk the study was performed as a service evaluation and as an extension of a previous ethics application (08/H0715/112). Anonymised data were entered into an Excel spreadsheet (v2010, Microsoft Corp., Redmond, Washington, USA) and summary statistics calculated. Statistical tests were performed using SPSS statistics (v20, IBM Corporation, Armonk, New York, USA). $p < 0.05$ was considered significant.

10.2.4. Collaborator contributions

The study was designed by the author with assistance from the PhD supervisors. Amendments were made to the study protocol based on the suggestions of LSRG collaborators and the LSRG committee. Data collection was performed by the author at one hospital and by the collaborators at

the remaining sites. All data was collated by the author who subsequently performed the data analysis. Anonymised data was provided to the collaborators for further analysis and local dissemination. All interpretation and manuscript preparation was performed by the author.

10.3. Results

The study was conducted at 5 hospitals in London and south-east England between August 2010 and June 2012, though data collection was staggered between hospitals (Table 10.1). Two of the included hospitals have medical schools on the same site and were designated as teaching hospitals for the purposes of this study. Four hospitals used an “on-call” daily consultant rota and one used a “surgeon of the week” system (Table 10.1). Two of the five hospitals had a surgical admissions unit.

Table 10.1: Included hospitals and their associated resources

Hospital Structure	Hospital A	Hospital B	Hospital C	Hospital D	Hospital E	Total
Number of patients included	80	75	61	50	49	315
Data collection dates	10/2011 to 12/2011	08/2010 to 05/2012	03/2012 to 06/2012	11/2010 to 09/2011	10/2011 to 05/2012	08/2010 to 06/2012
Teaching hospital status	No	Yes	Yes	No	No	
Surgical consultant rota type	On-Call	On-call	On-call	Weekly	On-call	
Surgical admissions unit	Yes	No	Yes	No	No	
Demographics						
Mean age ((SD) years)	71 (13)	70 (11)	67 (11)	69 (12)	69 (13)	69 (12)
Number of males (%)	34 (42.5%)	44 (58.7%)	32 (52.5%)	24 (48.0%)	18 (36.7%)	152 (48.3%)
Diagnoses						
Biliary conditions	16 (20%)	9 (12%)	10 (16%)	8 (16%)	6 (12%)	49 (16%)
Pancreatitis	7 (9%)	13 (17%)	4 (7%)	7 (14%)	7 (14%)	38 (12%)
Diverticulitis	13 (16%)	6 (8%)	5 (8%)	5 (10%)	6 (12%)	35 (11%)
Small bowel obstruction	5 (6%)	8 (11%)	1 (1%)	4 (8%)	7 (14%)	25 (8%)
Rectal bleeding	6 (8%)	8 (11%)	7 (11%)	3 (6%)	0	24 (8%)
Incarcarated/strangulated hernia	5 (6%)	7 (9%)	3 (5%)	6 (12%)	2 (4%)	23 (7%)
Non-specific abdominal pain	6 (8%)	1 (1%)	7 (11%)	0	6 (12%)	20 (6%)
Appendicitis	4 (5%)	6 (8%)	3 (5%)	2 (4%)	3 (6%)	18 (6%)
Other	18 (23%)	17 (23%)	21 (34%)	15 (30%)	12 (24%)	83 (26%)
Procedures						
None	60 (75%)	44 (59%)	39 (64%)	24 (48%)	32 (65%)	199 (63%)
Endoscopy including ERCP	9 (11%)	11 (15%)	5 (8%)	14 (28%)	7 (14%)	46 (15%)
Laparotomy	4 (5%)	11 (15%)	3 (5%)	7 (14%)	8 (16%)	33 (10%)
Appendicectomy	3 (4%)	6 (8%)	3 (5%)	2 (4%)	1 (2%)	15 (5%)
Hernia repair	2 (3%)	1 (1%)	1 (1%)	2 (4%)	0	6 (2%)
Other	2 (3%)	2 (3%)	10 (16%)	1 (2%)	1 (2%)	16 (5%)

SD Standard Deviation; **ERCP** Endoscopic Retrograde Cholangiopancreatography

10.3.1. Demographics

A total of 315 patients were included in the study across a variety of EGS diagnoses. Gallstone related pathology and diverticulitis were particularly common (Table 10.1). The majority of patients were treated non-operatively and the most common procedure was endoscopy (46/315, 14.6%). Laparotomy was the most frequently performed operation, in 33/315 patients (10.5%)(Table 10.1). There were no gross differences between hospitals in terms of diagnosis or procedures. The mean age of patients was 69 years and there was no statistical difference in mean age between hospitals (ANOVA: $F=1.15$, $p=0.335$). There were 152 males (48.2%) and there was similarly no difference in the proportion of male patients between hospitals ($\chi^2=7.355$, $p=0.118$)(Table 10.1).

There were 5 deaths across 3 hospitals and the median length of stay was 4 days (interquartile range (IQR) 3-8 days). Median length of stay varied significantly between hospitals from 3 days (IQR 2-6) at hospital D to 7 days (IQR 4-20) at hospital E (Kruskal-Wallis: $H(4)=27.81$, $p<0.001$)(Table 10.2). Time taken from admission to first review by a surgeon was, on average, 210 minutes (standard deviation (SD) 165 minutes) and there was no significant difference in this time between hospitals. There was however no data available on this metric for hospital D and only data for 160 patients overall (Table 10.2).

Table 10.2: Patient outcomes and adherence to fundamental processes

	Hospital A	Hospital B	Hospital C	Hospital D	Hospital E	Total	Statistical difference between hospitals
Number of patients included	80	75	61	50	49	315	
Outcomes							
Number of deaths	0	2	2	1	0	5	
Median length of stay ((IQR) days)	4 (2-6.75)	5 (3-10)	4 (2-7)	3 (2-6)	7 (4-20)	4 (3-8)	Kruskal-Wallis: H=27.81, p<0.001***
Mean time from admission to surgical review ((SD) minutes)	260 (149) n=34	201 (172) n=46	171 (101) n=40	NA	219 (211) n=40	210 (165) n=160	ANOVA: F=1.879, p=0.135
Processes							
Clear handover	80/80, 100%	73/75, 97%	61/61, 100%	50/50, 100%	48/49, 98%	312/315, 99%	$\chi^2=4.788$, p=0.310
Admission to an appropriate ward	80/80, 100%	61/75, 81%	60/61, 98%	48/50, 96%	20/49, 41%	269/315, 85%	$\chi^2=105.492$, p<0.001***
Consultant review by PTWR	34/78, 44%	51/75, 68%	43/61, 71%	41/50, 82%	33/49, 67%	202/313, 65%	$\chi^2=23.124$, p<0.001***
Intravenous access established	79/79, 100%	71/74, 96%	57/60, 95%	46/50, 92%	48/48, 100%	301/311, 97%	$\chi^2=8.678$, p=0.070
Appropriate intravenous fluids given	68/69, 99%	68/73, 93%	47/49, 96%	49/50, 98%	40/44, 91%	272/285, 95%	$\chi^2=5.266$, p=0.261
Catheterised if haemodynamically unstable	6/6, 100%	26/33, 79%	10/14, 71%	34/36, 94%	6/12, 50%	82/101, 81%	$\chi^2=14.172$, p=0.007**
Nasogastric tube inserted if vomiting and signs of SBO	6/10, 60%	14/18, 78%	6/7, 86%	21/23, 91%	2/11, 18%	49/69, 71%	$\chi^2=21.241$, p<0.001***
Vital sign observations performed at least 4 hourly	77/78, 99%	68/75, 91%	35/61, 57%	44/50, 88%	37/49, 76%	261/313, 83%	$\chi^2=48.854$, p<0.001***
Antibiotics within 3 hours for severe sepsis	2/4, 50%	4/10, 40%	1/5, 20%	31/31, 100%	3/10, 30%	41/60, 68%	$\chi^2=30.886$, p<0.001***
Appropriate analgesia administered	69/70, 99%	52/73, 71%	47/59, 80%	48/50, 96%	45/49, 92%	261/301, 87%	$\chi^2=31.129$, p<0.001***
Oxygen administered when appropriate	7/23, 30%	13/25, 52%	13/27, 48%	41/43, 95%	8/11, 64%	82/129, 64%	$\chi^2=34.270$, p<0.001***
Patient's routine medication prescribed	72/76, 95%	44/75, 59%	54/61, 89%	31/50, 62%	43/48, 90%	244/310, 79%	$\chi^2=44.854$, p<0.001***
Suitable patients given thromboprophylaxis	72/77, 94%	59/71, 83%	55/61, 90%	31/49, 63%	45/48, 94%	262/306, 86%	$\chi^2=27.746$, p<0.001***
Documentation legible, dated, timed and signed	40/79, 51%	65/75, 87%	34/61, 56%	46/50, 92%	23/49, 47%	208/314, 66%	$\chi^2=48.608$, p<0.001***
Registrar review within 4 hours of junior surgeon	57/68, 84%	47/73, 64%	37/60, 62%	46/50, 92%	45/49, 92%	232/300, 77%	$\chi^2=29.035$, p<0.001***
Preliminary diagnosis made by time of PTWR	72/78, 92%	71/75, 95%	46/61, 75%	44/50, 88%	34/48, 71%	267/312, 86%	$\chi^2=21.683$, p<0.001***
Treatment plan documented	79/80, 99%	74/75, 99%	61/61, 100%	49/50, 98%	43/48, 90%	306/314, 98%	$\chi^2=14.614$, p=0.006**
Plan for vital signs observation documented	5/78, 7%	19/75, 25%	30/61, 49%	20/50, 40%	2/48, 3%	76/312, 24%	$\chi^2=51.334$, p<0.001***
Basic blood tests performed	79/80, 99%	73/75, 97%	61/61, 100%	27/27, 100%	49/49, 100%	289/292, 99%	$\chi^2=3.443$, p=0.487
Blood group and save performed where appropriate	35/38, 92%	12/14, 86%	38/38, 100%	48/50, 96%	3/3, 100%	136/143, 95%	$\chi^2=5.583$, p=0.233
Documentation of first consultant review performed	45/79, 57%	52/55, 95%	48/49, 98%	41/41, 100%	37/39, 95%	223/263, 85%	$\chi^2=68.517$, p<0.001***
Old casenotes found for readmissions	63/76, 83%	18/73, 25%	4/46, 9%	43/50, 86%	35/45, 78%	163/290, 56%	$\chi^2=120.232$, p<0.001***
Mean number of key process omissions (SD)	3.24 (1.61)	4.09 (1.80)	3.89 (1.69)	2.42 (1.25)	4.20 (1.83)	3.59 (1.76)	ANOVA: F=11.008, p<0.001***

NA Not Available; SD Standard Deviation; PTWR Post-Take Ward Round; SBO Small Bowel Obstruction; IQR Interquartile Range

10.3.2. Poor process reliability

A total of 5668 processes were considered by the investigators to be indicated and, of these, 1130 (19.9%) were omitted by the treating team. The mean number of admissions processes omitted was 3.59 per patient (SD 1.76, range 0-9) and only six patients had all relevant processes performed. The finding that admissions processes are only 80% reliable is comparable to the published process reliability discussed in Chapter 3. The fact that less than 2% of patients had all recommended processes completed is notable.

A number of processes were performed particularly poorly. These include documentation of a plan for vital signs observation (76/312, 24%), retrieval of old casenotes (163/290, 56%), administration of oxygen to hypoxic patients (82/129, 64%), consultant review by the time of the post-take ward round (202/313, 65%) and administration of antibiotics within 3 hours for patients with severe sepsis (41/60, 68%)(Table 10.2). In 17/22 key processes there was significant difference between hospitals in adherence, demonstrating variability in the quality of care at a process level and mirroring the variability between hospitals in structure and outcomes shown in Chapters 7 and 8.

10.3.3. Variability between hospitals

Adherence to key admissions processes varied widely between hospitals and there was a significant difference in the mean number of process omissions between hospitals (ANOVA: $F=11.008$, $p<0.001$)(Table 10.2). Process omissions ranged from 2.42 per patient (SD 1.25) at hospital D to 4.20 per patient (SD 1.83) at hospital E.

There was a strong positive correlation between the mean number of process omissions at a hospital and the median length of stay (Spearman's $\rho = 0.975$, $p=0.005$). Despite this positive correlation between the mean number of process omissions and the median length of stay for hospitals, there was no significant correlation between these metrics at the individual patient level (Spearman's $\rho = 0.063$, $p=0.268$).

There was no significant correlation between the time to review by a surgeon, which might be considered a proxy measure of how busy the surgeon or emergency department was, and adherence to key processes (Spearman's $\rho = 0.046$, $p=0.562$). Similarly, there was no significant difference in key process adherence between weekend and weekday admissions (Mann-Whitney U test, $p=0.330$) nor for patients admitted outside weekday normal working hours (8am-5pm) (Mann-Whitney U test, $p=0.900$).

Teaching hospitals omitted significantly more processes than non-teaching hospitals (4.00 vs. 3.27, $p<0.001$). There was no difference in the number of missed processes between patients treated in hospitals with a surgical admissions unit and those treated elsewhere (Mann-Whitney U test, $p=0.680$). The hospital with fewest process failures was the only site that ran a "surgeon of the week" consultant duty rota. Patients treated at this hospital had significantly fewer missed processes than the remaining patients treated in a consultant "on-call" system (Mann-Whitney U test, $p<0.001$).

10.4. Discussion

10.4.1. Poor process reliability

This study has demonstrated poor adherence to key admission processes in the care of emergency general surgical patients. The mean process failure rate was 3.59 per patient and, though there were 22 processes assessed, some did not apply to all patients, meaning that the overall denominator was approximately 18 processes per patient. Therefore, the overall process failure rate was nearly 20%. This level of process reliability would never be accepted in any other high reliability organisation and yet it goes on almost unchallenged within the NHS. Unfortunately the harm caused by omitted processes is usually occult and can be easily attributed to the patient's underlying disease. As a result, clinicians do not give process reliability the attention it deserves.

In addition to poor reliability there was significant variability between hospitals in terms of the overall completion of key processes and the adherence to individual processes themselves. This finding mirrors the variability shown in NHS trust structure and outcomes in Chapters 7 and 8 of this thesis and corroborates the recent statements on variability in care by surgical associations (Royal College of Surgeons of England, 2011a, Royal College of Surgeons of England, 2011b, Association of Surgeons of Great Britain and Ireland, 2012). It is highly likely that these omissions in the process of care will have resulted in worse outcomes for these patients, though this is difficult to demonstrate without a huge cohort of patients. Nevertheless, an experienced panel considered the processes assessed in this study to be important in optimising patient's outcomes and therefore a demonstration of improved outcomes when the processes are performed correctly should not be necessary.

Some processes were performed well and these tended to be those that were routine and often performed by emergency department staff prior to surgical review. Examples include establishing intravenous access (301/311, 97%) and performing basic blood tests (289/292, 99%). Conversely, processes that were not required routinely and were done at the discretion of treating staff were performed much less robustly. Administration of oxygen to hypoxic patients (82/129, 64%), antibiotics for patients with severe sepsis (41/60, 68%) and appropriate use of nasogastric tubes (49/69, 71%) were all done poorly. Expert opinion would suggest that correct usage of these three processes would have a significant effect on patient's outcomes and so their poor reliability is particularly worrisome. Indeed the omission of oxygen for hypoxic patients and lack of antibiotics in severe sepsis approach medical negligence in some cases. It seems that allowing clinicians to pick and choose which processes to perform on which patient frequently results in inappropriate process omission.

One process, documentation of a plan for vital signs monitoring, was an outlier with only 76/312 (24%) correctly performed. It is likely that, despite a recommendation by a recent NCEPOD report

(Martin et al., 2007a), clinicians do not consider this necessary unless they want an abnormal regimen of observations to be performed.

10.4.2. Variability between hospitals

There was a significant correlation between hospitals that performed poorly on process reliability and those with a longer median length of stay. Despite this finding, there was no correlation between process adherence for individual patients and their length of stay. It is possible that poor process adherence reflects the lack of organisation of the treating clinical team or institution and that this is also reflected in increased lengths of stay in hospital. Given the small number of deaths in the study population it was not possible to draw any conclusions regarding process adherence and mortality.

The hospital with the fewest missed processes ran a surgeon of the week consultant rota. The small number of hospitals sampled makes it difficult to draw any conclusions about the impact of these differences in rotas but this finding would bear further investigation, given the lack of robust multicentre evidence for or against these types of working patterns.

10.4.3. Comparisons with similar studies

Stevenson et al. assessed adherence to a shorter list of generic processes as well as some disease specific processes for EGS patients (Stevenson et al., 2007). They found similar poor adherence to basic admissions processes and found that interventions that raised doctor's awareness of the processes expected in each scenario improved adherence. They also found that a reduction in the rate of process failure reduced adverse events in their study population, which suggests that improvements in the process of care may have a direct effect on outcomes. Such an effect on outcomes has been demonstrated by checklists of processes in other parts of the emergency care pathway. For example, subgroup analysis of the WHO patient safety checklist study has demonstrated that implementation of a perioperative checklist resulted in a more than 50%

reduction in mortality and greater than one third reduction in major complications in emergency surgical patients (Weiser et al., 2010). Similar checklists in elective surgery have shown a reduction in mortality approaching 50% (Haynes et al., 2009, de Vries et al., 2010). Given the high mortality of emergency general surgical patients and the importance of the initial phase of treatment, it is possible that the implementation of the type of checklist used in this study could produce a significant improvement in patient outcomes. A potential future study could assess the impact of this, or a similar checklist against control hospitals to see if its utilisation led to improved patient outcomes.

10.4.4. Limitations

This study has a number of limitations. Primarily, the inclusion and exclusion criteria disqualified patients that died prior to the post-take ward round or were admitted to ICU. These are the very patients most likely to benefit from this type of checklist; however it was necessary to exclude them to allow fair comparison between patients treated in similar environments and for reasons of logistics. The small number of data collectors meant that prospective inclusion of patients from the point of admission was not possible.

A second limitation is the potential lack of reliability between investigators at different sites. It is possible that different investigators had different thresholds for considering processes such as urethral catheterisation to be indicated or for when they considered a process like handover to be completed adequately. To attempt to counteract reliability issues, experienced surgeons were recruited as investigators. These investigators were given training in the use of data collection instruments and process descriptions were made as objective as possible. Because of manpower and NHS contract limitations it was not possible to arrange dual rating of patients to assess inter-rater reliability and this is a potential weakness of the study.

A final limitation was the lack of consecutive patient inclusion. This was due to investigators being part of each hospital's surgical team and therefore not being able to collect data on patients that they had treated themselves, in addition to investigators holidays and other absences. The study attempted to avoid inclusion bias by recruiting all suitable patients on days in which recruitment occurred.

10.5. Conclusion

This study has demonstrated the poor reliability of key admissions processes for EGS patients and shown significant variability in the effectiveness of care between the hospitals involved. It has also demonstrated that hospitals that have greater numbers of process omissions have a longer median length of stay. Interventions such as improving surgeon's awareness of these key admissions processes or the use of an admission checklist may improve the reliability and effectiveness of this facet of care and have the potential to improve patient outcomes.

Chapters 9 and 10 have assessed the reliability of processes of care for EGS patients through the admissions phase of care using an explicit, quantitative methodology. Beyond the admission phase of care treatment of EGS patients diverges significantly due to the variable treatment pathways for different EGS diseases. For this reason any study to evaluate the process of care beyond the first 24 hours requires an alternative methodology. The next chapter will look at the quality of the process of care for EGS patients after admission using a less explicit and more qualitative methodology.

11. EFFECTIVENESS OF CARE BEYOND ADMISSION

11.1. Introduction

The preceding chapter has demonstrated the poor reliability of basic processes in the admission phase of care for EGS patients. Assessing the effectiveness of care in the post-admission care pathway for these patients is complicated by the fact that there are a multitude of disease processes involved and therefore many different treatment regimens. As we have seen, EGS encompasses a wide variety of diagnoses, many patients do not require surgery and length of stay varies widely. For these reasons the use of an explicit checklist methodology to assess quality of care beyond the initial admission phase of care is impractical. A researcher would need a myriad of checklists covering every possible eventuality. An alternative to explicit checklists is the use of an “implicit”, qualitative methodology based on expert opinion and ethnographic field notes. The advantage of such a methodology is that any failure in the process of care can be examined, not just those found on an explicit pre-determined list. In addition, the aetiology of the event and information on preventability and the outcome for patients can also be collected. In conjunction with the work presented in this thesis, the Clinical Safety Research Unit at Imperial College have developed an implicit methodology to assess failures in the process of ward-based care (Symons et al., 2013a). This chapter will describe the application of this methodology to the care of EGS patients.

The aim of this study was to examine the frequency, preventability and aetiology of process failures in the care of EGS patients from the time of admission to discharge. In addition, the degree of harm caused to patients by these process failures was assessed.

11.2. Methods

11.2.1. Study population

This was a prospective, observational study performed at a large, urban teaching hospital between September 2010 and April 2012. The study included any EGS patient, over the age of 50 years, with an acute abdominal presenting complaint but excluding trauma, vascular, urological and gynaecological diagnoses. The population for this study was the same group of patients as those at Hospital C in the study of admission processes described in Chapter 10. Patients under the age of 50 were excluded to avoid the inclusion of large numbers of patients with appendicitis, non-specific abdominal pain and similar, less serious admission diagnoses. In addition, the study aimed to capture the quality of care for those patients with the most complex disease processes and greatest number of co-morbidities and the exclusion of younger patients facilitated this aim. Patients admitted to intensive care, either directly or via the operating theatre were excluded from the study as the structure and intensity of care provided in this environment is quite different to that on a general surgical ward. Patients who were initially admitted to a ward environment but subsequently required intensive care treatment were followed through this phase of care and to discharge. Patients who died before the post-take ward round and those admitted solely for palliative care were excluded from the study. Due to the single data collector it was not possible to recruit patients on consecutive days. On days that new patients were recruited to the study all suitable patients were included in order to minimise selection bias as far as possible.

11.2.2. Definitions

Several terms are used in the literature to describe untoward incidents in medical care. A “non-routine event” (NRE) is the broadest term used (Box 11.1). NREs include episodes in which medical management has been optimal, for example, a post-operative wound infection despite optimal surgical technique and appropriate antibiotic prophylaxis. The concept of NREs has been adapted

from the nuclear industry for use in the assessment of patient safety (Weinger and Slagle, 2002, Schraagen et al., 2011). “Process failures” are a subset of NREs and consist of those events in which an aspect of medical care (a process) was accidentally omitted, performed incorrectly or was incomplete (Box 11.2). An “adverse event” (Box 11.1) is a more specific term and, according to a strict definition, it is only present when a patient’s length of stay in hospital is prolonged or they have an on-going disability on discharge (Wilson et al., 1995). This study aimed to capture as wide a range of problematic events as possible. Therefore the first step taken was to observe and collate non-routine events in the care of EGS patients, before assessing whether or not a process failure had occurred and what impact this had on the patient.

Box 11.1: Definitions

Non-routine event (NRE)

“Any event that is perceived by care providers or skilled observers to be unusual, out-of-the-ordinary or atypical” (Weinger and Slagle, 2002, Schraagen et al., 2011)

Adverse event

“An injury caused by medical management (rather than the disease process) that results in either a prolonged hospital stay or disability at discharge” (Wilson et al., 1995)

11.2.3. Data collection

Patients were recruited at the time of the post-take ward round and, from that point until discharge, the lead researcher conducted daily observation of the patient’s care that consisted of attending morning ward rounds, examining patient casenotes, medication charts, vital sign observation charts and conducting interviews with clinical staff. The researcher had worked on the unit prior to the commencement of the study and so was familiar with the local policies and protocols and a number

of the permanent members of staff but this researcher was not involved in the care of any patient in the study.

Ethnographic field notes were used to collect data on any NRE, whether leading to patient harm or not. The majority of these field notes related to events that had occurred in the preceding twenty four hours. For these incidents, field notes reflected the content of the casenotes, charts and discussion with the healthcare team. A minority of NREs were directly observed during the ward rounds attended. In these cases the field notes reflected the researcher's own observations in addition to the other sources described. Field notes recorded the circumstances surrounding each NRE, any precipitating factors and the outcome for the patient. At this stage the presence or absence of process failures and adverse events was not considered.

11.2.4. Data analysis

Once data collection was complete NRE field notes were analysed independently by two surgical registrars. One coder had participated in the data collection (the author) and one (Mr Alex Almoudaris) was blinded to patient outcome in order to minimize hindsight bias. Both coders had experience in surgical post-operative care, patient safety research and familiarity with this research methodology.

Table 11.1: Coding of non-routine events and inter-rater reliability

Coding category	Coding variables	Inter-rater reliability (intraclass correlation coefficient)
Process failure	Present or absent	0.587, $p < 0.001$
Patient harm	No harm/minor harm/adverse event	0.629, $p < 0.001$
Preventability	1-6 Likert scale (≥ 4 considered preventable)	0.598, $p < 0.001$
Communication failure	Present or absent	0.648, $p < 0.001$
Delay	Present or absent	0.537, $p < 0.001$

NREs were firstly assessed for the presence or absence of a process failure. Those NREs in which there was no evidence of any process failure were therefore not the result of medical management. NREs that contained process failures were then coded according to the degree of harm suffered by the patient and the incident's preventability (Table 11.1). This coding strategy was based on the methods employed by case-record review studies for similar incidents and events (Brennan et al., 1991, Wilson et al., 1995, Vincent et al., 2001), specifically the Quality in Australian Healthcare Study (Wilson et al., 1995).

Coding for harm was adapted to differentiate adverse events; minor harm that did not meet the threshold for adverse events; and no harm (Table 11.1). This differentiation was not included in the cited case-record review studies as these studies had a lower sensitivity and a higher threshold for reporting harm. Process failures scoring 4 or more on a 6 point Likert scale for preventability were considered preventable (Wilson et al., 1995). Finally, field notes were assessed for any communication failures or delays that led, directly or indirectly, to the process failure in question. This method for coding non-routine events has been peer-reviewed in the author's recent evaluation of elective post-operative care (Symons et al., 2013a).

Box 11.2: Examples of process failures and coding strategy

Non-routine event without process failure

A patient with small bowel obstruction, who had previously refused an operation, became increasingly unwell and required an urgent laparotomy and right hemicolectomy

Preventable process failure with no harm to the patient

A patient's routine medication was not prescribed for 2 days despite written documentation of drugs and doses and a request to write them up by the pharmacist

Non-preventable process failure with minor harm

A patient became acutely confused and pulled out their tracheostomy and nasogastric tube. This required sedation and reinsertion of the dislodged tubes

Preventable process failure and adverse event

A flexible sigmoidoscopy was ordered for a patient with rectal bleeding but, due to poor communication, the endoscopy was performed per stoma rather than per rectum. This resulted in the investigation being repeated and the patient's discharge delayed

Inter-rater reliability for all domains was assessed using the intra-class correlation coefficient and a two-way mixed, single measures model with absolute agreement (Shrout and Fleiss, 1979)(Table 11.1). Discrepancies in coding were then resolved by consensus discussion between the raters. Statistical analyses were performed using IBM SPSS Statistics v20 (IBM Corporation, Armonk, New York). The study was approved as a service evaluation in an extension of a previous application to the local Research Ethics Committee (08/H0715/112) by the National Research Ethics Service helpdesk.

11.3. Results

The study included 75 EGS patients and daily observations were conducted over a total of 645 days of inpatient care (Table 11.2). The study cohort included 44 males (59%) and the median age was 71 years (range 50-96). There were 2 deaths in hospital and the median length of stay was 5 days (range 2-72). The study population covered a wide range of EGS diagnoses of varying severity, as demonstrated by the range of length of stay (Table 11.2). 8 patients (11%) were treated in the intensive care unit (ICU) during their hospital stay and the median ICU stay was 6.5 days. A further 12 patients were treated in the high dependency unit whilst an inpatient (Table 11.2).

11.3.1. Non-routine events and process failures

The study identified 276 NREs, a mean of 3.7 per patient, with a range of 0 to 30. Of these 276 NREs, 220 (80%) were classified by the raters as process failures (Fig. 11.1), resulting in a mean number of process failures per patient of 2.9 (range 0-16). The process failures that were identified included a wide range of problems with varying severity (Box 11.2). The 56 NREs that were not classified as process failures consisted mainly of complications of the patient's presenting complaint or exacerbations of pre-existing comorbidities.

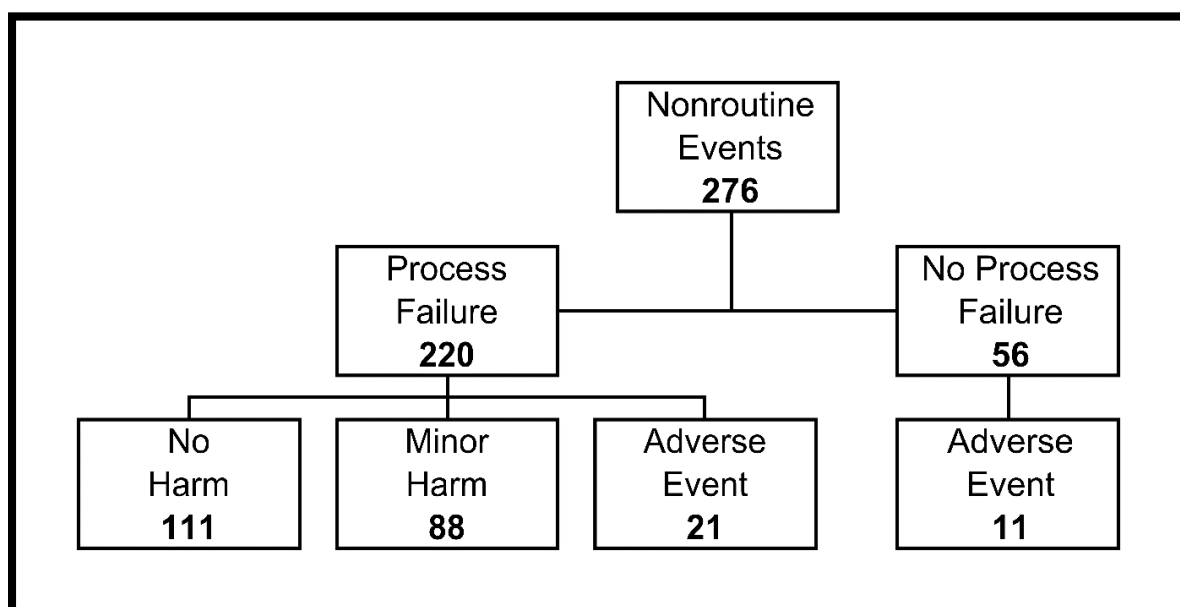
Table 11.2: Demographics of study population

Sex (male:female)	44:31
Age (years): median (range)	71 (50-96)
Diagnoses (%)	
Bowel obstruction	14 (19%)
Pancreatitis	13 (17%)
Biliary disease	9 (12%)
Rectal bleeding	8 (11%)
Diverticulitis	6 (8%)
Appendicitis	6 (8%)
Bowel perforation	6 (8%)
Hernia complications	4 (5%)
Other	9 (12%)
Procedures (%)	
None	44 (59%)
Endoscopy, including ERCP	11 (15%)
Laparotomy	10 (13%)
Appendicectomy	6 (8%)
Other	4 (5%)
Length of stay (days): median (range)	5 (2-72)
ICU admission (%)	8 (11%)
HDU admission (%)	20 (27%)
Inpatient death (%)	2 (3%)

ERCP Endoscopic Retrograde Cholangiopancreatography

ICU Intensive Care Unit

HDU High Dependency Unit

Figure 11.1: Flowchart of incident coding

The raters categorised process failures into one of 4 major groups. These were medication provision, care management and delivery, patient assessment and investigations (Table 11.3). These 4 groups were then sub-divided into logical categories based on the type of process failure that they described. Failures of medication prescribing and administration were most prevalent. Process failures to do with surgical lines, tubes and drains and those related to either delays in patient assessment or its documentation were also common.

Table 11.3: Frequency, preventability and harm caused by process failures

Process failure	Frequency (% of total)	No. preventable (% of frequency)	Harm caused by process failures (% of frequency)		
			No Harm	Minor Harm	Adverse Event
Medication	92 (42%)	91 (99%)[#]	61 (66%)*	28 (30%)*	3 (3%)*
Prescribing	54	53 (98%)	30 (56%)	21 (39%)	3 (6%)
Distribution/supply	4	4 (100%)	2 (50%)	2 (50%)	-
Administration	34	34 (100%)	29 (85%)	5 (15%)	-
Care management /delivery	59 (27%)	44 (75%)[#]	10 (17%)*	41 (69%)*	8 (14%)*
Lines/tubes/drains	29	15 (52%)	3 (10%)	24 (83%)	2 (7%)
Patient transfers	9	8 (89%)	3 (33%)	5 (56%)	1 (11%)
Therapies	7	7 (100%)	1 (14%)	4 (57%)	2 (29%)
Equipment	4	4 (100%)	2 (50%)	2 (50%)	-
Other	10	10 (100%)	1 (10%)	6 (60%)	3 (30%)
Assessment	47 (21%)	45 (96%)[#]	28 (60%)*	12 (26%)*	7 (15%)*
Documentation	21	21 (100%)	21 (100%)	-	-
Delay	20	19 (95%)	4 (20%)	9 (45%)	7 (35%)
Other	6	5 (83%)	3 (50%)	3 (50%)	-
Investigations	22 (10%)	22 (100%)[#]	12 (55%)*	7 (32%)*	3 (14%)*
Imaging	15	15 (100%)	8 (53%)	6 (40%)	1 (7%)
Blood investigations	5	5 (100%)	4 (80%)	-	1 (20%)
Endoscopy	2	2 (100%)	-	1 (50%)	1 (50%)
Total	220	202 (92%)	111 (51%)	88 (40%)	21 (10%)

[#] $\chi^2 = 32.44$, $p < 0.001$; * $\chi^2 = 42.91$, $p < 0.001$

Process failures were highly preventable. Overall, the raters considered 202 (92%) process failures to be preventable. This consisted of almost all failures in the medication, assessment and investigation categories (158/161, 98%) and 75% (44/59) of failures in the care management and delivery category (Table 11.3). This variation in preventability between categories of process failure was significant ($\chi^2 = 32.44$, $p < 0.001$).

109 (50%) process failures led to either patient harm or an extended length of stay in hospital. Again, care management and delivery had a significantly greater proportion of process failures that led to harm (49/59, 83%) than other groups ($\chi^2 = 42.91$, $p < 0.001$). Endoscopy investigations and lines, tubes and drains had the highest rates of patient harm (100% and 90 % respectively). Of 109 process failures that led to harm, 92 (84%) were considered preventable. Process failures that led to harm were significantly less preventable than those that did not ($\chi^2 = 15.81$, $p < 0.001$) because the relatively less preventable process failures in the care management and delivery category had a greater rate of patient harm.

11.3.2. Adverse events

This study identified 32 adverse events, which occurred in 21 patients (28% of patients, range 0-5). Of these adverse events, 21 were associated with a process failure (Fig. 11.1) and 11 related to progression of the patient's underlying disease, their comorbidities or were otherwise unrelated to their medical care. Adverse events were rare in the medication provision category of process failures but constituted about 15% of process failures in all other groups (Table 11.3). The 21 adverse events that were associated with a process failure occurred in 17 patients and all but one (20/21, 95%) were considered preventable. Adverse events caused by process failures were significantly more preventable than those unrelated to medical management (95% vs. 18%, $\chi^2 = 19.95$, $p < 0.001$). Out of all adverse events, 22/32 (69%) were considered preventable, which is comparable to the findings of the case record review studies on which the methodology for this study is based (Wilson et al., 1995, Vincent et al., 2001, de Vries et al., 2008).

Box 11.3: Examples of adverse events

Medication prescribing

A patient was prescribed 8.5 liters of IV fluid and 2 units of blood in the first 48 hours post-op. This resulted in significant oedema and hypokalaemia and led to delayed discharge

Lines/tubes/drains

A percutaneous tracheostomy was inserted and a little bleeding from the site stopped with pressure. The same night the patient suffered significant bleeding and had to be taken to the operating theatre for exploration

Delay in assessment

A patient was handed over from one surgical team to another but due to miscommunication the patient was not reviewed by anyone other than a house officer for 3 days

Imaging investigations

A patient was seen in the emergency department 3 days prior to admission and had an abdominal x-ray that showed obvious small bowel obstruction. The patient was diagnosed with constipation and discharged with suppositories

11.3.3. Aetiology of process failures

Process failures were assessed by the raters for the presence of either a breakdown in communication or a delay in medical care as the underlying cause for the incident (Table 11.4). Either communication failure or delay were the causative factor in 133/220 (60%) process failures and in 32 cases both communication failure and delay were present. Communication failures were particularly common in the assessment of patients (27/47, 57%), especially in terms of problems with documentation. Delays occurred most frequently in process failures to do with patient investigations (15/22, 68%) (Table 11.4). Failure to carry out planned care or administer prescribed medications was another common cause of process failures as were patient related issues such as the displacement of lines, tubes and drains.

Table 11.4: Aetiology of process failures

Process failure category	Communication failure (%)	Delay (%)
Medication	33 (36%) [#]	23 (25%)*
Care management/delivery	16 (27%) [#]	23 (39%)*
Assessment	27 (57%) [#]	21 (45%)*
Investigations	7 (32%) [#]	15 (68%)*
Total	83 (38%)	82 (37%)

[#] $\chi^2 = 11.07$, $p=0.011$; * $\chi^2 = 16.09$, $p=0.001$

11.4. Discussion

This study identified 220 process failures in the care of emergency surgical admissions, an average of nearly 3 per patient and an incidence of approximately one for every three days of inpatient care.

Half of these process failures caused harm to patients or a prolonged inpatient stay. Failures in medication prescribing and administration were particularly common and problems with lines, tubes and drains and endoscopic investigations lead to greatest harm. More than 90% of process failures were considered preventable and 60% were caused by either delay in medical care or a breakdown in communication. Given the frequency of process failures when examined using an explicit list in the preceding chapter, it is likely that this study has only captured the most serious failures that came to the attention of the treating teams.

As discussed in the preceding chapter, Stephenson et al. have examined failures in the process of care for emergency surgical admissions using explicit checklists and found even more failures than were present in the current investigation (4.8 process failures per patient) (Stevenson et al., 2007). This study, however, used a very different methodology and therefore found rather different types of failure. In addition, it was confined to the admission phase of care, whereas this study followed patients from admission to discharge. Kreckler et al. examined “safety events” in emergency surgical admissions and found them to be present in 26% of patients. This study also noted poor reliability in 7 audited processes of care. The authors did not, however, link audited processes to patient harm and used a somewhat different definition of adverse events that makes comparison between the

studies difficult. It is however clear from these studies, in addition to those in this thesis, that the process of care for EGS patients is subject to frequent and widespread process failures.

The very skewed number of process failures per patient is a reflection of the relatively large number of EGS patients who have simple, non-operative management (and therefore a small number of processes and consequently few failures) versus the small number of patients who are very unwell, have complex treatment and therefore have a large number of processes performed and hence a relatively larger number of process failures. Because the number of processes performed for each patient is highly variable it is not possible to discern the rate of failure of processes however an investigation of process failures in intensive care units, estimated the rate of process failure at approximately 1% (Donchin et al., 1995). Given that the airline and manufacturing industries aim for a failure rate of “six sigma” or 0.00034% there is significant room for improvement in healthcare (Chassin, 1998).

Patients suffered harm as a result of half of all process failures however it is likely that this is an underestimate due to the difficulty in identifying harm caused by failed processes. Firstly, there may be a time lag between a failure and harm occurring, for example missed chest physiotherapy may lead to a post-operative chest infection but the time delay between failure and harm makes causation impossible to ascertain. A second reason for potential underestimation of harm caused by process failures lies in the uncertainty in outcome had the process been completed. An example of this is the accidental omission of antibiotic doses; we don’t know whether the patient would have made a swifter recovery if the omitted doses had actually been administered as prescribed.

With the exception of lines, tubes and drains and patient transfers, almost all process failures identified in this study were considered preventable. This may be because the care of many EGS patients is relatively simple by comparison with elective surgical care, indeed, only 40% of patients in the study had an operation or endoscopy. Documentation of patient’s assessments and

investigations was a recurring problem and, while rarely leading to harm, this often incurred delays in treatment and was universally preventable.

11.4.1. Comparison with process failures in elective surgical care

A recent study performed using an identical methodology by the same research group and in the same hospital has recently been published and allows some comparisons between process failures in elective and emergency surgical care (Symons et al., 2013a). The elective study included 50 patients who had undergone major elective surgery, primarily for gastrointestinal cancers, and followed them from the time of surgery to discharge. Despite the smaller number of patients, the duration of the studies in terms of days of inpatient care was almost identical (659 days vs. 645 days). There are striking similarities between the studies in terms of the number and type of process failures identified, their preventability and the degree of harm caused to patients (Table 11.5).

Table 11.5: Comparison of process failures in elective and emergency surgical care

	Elective surgery (Symons et al., 2013a)	Emergency surgery
Process failures per patient per day	0.39	0.34
Preventability (%)	216/256 (85%)	202/220 (92%)
No harm (%)	126/256 (49%)	111/220 (51%)
Minor harm (%)	107/256 (42%)	88/220 (40%)
Adverse event (%)	23/256 (9%)	21/220 (10%)
Communication failure (%)	105/256 (41%)	83/220 (38%)
Delay (%)	91/256 (36%)	82/220 (37%)

In addition to the similarities in headline figures, the distribution of process failures between coding categories and the degree of harm caused within these categories were also comparable between studies. The parallels in results between these two studies, conducted on similar wards but investigating very different patients, suggest that the underlying causes of process failures in ward-based care lie with the delivery of this care and not on the illness, severity or acuity of patients treated.

11.4.2. Implications

Process failures accounted for more than 90% of all preventable adverse events in this study, which suggests that they are a suitable target for quality improvement initiatives. Two possible avenues for improvements in the process of care are suggested by these results. Firstly, interventions could be directed at those processes of care with the greatest frequency, preventability and potential for harm. Secondly, efforts could be made to tackle the underlying problems that lead to failures in the process of care. Both this study and the preceding elective surgery investigation suggest that reducing communication breakdowns between staff and decreasing delays in the provision of treatment and assessment would go some way to improving the reliability of care. Addressing the aetiologies of process failures would allow us to reduce the incidence of many types of process failures simultaneously. The use of daily goals for each patient has been shown to improve communication between staff members in intensive care (Pronovost et al., 2003) and it has been shown that similar plans are missing in as many as 40% of surgical patients (Nagpal et al., 2010a). Team training, based on the Crew Resource Management training schemes developed by the aviation industry, has been used successfully to reduce surgical mortality when utilised by operating theatre teams and it is possible that a similar programme may address some of the underlying causes of process failures on surgical wards (Neily et al., 2010).

11.4.3. Limitations

Observational studies such as this one are subject to the Hawthorne effect. This phenomenon results in subjects of studies (in this case healthcare professionals) improving their performance in response to being observed. It is unlikely that this had a significant effect in this study because only a minority of process failures were directly observed; the majority of field notes related to issues that occurred in the day preceding each morning's ward round. The Hawthorne effect would also tend to reduce, not increase the number of process failures observed. It is possible that some process failures were missed, either due to oversight by the single observer or because they were not discussed or

recorded and no harm occurred. Both of these limitations would also lead to an underestimate of the number of process failures identified.

Observational studies are very resource intensive and rely on expert opinion, however they allow the investigation of complex systems such as ward care, in which failures are not easily identified using explicit methodologies. In addition, the collection of field notes allows an assessment of the aetiologies involved in process failures and coding of field notes by multiple assessors to improve the reliability of results (Lilford et al., 2007).

This study and the similar investigation into elective surgery were conducted at a single NHS hospital and, as such, the results may not be generalizable to other hospitals. The unit in question is however typical of busy general surgical departments in the NHS in terms of caseload, staffing and resources. In addition, the trust studied has a standardised mortality ratio significantly below the mean and a lower than average rate of deaths after surgery, based on HES data for 2009/10.

11.5. Conclusions

This study has identified large numbers of process failures in the post-admission phase of care for EGS patients. These failures correlate closely with those for elective surgical inpatients in terms of type, number, severity and preventability. In combination with the study in Chapter 10, which demonstrates significant failures in basic admissions processes, this study shows just how great a margin there is for improvements in ward based care. Interventions to improve the reliability of this care, focussed on high risk processes and the underlying causes of process failures will prevent avoidable harm to patients, decrease wastage of resources and also have the potential to improve patient's outcomes, particularly in terms of length of stay.

The concluding chapter will bring together the results of all the studies described in this thesis, identify residual gaps in our understanding of quality of care in emergency general surgery and suggest potential avenues for future research.

12. DISCUSSION

This thesis aimed to investigate the quality of care for emergency general surgery in the National Health Service using Avedis Donabedian's structure, process and outcome model as a basis for assessment. The series of studies presented in this thesis aimed, in particular, to examine the efficacy and the effectiveness of care delivered to patients. A secondary goal for the thesis was to identify areas in which treatment of EGS patients could be improved and those in which further research is warranted.

The introductory chapters describe the current organisation and workload for a typical EGS service, summarise the available literature on methods of assessment of the quality of healthcare and review the current research into quality in emergency general surgery. In combination with the initial interview study, these chapters provide a basic understanding of the current issues surrounding EGS and the likely areas in which research efforts should be focussed.

The outcomes section of the thesis aimed to corroborate the assertion that there is significant variability in the outcomes for EGS patients between institutions. Hospital Episode Statistics were introduced and used to identify a group of high risk EGS patients. These patients' outcomes were used to assess risk adjusted mortality, length of stay and readmission rate for NHS Trusts in England.

In the chapter on the structure of EGS care, NHS Trusts' infrastructure data from the Department of Health was amalgamated and then used to investigate the effect of structure on outcomes for high risk EGS patients.

Studies in the process of care section of the thesis assessed both initial admission of patients and ongoing ward care. Delphi consensus methodology was used to develop a gold standard for the process of care during the admission of EGS patients and these standards were audited in a multicentre study. Ongoing ward care was investigated using a qualitative observational

methodology to identify and categorise failures in the process of care.

This chapter will discuss the key findings of each study, the strengths and limitations of the studies themselves, as well as the thesis overall. The implications for individual units and the NHS will be discussed and suggestions made for future research.

12.1. Key findings

12.1.1. Expert opinion on the care of emergency general surgical admissions

Interviewees were asked to identify areas in which care for EGS patients was problematic. Common themes raised could be broadly divided into issues with the structure of care, the process of care and problems with teamwork and communication.

Structure problems that were identified included access to critical care facilities and operating theatre space as well as staffing problems for both doctors and nurses. The frontline staff interviewed felt relatively helpless to address issues to do with the structure within which they work. Lack of dialogue between management and clinical staff frequently exacerbates this type of problem. Staff were however actively involved in the management and improvement of the process of care. Regular audit and clinical governance is used widely but has highly variable effectiveness. Incorrect or delayed diagnosis and the failure to recognise unwell patients were frequently highlighted by interviewees.

Inadequate teamwork was the most frequently mentioned cause of errors and adverse events. This consisted of problems with both written and verbal communication, leadership, coordination and handover. The overwhelming majority of problems mentioned by participants occurred outside the operating theatre or in planning for an operation, not during the operations themselves.

Overall, this study provided good background information on which to base further study of quality of care in emergency general surgery. It prompted the use of the Donabedian structure, process and

outcome framework as a basis for the thesis and highlighted the importance of teamwork and communication.

12.1.2. Outcomes for high risk emergency general surgical admissions

This thesis was based on the premise that variability in the quality of care delivered to EGS patients would result in variability in patient's outcomes. It therefore made sense to start by studying the outcomes of NHS trusts treating EGS patients to demonstrate that this hypothesis was indeed correct.

Administrative data, in the form of Hospital Episode Statistics, was used to identify a group of high risk EGS patients and these patient's outcomes were examined. 367,796 patients were included in the study and mortality was over 15%. The diagnosis and the patient's age had the greatest effect on mortality when subjected to multiple logistic regression, with the degree of comorbidity, social deprivation, year of discharge and gender having significant but lesser effects.

The majority of the patients in this study were elderly and the most frequent age at admission was 80 years. There was a significant reduction in mortality between 2000 and 2009 and, in particular, a reduction in the proportion of patients that died following an operation. The increasing age of the UK population suggests that the issues associated with managing emergency surgery in the elderly will be greatly magnified in the coming years. The clinical pathway for these patients needs to be clarified and optimised to improve patient's outcomes and minimise the burden on the health service.

Risk adjusted 30 day in-hospital mortality for 145 NHS trusts in England demonstrated significant variability between providers, with a doubling in mortality from 9.2% to 18.2% between best and worst institution. There were 4 high mortality outlying NHS trusts at 3 standard deviations and 12 low mortality outliers. The variability in mortality demonstrated in this study has long been alluded to but this is the first study to publish a detailed breakdown of outcomes and risk factors in EGS. This

study should act as a catalyst for units treating EGS patients to look at their own mortality outcomes and try to understand the underlying differences in structure and process that lead to variability. Understanding these differences will allow suitable quality improvement initiatives to be developed to reduce inequalities in care.

Age group and diagnosis had the greatest influence on patient's length of stay. Diagnoses treated primarily with surgery had the lowest readmission rate though readmission rate overall increased significantly during the study. This resulted in little variability in risk adjusted 28 day readmission rates between trusts.

The results of this study confirmed that variability in mortality does exist between NHS trusts. It also provided useful background information on the demographics of the EGS population and quantified the huge effect of patients' age and diagnosis on the risk of mortality. Having demonstrated variability, the subsequent studies in the thesis aimed to investigate some of the underlying causes for these differences by looking at both the structure and the process of care.

12.1.3. The effect of NHS Trust structure on risk adjusted outcomes

The second HES-based study in the thesis aimed to compare data on infrastructure provision at NHS Trusts with their risk-adjusted mortality outcomes. This analysis aimed to demonstrate that variability in structure has a significant effect on mortality, and that this may, in part, explain the variability in NHS Trusts' outcomes found in the preceding chapter. This type of quantitative assessment of the influence of structure on patient outcome has not previously been undertaken in EGS and the results add significant weight to the debate on the provision of critical care and radiology services.

There were significant increases in the provision of operating theatres, high dependency and intensive care beds between 2000 and 2009. These were matched by rapid increases in the usage of non-obstetric ultrasound and CT scanning. Multiple logistic regression analysis demonstrated that

patients admitted to NHS Trusts in the highest tercile for ICU and HDU bed provision and the highest tercile of CT scan usage had a lower risk of 30 day in-hospital mortality. Patients admitted to trusts in the bottom tercile for bed occupancy and operating theatre provision also had lower risk of death.

Comparison of high and low mortality outlying hospitals demonstrated that the best performing hospitals had significantly more intensive care beds and performed significantly greater numbers of ultrasound and CT scans per bed than the worst performing hospitals. These findings corroborated those from the logistic regression, underlined the influence of NHS Trust structure on outcomes and further emphasised the variability in care provided by different institutions.

NHS Trusts that have poor provision of critical care and radiology services need to examine ways in which this can be improved if they want to optimise outcomes for EGS patients. Improvements in infrastructure are likely to benefit a wide range of patients and not just emergency surgical admissions.

12.1.4. Process of care for emergency general surgical admissions

The final section of the thesis deals with investigation of the process of care for emergency surgical admissions. Unfortunately there is no national data available on the process of care that EGS patients receive and therefore comparison between NHS Trusts is much more complicated than for either structure or outcomes. In addition there is little in the way of standards of care for EGS admissions to compare institutions' practice against. To circumvent these issues the Delphi consensus methodology was used to generate a list of standard processes which should be performed (or deliberately excluded) during the admission phase of care. This standard was then audited at five NHS Trusts to try to identify variability in the process of care between these institutions.

The Delphi process identified 21 core processes for inclusion from a total of 28 considered. The included processes covered both clinical and organisational facets of care and drew heavily on

recommendations from NCEPOD reports and clinical guidelines from NICE and other organisations.

Data on the process of care for 315 patients from 5 different NHS hospitals in London and south-east England were collected by the author and members of the London Surgical Research Group. Out of 5668 processes that the data collectors considered were indicated 1130 (19.9%) were omitted, an average of 3.59 (range 0-9) omissions per patient. Only six patients had all processes performed correctly. A number of processes were performed poorly, including planning of vital signs observations, retrieval of old casenotes, appropriate administration of oxygen, prompt consultant review and rapid treatment with antibiotics for severe sepsis. There were no differences in the number of omissions for patients admitted at the weekend or out of normal working hours. These findings are a stark reminder to all clinicians about the poor reliability of the process of care in EGS. There is growing evidence that improved processes do result in better outcomes (de Vries et al., 2010, Haynes et al., 2009) and process reliability of 80% is not good enough. This level of adherence to best practice would not be acceptable in any other business, let alone within a high reliability organisation.

There was also a significant difference in the average number of process omissions per patient between the hospitals studied. The best performing hospital omitted, on average, 2.42 processes per patient and the worst missed 4.20 processes per patient. There was a significant correlation between hospitals' mean number of process omissions and the median length of inpatient stay. At the individual patient level however there was no correlation between process omissions and length of stay. It is not clear whether the differences between hospitals are a general reflection on a hospital's culture and organisation or if they are due to specific differences in the arrangement of the EGS service, either with consultant work patterns, emergency surgical admission units or other unrecognised differences.

This study demonstrated poor adherence to basic processes of care across all five hospitals involved. It also shows significant differences in performance, which were correlated with hospitals' median

length of stay. These findings support the variability found in both the provision of infrastructure and NHS Trusts' outcomes for EGS. They also corroborate the assertions of reports suggesting that there is variability in the quality of care provided to EGS patients by NHS Trusts (Association of Surgeons of Great Britain and Ireland, 2007, Royal College of Surgeons of England, 2011a).

12.1.5. Effectiveness of care beyond admission

The final study in the thesis aimed to capture the quality of care throughout admission to hospital.

This task is complicated by the diverse diagnoses and treatment pathways involved in EGS care but was made possible by the use of a novel ethnographic methodology developed by the author and the Clinical Safety Research Unit at Imperial College. Coded field notes allowed quantification of non-routine events, process failures and adverse events and also allowed some assessment of the aetiology of process failures. Due to the complexity of this research methodology it was performed at a single site.

75 patients were observed for 645 days of inpatient care. Field notes revealed 276 non-routine events, of which 220 were considered to be process failures by the two clinicians rating them. Half of these process failures caused harm to the patient, including 21 that were adverse events.

Medication prescribing and administration and management of lines, tubes and drains were the most frequent sources of failures. Failures to do with medication, patient assessment and patient investigations were almost entirely preventable and even those to do with patient management were preventable on three-quarters of occasions. Process failures were caused by either communication failure or delay in 60% of cases and these factors were commonly found in combination with each other.

This study has revealed the large number of process failures that occur during the routine management of emergency general surgical patients and it also shows that the majority of these failures are highly preventable. Fortunately most process failures do not lead to significant harm to

patients, however delay in discharge as a result of process failures is common.

This study identified recurring process failures that frequently lead to harm and these failures correlate closely with those found in a partner study of elective surgical admissions (Symons et al., 2013c). It has also highlighted common aetiologies for process failures, in particular communication failure and delay. These recurring themes and repeated process failures should be identified and addressed as a matter of urgency by all surgical units. Repeating the same failure over and over again is a sign of an organisation that does not care about the quality of care delivered to its patients. Hopefully the results of this study will assist in the development of interventions to improve the reliability of the process of care.

12.2. Strengths and limitations

The main strength of this thesis is the breath and variety of approaches it has taken to the study of quality of care in emergency general surgery. The use of interviews, administrative data sources, prospective multicentre data collection and local ethnographic research has allowed a broad picture of the current quality of care to be built. The studies presented include analysis of data from the whole of England as well as more detailed analysis of field notes from a single centre. The use of Donabedian's structure, process and outcome framework allows these studies to be placed into a logical order and to break the emergency general surgical pathway into manageable pieces for analysis.

The results of this diverse group of studies contain remarkably similar themes, in terms of the variability in care provided, and this strengthens the conclusions of the thesis. The concept of variability in care for EGS has been widely cited but little evidence to prove this hypothesis has existed until recently. This thesis has added weight to this theory by demonstrating variability in care on multiple levels and has also identified some specific aspects of care suitable for quality improvement.

The main limitation of the thesis as a whole is that there are significant gaps in the assessment of the quality of EGS care. These gaps are inevitable when trying to cover such a large topic as a single researcher, despite the many collaborations involved. The thesis has not, for example, touched on intraoperative care at all. This was a deliberate decision because it is largely similar to elective intraoperative care, which has been investigated in detail previously.

The assessment of the process of care was done on a much more limited population than the outcomes and structure studies because data on the process of care at a national level was not publicly available. The panel for the Delphi consensus was drawn from experienced clinical staff from a single site and, if this were to be repeated, it would benefit from the inclusion of greater numbers of experts from a wider variety of institutions. Collection of data for the two process of care studies was conducted at 5 sites and a single site respectively and these numbers were limited by time and manpower constraints. There were, however relatively large numbers of patients in each study with 315 and 75 respectively for the 2 process of care studies.

There are a number of general limitations of the studies in this thesis which are worth highlighting. The first concerns the use of HES data for analysis of patient outcomes. HES provides an excellent resource for investigating outcomes and, because it includes all admissions to hospital, it is comprehensive. Unfortunately, despite these advantages, HES does not contain any clinical data on severity of disease and this makes risk adjustment potentially insensitive. In addition, there are a number of potential issues to do with coding of data that, while much improved in recent years, are still potential confounders. For instance, it is not clear why the numbers of high risk EGS admissions increased so much between 2000 and 2010. One possibility is that the Department of Health's payment by results system of compensation encouraged hospitals to code borderline cases into more complex diagnostic codes or add additional data on comorbidities that they may not have done previously. Fortunately there is reasonably good evidence that coding of mortality is very accurate and coding of diagnosis has improved greatly. Further development and greater access to

the HES system would be of great benefit to the NHS, allowing the type of outcomes research in this thesis to be performed on a wider scale.

The second notable study limitation concerns observational research methodologies. The two main process of care studies used quite different observational methods. The major limitation of both these methods concerns the repeatability and reliability of these observations. The investigators for the multicentre study on fundamental care processes were briefed, given explicit checklists and chosen for their experience in EGS but there were no formal assessments of inter-rater reliability and investigators may have had different thresholds for process failure. As a result, part of the variation between hospitals may have been due to variability between researchers.

In the single centre study of process failure after admission there was dual assessment of field notes but the initial data collection was conducted by a single researcher who may have been prone to bias. A second data collector at this point may have interpreted events differently or identified further events that the single researcher missed. If these studies were to be repeated then addition of rater reliability assessment would make them much more robust to criticism.

This thesis has not examined the cost effectiveness of emergency general surgical care, nor the social aspects of the quality of care discussed in Chapter 2. By limiting itself to the efficacy and effectiveness of EGS care, the thesis inevitably provides only a part of the whole picture of quality. Efficacy and effectiveness are however the aspects of care that most closely affect individual clinicians and patients and they are also the aspects that are most likely to be amenable to local quality improvement initiatives.

Overall, the thesis provides good evidence for variability in care on multiple levels and, while it is not comprehensive nor free of limitations, it provides sufficient information to substantiate assertions that the quality of EGS care is highly variable.

12.3. Clinical implications

Wide variation in outcomes is undesirable because it implies that all institutions could perform at the level attained by the best units. The variability in outcomes demonstrated in this thesis appears to be occurring largely due to differences in the structure and process of care. There is little evidence for systematic differences between patients treated at different hospitals. NHS Trusts should therefore be examining the available data and, if necessary, collecting their own, to understand better how they compare to their peers. Whilst this type of benchmarking is relatively advanced in many elective surgical subspecialties, it is unheard of in emergency care. Comparison of the structure and process of care between high and low performing units will undoubtedly highlight areas in which poor performing units can improve. Some of these have been suggested already in this thesis, for example, the provision of critical care beds, utilisation of imaging investigations and adherence to basic processes of care during admission of EGS patients. It is the responsibility of all NHS Trusts to examine the available outcomes data and see how they compare to national performance. Outlier status can occasionally be explained by data inconsistencies (Lewis et al., 2012), but institutions must be much more aggressive in identifying and rectifying differences in infrastructure and process of care between themselves and their peers.

Improvements in healthcare cannot be made if measurement of quality is not built in (Darzi, 2008). Indeed, measurement and feedback of results may produce significant improvement without any intervention at all (Landsberger, 1961). A key part of quality improvement therefore is the development of robust methods of quality measurement and this must be the first step in any programme that hopes to optimise outcomes.

Improvement in outcomes to the level of the best current performers is a good first step but it is clear that further improvements can be made. Even the best performing hospitals had many omissions in the process of care for EGS admissions and process failures are common throughout ward care. Significant further advances in EGS care can be made by improving the quality of care

across all hospitals, not just the poorly performing ones. In fact this approach is likely to result in a greater improvement in care than solely focussing on the high mortality outliers (Lilford et al., 2007).

Processes of care are much easier to improve than infrastructure provision and therefore these should form the basis of improvement efforts in most situations. Focus on communication, especially within large clinical teams is critical. Clear documentation, robust handover, multidisciplinary team working (and training) may all help to improve this often neglected aspect of EGS care. Specific high risk processes can be targeted for local audit and multicentre audit should form a much larger part of clinical governance than it does currently. Comparison to peers will be far more effective than audit in isolation. The development of surgical trainee research collaboratives such as the London Surgical Research Group, who contributed to the fundamental care process study in this thesis, should make this type of research much more widespread and allow dissemination of best practice.

Finally, one of the greatest drivers of variability in care is the lack of robust evidence of best practice. Much of emergency general surgical care has been determined by trial and error over many years and developed long before the advent of evidence based medicine. There is almost no literature available regarding the indications for a urinary catheter, a nasogastric tube or a CT scan in EGS patients. These decisions are taught to surgeons by apprenticeship and most consultants chose to treat patients using an amalgamation of the practice they observed whilst a trainee. This contrasts markedly with the advent of evidence based treatment pathways such as the Enhanced Recovery After Surgery (ERAS) programme used in elective surgery (Kehlet and Wilmore, 2002). This type of treatment pathway is slowly being adopted into emergency care, primarily in the form of pathways for patients with fractured neck of femur (Roberts et al., 2004), however much more basic research is required to determine best practice across the whole of EGS. Publication of such evidence is likely to have the greatest influence in reducing variability in the treatment pathway for EGS patients.

12.4. Future research

Future research into emergency general surgery can focus on filling the gaps in the assessment of quality of care left by this thesis or could aim to evaluate interventions designed to improve quality. Studies assessing quality could look at alternative outcomes, particularly patient reported outcome measures (PROMS) which are increasingly being used to evaluate healthcare. Additional elements in the structure of care for EGS patients could be investigated in much the same way that they were in Chapter 8, assessing their effect on outcomes by comparison with HES data. High and low mortality outlying NHS Trusts could be used as the basis for detailed comparative studies investigating more subtle differences in the structure and process of care between good and poor performing institutions. Finally, investigation of the process of care across greater numbers of hospitals may shed further light on its influence on outcomes.

Interventions to improve outcomes for EGS patients have been suggested by the work in this thesis and further studies could be performed to evaluate their efficacy. The most obvious is the implementation of the checklist developed in chapter 9 and assessed in chapter 10. Similar checklists have been shown to improve outcomes in elective surgery and there is no reason to think that they would not work in EGS as well (de Vries et al., 2010, Haynes et al., 2009). The effect of changes in the provision of infrastructure could be examined by looking at variability in outcomes for institutions before and after structural improvements. While this would be subject to significant confounding if done at just one hospital, it may be possible to investigate differential outcomes across many hospitals to minimise any bias. Finally, interventions designed to address communication and human factors in healthcare have shown some promise in terms of reducing process failures and adverse events and these may work similarly in the care of EGS patients (Pronovost et al., 2003, Vincent et al., 2004).

12.5. Wider implications

The findings of this thesis have significant implications for the NHS. These issues are currently being widely debated in the press as variations in the quality of care are uncovered on an almost daily basis. Problems with poor quality care have led to the Francis report into care at Mid-Staffordshire NHS Foundation Trust and, more recently, investigation into 14 NHS trusts that appeared to have high mortality rates (Francis, 2010, Keogh, 2013). The more recent Keogh review led to 11 trusts being put on special measures to improve standards. Similar investigations are being undertaken at the individual consultant level and paediatric cardiothoracic surgery was recently suspended at one institution whilst an investigation was carried out. The imminent publication of outcomes across all 9 surgical subspecialties seem likely to lead to further similar inquiries in the future. It is clear that the public consider variability in outcomes to be unacceptable and therefore the NHS must try to minimise such variation as far as possible.

The public outcry over variability has significant implications for the NHS. Whilst much can be done to improve quality within current resource limitations a national debate regarding limits on treatment available through the NHS is needed. If the public want all services to remain free at the point of use and to be of the highest quality and free of variability then they must be prepared to pay the tax burden associated with such care provision. Improvements in infrastructure almost always require increased costs in either capital expenditure or manpower. Process improvements can be cost neutral but frequently imply doing more. Some of these costs can be offset by reduced length of stay or decreased burden on social services following discharge but there are frequently upfront charges to pay before any cost saving is realised. One way of reducing costs may be in centralisation of emergency care, particularly in urbanised areas with many hospitals. This should result in economies of scale but Chapter 7 has shown that larger NHS Trusts do not necessarily produce better outcomes for emergency general surgery. In addition there is significant public opposition to the closure of acute hospitals and emergency departments in particular.

Education has a significant role to play in improving the workforce's understanding of the issues addressed by this thesis. Healthcare professionals need a better understanding of the principles of quality measurement and quality improvement and this needs to be built into their curricula from an early stage of training. Unfortunately this type of improvement takes a whole generation to filter through into the workforce and therefore additional measures must be taken to encourage more senior members of staff to participate. Junior doctors are in an ideal position to effect change because they experience different systems at multiple hospitals and are connected to patients and all members of the multidisciplinary team on a daily basis. Unfortunately many barriers are placed in the path of trainee led quality improvement, including difficulties engaging permanent staff in change, short timescale of rotations, little continuity from one trainee to the next and lack of support from senior clinicians and management. Greater emphasis on trainee led quality improvement from senior hospital management and regional training committees could allow junior doctors a greater role in these projects.

Research such as that in this thesis provides some of the background necessary for evidence based improvements in practice that aim to minimise variability in outcomes. Emergency general surgery is lagging behind elective surgery in this respect and greater focus and investment in EGS services is needed to ensure that it does not become the subject of the next NHS inquiry. This thesis has demonstrated that significant improvements can be made in both the structure and process of care in order to improve outcomes and urgent action is needed to reduce inequalities in care for EGS patients.

12.6. Conclusion

This thesis aimed to assess the quality of care in emergency general surgery. This was done using mixed methods, including quantitative analysis of outcomes and structures, the Delphi consensus methodology, multicentre audit and qualitative field notes. The use of these diverse approaches has

generated a broad picture of the state of quality of care in EGS and identified potential avenues for improvement. It appears that there is significant variability in the structure, process and outcomes for emergency general surgical admissions at NHS Trusts in England. Hopefully this thesis can provide some assistance in developing evidence based improvement in outcomes for emergency general surgery patients.

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APPENDIX A: INTERVIEW PROTOCOL, CHAPTER 5

INTERVIEWER'S INTRODUCTION AND INSTRUCTIONS TO INTERVIEWEE – SWITCH ON RECORDER

This interview is designed to assess your current thoughts about emergency surgical patient care in your Trust.

Your responses to this interview are anonymous and confidential. If there are any questions you do not wish to answer, you do not have to do so; however please try to answer every question.

I would like you to provide some basic details about yourself:

Gender (M/F)	<input type="text"/>	
Professional role	<input type="text"/>	Consultant
	<input type="text"/>	Registrar
	<input type="text"/>	Nurse (including grade)
Specialty	<input type="text"/>	Surgery
	<input type="text"/>	Intensive Care
	<input type="text"/>	Theatres
Years in specialty:		

Interviewer One

SECTION 1: CASE STUDY

Can you give us an example of a specific situation when you observed a problem with operative or non-operative care of an emergency surgery patient?

- What were the issues/difficulties you experienced?
- What were the consequences?
- What were the precipitating factors?
- In your experience, how frequently would you say events like the one you described occurred?

SECTION 2: PATIENT SAFETY ISSUES AND AREAS FOR IMPROVEMENT

- What other problems do you regularly see or experience?
- Are there any key areas for improvement?

Interviewer Two

SECTION 3: KEY FACTORS IN QUALITY OF CARE

What do you think are the most important factors that contribute to the safety and quality of emergency surgery patient care?

- Process factors
 - e.g. Medications, procedures, diagnostics etc.
- Systems factors
 - e.g. Hospital setup, A&E, theatres, access to investigations etc.
- Non-technical factors
 - communication, leadership, coordination, cooperation, situation awareness, teamwork etc.
- How do you prioritise between elective and emergency patients?
 - Do you find any conflict between care of elective and emergency patients?
-

Interviewer One

Interviewer Two

Interviewer One

SECTION 4: INFORMATION PROVISION AND COMMUNICATION

How much information do you think is necessary to give to emergency surgery patients/relatives?

- Diagnostic information
- Prognostic information
- Consent issues

Interviewer Two

SECTION 5: RECOMMENDATIONS AND IMPROVEMENTS

In the light of all the issues discussed so far, what are the key improvements that you would recommend for emergency care?

- What are the barriers to such improvement (efforts)?
- Is there a need for additional training? Who should be trained and how?
- Are you aware of the NCEPOD recommendations?
- Could you comment on these recommendations from the recent NCEPOD emergency admission study?
 - *Give interviewee copy of recommendations.*
- Are they currently implemented in your Trust?
- What do you think about making them compulsory nationwide?

Interviewer One

APPENDIX B: INCLUDED OPERATION CODES, CHAPTER 7

Included codes from the Office of Population, Census and Surveys schedule of procedures, version 4	
Oesophagus	
G01.1	Oesophagogastrrectomy and anastomosis of oesophagus to stomach
G01.2	Oesophagogastrrectomy and anastomosis of oesophagus to transposed jejunum
G01.3	Oesophagogastrrectomy and anastomosis of oesophagus to jejunum NEC
G01.8	Other specified excision of oesophagus and stomach
G01.9	Unspecified excision of oesophagus and stomach
G02.1	Total oesophagectomy and anastomosis of pharynx to stomach
G02.2	Total oesophagectomy and interposition of microvascularily attached jejunum
G02.3	Total oesophagectomy and interposition of jejunum NEC
G02.4	Total oesophagectomy and interposition of microvascularily attached colon
G02.5	Total oesophagectomy and interposition of colon NEC
G02.8	Other specified total excision of oesophagus
G02.9	Unspecified total excision of oesophagus
G03.1	Partial oesophagectomy and end to end anastomosis of oesophagus
G03.2	Partial oesophagectomy and interposition of microvascularily attached jejunum
G03.3	Partial oesophagectomy and anastomosis of oesophagus to transposed jejunum
G03.4	Partial oesophagectomy and anastomosis of oesophagus to jejunum NEC
G03.5	Partial oesophagectomy and interposition of microvascularily attached colon
G03.6	Partial oesophagectomy and interposition of colon NEC
G03.8	Other specified partial excision of oesophagus
G03.9	Unspecified partial excision of oesophagus
G04.1	Excision of lesion of oesophagus
G05.1	Bypass of oesophagus by anastomosis of oesophagus to oesophagus
G05.2	Bypass of oesophagus by anastomosis of oesophagus to stomach
G05.4	Bypass of oesophagus by interposition of jejunum NEC
G05.6	Bypass of oesophagus by interposition of colon NEC
G06.1	Revision of interposition anastomosis of oesophagus
G06.2	Revision of anastomosis of oesophagus NEC
G06.3	Removal of bypass of oesophagus
G06.8	Other specified attention to connection of oesophagus
G06.9	Unspecified attention to connection of oesophagus
G07.4	Repair of rupture of oesophagus
G07.8	Other specified repair of oesophagus
Diaphragmatic Hernia	
G23.1	Repair of oesophageal hiatus using thoracic approach
G23.2	Repair of diaphragmatic hernia using thoracic approach NEC
G23.3	Repair of oesophageal hiatus using abdominal approach
G23.4	Repair of diaphragmatic hernia using abdominal approach NEC
G23.8	Other specified repair of diaphragmatic hernia
G23.9	Unspecified repair of diaphragmatic hernia
G24.1	Antireflux fundoplication using thoracic approach
G24.2	Antireflux operation using thoracic approach NEC
G24.3	Antireflux fundoplication using abdominal approach
G24.4	Antireflux gastropexy
G24.5	Gastroplasty and antireflux procedure HFQ
G24.6	Insertion of angelchick prosthesis
G24.8	Other specified antireflux operations
G24.9	Unspecified antireflux operations
G25.1	Revision of fundoplication of stomach
G25.3	Removal of angelchick prosthesis

G25.8	Other specified revision of antireflux operations
G25.9	Unspecified revision of antireflux operations
Stomach Operations	
G27.1	Total gastrectomy and excision of surrounding tissue
G27.2	Total gastrectomy and anastomosis of oesophagus to duodenum
G27.3	Total gastrectomy and interposition of jejunum
G27.4	Total gastrectomy and anastomosis of oesophagus to transposed jejunum
G27.5	Total gastrectomy and anastomosis of oesophagus to jejunum NEC
G27.8	Other specified total excision of stomach
G27.9	Unspecified total excision of stomach
G28.1	Partial gastrectomy and anastomosis of stomach to duodenum
G28.2	Partial gastrectomy and anastomosis of stomach to transposed jejunum
G28.3	Partial gastrectomy and anastomosis of stomach to jejunum NEC
G28.4	Sleeve gastrectomy and duodenal switch
G28.5	Sleeve gastrectomy NEC
G28.8	Other specified partial excision of stomach
G28.9	Unspecified partial excision of stomach
G29.1	Open excision of polyp of stomach
G29.2	Open excision of lesion of stomach NEC
G30.1	Gastroplasty NEC
G30.2	Partitioning of stomach NEC
G30.3	Partitioning of stomach using band
G30.4	Partitioning of stomach using staples
G30.5	Maintenance of gastric band
G30.8	Other specified plastic operations on stomach
G30.9	Unspecified plastic operations on stomach
G31.0	Conversion from previous anastomosis of stomach to duodenum
G31.1	Bypass of stomach by anastomosis of oesophagus to duodenum
G31.2	Bypass of stomach by anastomosis of stomach to duodenum
G31.3	Revision of anastomosis of stomach to duodenum
G31.4	Conversion to anastomosis of stomach to duodenum
G31.5	Closure of connection of stomach to duodenum
G31.6	Attention to connection of stomach to duodenum
G31.8	Other specified connection of stomach to duodenum
G31.9	Unspecified connection of stomach to duodenum
G32.1	Bypass of stomach by anastomosis of stomach to transposed jejunum
G32.2	Revision of anastomosis of stomach to transposed jejunum
G32.3	Conversion to anastomosis of stomach to transposed jejunum
G32.4	Closure of connection of stomach to transposed jejunum
G32.5	Attention to connection of stomach to transposed jejunum
G32.9	Unspecified connection of stomach to transposed jejunum
G33.0	Conversion from previous anastomosis of stomach to jejunum NEC
G33.1	Bypass of stomach by anastomosis of stomach to jejunum NEC
G33.2	Revision of anastomosis of stomach to jejunum NEC
G33.3	Conversion to anastomosis of stomach to jejunum NEC
G33.4	Open reduction of intussusception of gastroenterostomy
G33.5	Closure of connection of stomach to jejunum NEC
G33.6	Attention to connection of stomach to jejunum
G33.8	Other specified other connection of stomach to jejunum
G33.9	Unspecified other connection of stomach to jejunum
G38.4	Open removal of foreign body from stomach
G38.5	Incision of stomach NEC
G38.6	Reduction of volvulus of stomach
G38.7	Removal of gastric band

G38.8	Other specified other open operations on stomach
G35.1	Closure of perforated ulcer of stomach
G35.2	Closure of ulcer of stomach NEC
G35.8	Other specified operations on ulcer of stomach
G35.9	Unspecified operations on ulcer of stomach
G36.1	Gastropexy NEC
G36.2	Closure of perforation of stomach NEC
G36.3	Closure of abnormal opening of stomach NEC
G36.8	Other specified other repair of stomach
G36.9	Unspecified other repair of stomach
Small Intestine Operations	
G52.1	Closure of perforated ulcer of duodenum
G52.2	Suture of ulcer of duodenum NEC
G52.3	Oversew of blood vessel of duodenal ulcer
G52.8	Other specified operations on ulcer of duodenum
G52.9	Unspecified operations on ulcer of duodenum
G53.1	Open biopsy of lesion of duodenum
G53.2	Closure of perforation of duodenum NEC
G53.3	Open removal of foreign body from duodenum
G53.5	Incision of duodenum NEC
G53.6	Correction of malrotation of duodenum
G53.8	Other specified other open operations on duodenum
G53.9	Unspecified other open operations on duodenum
G57.8	Other specified other operations on duodenum
G58.1	Total jejunectomy and anastomosis of stomach to ileum
G58.2	Total jejunectomy and anastomosis of duodenum to ileum
G58.3	Total jejunectomy and anastomosis of duodenum to colon
G58.4	Partial jejunectomy and anastomosis of jejunum to ileum
G58.5	Partial jejunectomy and anastomosis of duodenum to colon
G58.8	Other specified excision of jejunum
G58.9	Unspecified excision of jejunum
G59.1	Excision of lesion of jejunum
G60.1	Creation of jejunostomy
G60.2	Refashioning of jejunostomy
G60.3	Closure of jejunostomy
G60.8	Other specified artificial opening into jejunum
G60.9	Unspecified artificial opening into jejunum
G61.1	Bypass of jejunum by anastomosis of jejunum to jejunum
G61.2	Bypass of jejunum by anastomosis of jejunum to ileum
G61.3	Bypass of jejunum by anastomosis of jejunum to colon
G61.8	Other specified bypass of jejunum
G61.9	Unspecified bypass of jejunum
G63.3	Closure of perforation of jejunum
G63.9	Unspecified other open operations on jejunum
G69.1	Ileectomy and anastomosis of stomach to ileum
G69.2	Ileectomy and anastomosis of duodenum to ileum
G69.3	Ileectomy and anastomosis of ileum to ileum
G69.4	Ileectomy and anastomosis of ileum to colon
G69.8	Other specified excision of ileum
G69.9	Unspecified excision of ileum
G70.1	Excision of meckel diverticulum
G70.2	Excision of lesion of ileum NEC
G70.3	Open destruction of lesion of ileum
G70.8	Other specified open extirpation of lesion of ileum

G70.9	Unspecified open extirpation of lesion of ileum
G71.1	Bypass of ileum by anastomosis of jejunum to ileum
G71.2	Bypass of ileum by anastomosis of ileum to ileum
G71.3	Bypass of ileum by anastomosis of ileum to caecum
G71.4	Bypass of ileum by anastomosis of ileum to transverse colon
G71.5	Bypass of ileum by anastomosis of ileum to colon NEC
G71.6	Duodenal switch
G71.8	Other specified bypass of ileum
G71.9	Unspecified bypass of ileum
G72.1	Anastomosis of ileum to caecum
G72.2	Anastomosis of ileum to transverse colon
G72.3	Anastomosis of ileum to colon NEC
G72.4	Anastomosis of ileum to rectum
G72.5	Anastomosis of ileum to anus and creation of pouch HFQ
G72.8	Other specified other connection of ileum
G72.9	Unspecified other connection of ileum
G73.1	Revision of anastomosis of ileum
G73.2	Closure of anastomosis of ileum
G73.3	Resection of ileostomy
G73.4	Resection of ileo-colic anastomosis
G73.8	Other specified attention to connection of ileum
G73.9	Unspecified attention to connection of ileum
G74.1	Creation of continent ileostomy
G74.2	Creation of temporary ileostomy
G74.3	Creation of defunctioning ileostomy
G74.8	Other specified creation of artificial opening into ileum
G74.9	Unspecified creation of artificial opening into ileum
G75.1	Refashioning of ileostomy
G75.2	Repair of prolapse of ileostomy
G75.3	Closure of ileostomy
G75.8	Other specified attention to artificial opening into ileum
G75.9	Unspecified attention to artificial opening into ileum
G76.1	Open reduction of intussusception of ileum
G76.2	Open relief of strangulation of ileum
G76.3	Open relief of obstruction of ileum NEC
G76.4	Plication of ileum
G76.8	Other specified intra-abdominal manipulation of ileum
G76.9	Unspecified intra-abdominal manipulation of ileum
G78.1	Open biopsy of lesion of ileum
G78.2	Strictureplasty of ileum
G78.3	Removal of foreign body from ileum
G78.4	Closure of perforation of ileum
G78.5	Exclusion of segment of ileum
G78.6	Open intubation of ileum
G78.8	Other specified other open operations on ileum
G78.9	Unspecified other open operations on ileum
G82.8	Other specified other operations on ileum
G82.9	Unspecified other operations on ileum
Appendix Operations	
H01.1	Emergency excision of abnormal appendix and drainage HFQ
H01.2	Emergency excision of abnormal appendix NEC
H01.3	Emergency excision of normal appendix
H01.8	Other specified emergency excision of appendix
H01.9	Unspecified emergency excision of appendix

H02.1	Interval appendicectomy
H02.2	Planned delayed appendicectomy NEC
H02.3	Prophylactic appendicectomy NEC
H02.4	Incidental appendicectomy
H02.8	Other specified other excision of appendix
H02.9	Unspecified other excision of appendix
H03.1	Drainage of abscess of appendix
H03.2	Drainage of appendix NEC
H03.8	Other specified other operations on appendix
H03.9	Unspecified other operations on appendix
Colon Operations	
H04.1	Panproctocolectomy and ileostomy
H04.2	Panproctocolectomy and anastomosis of ileum to anus and creation of pouch HFQ
H04.3	Panproctocolectomy and anastomosis of ileum to anus NEC
H04.8	Other specified total excision of colon and rectum
H04.9	Unspecified total excision of colon and rectum
H05.1	Total colectomy and anastomosis of ileum to rectum
H05.2	Total colectomy and ileostomy and creation of rectal fistula HFQ
H05.3	Total colectomy and ileostomy NEC
H05.8	Other specified total excision of colon
H05.9	Unspecified total excision of colon
H06.1	Extended right hemicolectomy and end to end anastomosis
H06.2	Extended right hemicolectomy and anastomosis of ileum to colon
H06.3	Extended right hemicolectomy and anastomosis NEC
H06.4	Extended right hemicolectomy and ileostomy HFQ
H06.8	Other specified extended excision of right hemicolon
H06.9	Unspecified extended excision of right hemicolon
H07.1	Right hemicolectomy and end to end anastomosis of ileum to colon
H07.2	Right hemicolectomy and side to side anastomosis of ileum to transverse colon
H07.3	Right hemicolectomy and anastomosis NEC
H07.4	Right hemicolectomy and ileostomy HFQ
H07.8	Other specified other excision of right hemicolon
H07.9	Unspecified other excision of right hemicolon
H08.1	Transverse colectomy and end to end anastomosis
H08.2	Transverse colectomy and anastomosis of ileum to colon
H08.3	Transverse colectomy and anastomosis NEC
H08.4	Transverse colectomy and ileostomy HFQ
H08.5	Transverse colectomy and exteriorisation of bowel NEC
H08.8	Other specified excision of transverse colon
H08.9	Unspecified excision of transverse colon
H09.1	Left hemicolectomy and end to end anastomosis of colon to rectum
H09.2	Left hemicolectomy and end to end anastomosis of colon to colon
H09.3	Left hemicolectomy and anastomosis NEC
H09.4	Left hemicolectomy and ileostomy HFQ
H09.5	Left hemicolectomy and exteriorisation of bowel NEC
H09.8	Other specified excision of left hemicolon
H09.9	Unspecified excision of left hemicolon
H10.1	Sigmoid colectomy and end to end anastomosis of ileum to rectum
H10.2	Sigmoid colectomy and anastomosis of colon to rectum
H10.3	Sigmoid colectomy and anastomosis NEC
H10.4	Sigmoid colectomy and ileostomy HFQ
H10.5	Sigmoid colectomy and exteriorisation of bowel NEC
H10.8	Other specified excision of sigmoid colon
H10.9	Unspecified excision of sigmoid colon

H11.1	Colectomy and end to end anastomosis of colon to colon NEC
H11.2	Colectomy and side to side anastomosis of ileum to colon NEC
H11.3	Colectomy and anastomosis NEC
H11.4	Colectomy and ileostomy NEC
H11.5	Colectomy and exteriorisation of bowel NEC
H11.8	Other specified other excision of colon
H11.9	Unspecified other excision of colon
H12.1	Excision of diverticulum of colon
H12.2	Excision of lesion of colon NEC
H12.3	Destruction of lesion of colon NEC
H12.8	Other specified extirpation of lesion of colon
H12.9	Unspecified extirpation of lesion of colon
H13.1	Bypass of colon by anastomosis of ileum to colon
H13.2	Bypass of colon by anastomosis of caecum to sigmoid colon
H13.3	Bypass of colon by anastomosis of transverse colon to sigmoid colon
H13.4	Bypass of colon by anastomosis of transverse colon to rectum
H13.5	Bypass of colon by anastomosis of colon to rectum NEC
H13.8	Other specified bypass of colon
H13.9	Unspecified bypass of colon
H29.1	Subtotal excision of colon and rectum and creation of colonic pouch and anastomosis of colon to anus
H29.2	Subtotal excision of colon and rectum and creation of colonic pouch NEC
H29.3	Subtotal excision of colon and creation of colonic pouch and anastomosis of colon to rectum
H29.4	Subtotal excision of colon and creation of colonic pouch NEC
H29.8	Other specified subtotal excision of colon
H29.9	Unspecified subtotal excision of colon
H66.1	Excision of ileoanal pouch
H66.2	Revision of ileo-anal pouch
H66.8	Other specified therapeutic operations on ileoanal pouch
H14.8	Other specified exteriorisation of caecum
H14.9	Unspecified exteriorisation of caecum
H15.1	Loop colostomy
H15.2	End colostomy
H15.3	Refashioning of colostomy
H15.4	Closure of colostomy
H15.8	Other specified other exteriorisation of colon
H15.9	Unspecified other exteriorisation of colon
H17.1	Open reduction of intussusception of colon
H17.2	Open reduction of volvulus of caecum
H17.3	Open reduction of volvulus of sigmoid colon
H17.4	Open reduction of volvulus of colon NEC
H17.5	Open relief of strangulation of colon
H17.6	Open relief of obstruction of colon NEC
H17.8	Other specified intra-abdominal manipulation of colon
H17.9	Unspecified intra-abdominal manipulation of colon
H19.2	Fixation of colon
H19.3	Enterorrhaphy of colon
H19.4	Open removal of foreign body from colon
H19.8	Other specified other open operations on colon
H19.9	Unspecified other open operations on colon
Rectum Operations	
H33.1	Abdominoperineal excision of rectum and end colostomy
H33.2	Proctectomy and anastomosis of colon to anus
H33.3	Anterior resection of rectum and anastomosis of colon to rectum using staples
H33.4	Anterior resection of rectum and anastomosis NEC

H33.5	Rectosigmoidectomy and closure of rectal stump and exteriorisation of bowel
H33.6	Anterior resection of rectum and exteriorisation of bowel
H33.7	Perineal resection of rectum HFQ
H33.8	Other specified excision of rectum
H33.9	Unspecified excision of rectum
H35.1	Anterior fixation of rectum
H35.2	Posterior fixation of rectum using prosthetic material
H35.3	Posterior fixation of rectum NEC
H35.4	Fixation of rectum using fascia lata
H35.8	Other specified fixation of rectum for prolapse
H35.9	Unspecified fixation of rectum for prolapse
H36.1	Abdominal repair of levator ani muscles
H36.8	Other specified other abdominal operations for prolapse of rectum
H36.9	Unspecified other abdominal operations for prolapse of rectum
Liver Operations	
J01.1	Orthotopic transplantation of liver NEC
J01.2	Heterotopic transplantation
J01.3	Replacement of previous liver transplant
J01.5	Orthotopic transplantation of whole liver
J01.8	Other specified transplantation of liver
J01.9	Unspecified transplantation of liver
J02.1	Right hemihepatectomy
J02.2	Left hemihepatectomy
J02.3	Resection of segment of liver
J02.4	Wedge excision of liver
J02.5	Marsupialisation of lesion of liver
J02.6	Extended right hemihepatectomy
J02.7	Extended left hemihepatectomy
J02.8	Other specified partial excision of liver
J02.9	Unspecified partial excision of liver
J04.2	Repair of laceration of liver
J04.3	Packing of laceration of liver
J04.8	Other specified repair of liver
J05.1	Open drainage of liver
J07.8	Other specified other open operations on liver
J07.9	Unspecified other open operations on liver
Cholecystectomy	
J18.1	Total cholecystectomy and excision of surrounding tissue
J18.2	Total cholecystectomy and exploration of common bile duct
J18.3	Total cholecystectomy NEC
J18.4	Partial cholecystectomy and exploration of common bile duct
J18.5	Partial cholecystectomy NEC
J18.8	Other specified excision of gall bladder
J18.9	Unspecified excision of gall bladder
J19.1	Anastomosis of gall bladder to stomach
J19.2	Anastomosis of gall bladder to duodenum
J19.3	Anastomosis of gall bladder to jejunum
J19.4	Anastomosis of gall bladder to intestine NEC
J19.5	Revision of anastomosis of gall bladder
J19.6	Closure of anastomosis of gall bladder
J20.1	Closure of fistula of gall bladder
J20.2	Closure of cholecystotomy
J20.3	Repair of perforation of gall bladder
J20.8	Other specified repair of gall bladder

J21.1	Open removal of calculus from gall bladder
Bile Duct Operations	
J29.1	Anastomosis of hepatic duct to transposed jejunum and insertion of tubal prosthesis HFQ
J29.2	Anastomosis of hepatic duct to jejunum NEC
J29.3	Revision of anastomosis of hepatic duct
J29.4	Open dilation of anastomosis of hepatic duct
J30.1	Anastomosis of common bile duct to duodenum
J30.2	Anastomosis of common bile duct to transposed jejunum
J30.3	Anastomosis of common bile duct to jejunum NEC
J30.4	Revision of anastomosis of common bile duct
J30.5	Open dilation of anastomosis of common bile duct
J30.8	Other specified connection of common bile duct
J30.9	Unspecified connection of common bile duct
Pancreas Operations	
J54.1	Transplantation of pancreas and duodenum
J54.2	Transplantation of whole pancreas
J54.4	Transplantation of islet of langerhans
J54.8	Other specified transplantation of pancreas
J54.9	Unspecified transplantation of pancreas
J55.1	Total pancreatectomy and excision of surrounding tissue
J55.2	Total pancreatectomy NEC
J55.3	Excision of transplanted pancreas
J55.8	Other specified total excision of pancreas
J55.9	Unspecified total excision of pancreas
J56.1	Pancreaticoduodenectomy and excision of surrounding tissue
J56.2	Pancreaticoduodenectomy and resection of antrum of stomach
J56.3	Pancreaticoduodenectomy NEC
J56.4	Subtotal excision of head of pancreas with preservation of duodenum and drainage HFQ
J56.8	Other specified excision of head of pancreas
J56.9	Unspecified excision of head of pancreas
J57.1	Subtotal pancreatectomy
J57.2	Left pancreatectomy and drainage of pancreatic duct
J57.3	Left pancreatectomy NEC
J57.4	Excision of tail of pancreas and drainage of pancreatic duct
J57.5	Excision of tail of pancreas NEC
J57.6	Pancreatic necrosectomy
J57.8	Other specified other partial excision of pancreas
J57.9	Unspecified other partial excision of pancreas
J58.1	Excision of lesion of islet of langerhans
J58.2	Excision of lesion of pancreas NEC
J58.3	Destruction of lesion of pancreas
J58.8	Other specified extirpation of lesion of pancreas
J59.2	Anastomosis of pancreatic duct to duodenum
J59.3	Anastomosis of pancreatic duct to transposed jejunum
J59.4	Anastomosis of pancreatic duct to jejunum NEC
J59.5	Revision of anastomosis of pancreatic duct
J59.9	Unspecified connection of pancreatic duct
J68.8	Other specified other operations on pancreas
Splenectomy	
J69.1	Total excision of spleen and replantation of fragments of spleen
J69.2	Total splenectomy
J69.8	Other specified total excision of spleen
J69.9	Unspecified total excision of spleen
J70.1	Partial splenectomy

J70.2	Marsupialisation of lesion of spleen
J70.8	Other specified other excision of spleen
J70.9	Unspecified other excision of spleen
Hernia Repair	
T19.1	Bilateral herniotomy
T19.2	Unilateral herniotomy
T19.3	Ligation of patent processus vaginalis
T19.8	Other specified simple excision of inguinal hernial sac
T19.9	Unspecified simple excision of inguinal hernial sac
T20.1	Primary repair of inguinal hernia using insert of natural material
T20.2	Primary repair of inguinal hernia using insert of prosthetic material
T20.3	Primary repair of inguinal hernia using sutures
T20.4	Primary repair of inguinal hernia and reduction of sliding hernia
T20.8	Other specified primary repair of inguinal hernia
T20.9	Unspecified primary repair of inguinal hernia
T21.1	Repair of recurrent inguinal hernia using insert of natural material
T21.2	Repair of recurrent inguinal hernia using insert of prosthetic material
T21.3	Repair of recurrent inguinal hernia using sutures
T21.4	Removal of prosthetic material from previous repair of inguinal hernia
T21.8	Other specified repair of recurrent inguinal hernia
T21.9	Unspecified repair of recurrent inguinal hernia
T22.1	Primary repair of femoral hernia using insert of natural material
T22.2	Primary repair of femoral hernia using insert of prosthetic material
T22.3	Primary repair of femoral hernia using sutures
T22.8	Other specified primary repair of femoral hernia
T22.9	Unspecified primary repair of femoral hernia
T23.1	Repair of recurrent femoral hernia using insert of natural material
T23.2	Repair of recurrent femoral hernia using insert of prosthetic material
T23.3	Repair of recurrent femoral hernia using sutures
T23.4	Removal of prosthetic material from previous repair of femoral hernia
T23.8	Other specified repair of recurrent femoral hernia
T23.9	Unspecified repair of recurrent femoral hernia
T24.1	Repair of umbilical hernia using insert of natural material
T24.2	Repair of umbilical hernia using insert of prosthetic material
T24.3	Repair of umbilical hernia using sutures
T24.4	Removal of prosthetic material from previous repair of umbilical hernia
T24.8	Other specified primary repair of umbilical hernia
T24.9	Unspecified primary repair of umbilical hernia
T25.1	Primary repair of incisional hernia using insert of natural material
T25.2	Primary repair of incisional hernia using insert of prosthetic material
T25.3	Primary repair of incisional hernia using sutures
T25.8	Other specified primary repair of incisional hernia
T25.9	Unspecified primary repair of incisional hernia
T26.1	Repair of recurrent incisional hernia using insert of natural material
T26.2	Repair of recurrent incisional hernia using insert of prosthetic material
T26.3	Repair of recurrent incisional hernia using sutures
T26.4	Removal of prosthetic material from previous repair of incisional hernia
T26.8	Other specified repair of recurrent incisional hernia
T26.9	Unspecified repair of recurrent incisional hernia
T27.1	Repair of ventral hernia using insert of natural material
T27.2	Repair of ventral hernia using insert of prosthetic material
T27.3	Repair of ventral hernia using sutures
T27.4	Removal of prosthetic material from previous repair of ventral hernia
T27.8	Other specified repair of other hernia of abdominal wall

T27.9	Unspecified repair of other hernia of abdominal wall
Laparotomy	
T30.1	Reopening of abdomen and reexploration of intraabdominal operation site and surgical arrest of postoperative bleeding
T30.2	Reopening of abdomen and reexploration of intraabdominal operation site NEC
T30.3	Reopening of abdomen NEC
T30.4	Opening of abdomen and exploration of groin
T30.8	Other specified opening of abdomen
T30.9	Unspecified opening of abdomen
T34.1	Open drainage of subphrenic abscess
T34.2	Open drainage of pelvic abscess
T34.3	Open drainage of abdominal abscess NEC
T34.8	Other specified open drainage of peritoneum
T34.9	Unspecified open drainage of peritoneum
Adhesiolysis	
T41.2	Division of band of peritoneum
T41.3	Freeing of adhesions of peritoneum
T41.4	Open removal of foreign body from peritoneum
T41.5	Freeing of extensive adhesions of peritoneum
T41.8	Other specified other open operations on peritoneum
T41.9	Unspecified other open operations on peritoneum
T42.1	Endoscopic resection of lesion of peritoneum
T42.2	Endoscopic destruction of lesion of peritoneum
T42.3	Endoscopic division of adhesions of peritoneum

NEC not elsewhere classified; HFQ however further qualified

APPENDIX C: EXCLUDED DIAGNOSTIC CODES, CHAPTER 7

International Classification of Diseases, version 10 diagnostic code	Number of cases 2000-2009	30-day in-hospital mortality	% treated by a surgeon
K76.7 Hepatorenal syndrome	1871	75.7%	11.9%
K70.4 Alcoholic hepatic failure	8684	37.5%	3.2%
K71.3 Toxic liver disease with chronic persistent hepatitis	8	37.5%	12.5%
K72.1 Chronic hepatic failure	352	31.8%	4.5%
K72.9 Hepatic failure, unspecified	6451	31.1%	4.9%
K75.1 Phlebitis of portal vein	13	30.8%	30.8%
K74.1 Hepatic sclerosis	40	25.0%	12.5%
K27.4 Peptic ulcer, chronic or unspecified with haemorrhage	1056	24.4%	15.6%
K71.8 Toxic liver disease with other disorders of liver	25	24.0%	8.0%
K72.0 Acute and subacute hepatic failure	3704	21.6%	10.6%
K70.2 Alcoholic fibrosis and sclerosis of liver	386	20.5%	9.3%
K71.7 Toxic liver disease with fibrosis and cirrhosis of liver	54	20.4%	14.8%
K71.1 Toxic liver disease with hepatic necrosis	498	19.5%	10.2%
K70.3 Alcoholic cirrhosis of liver	25337	18.7%	5.7%
K27.0 Peptic ulcer, acute with haemorrhage	264	17.8%	14.0%
K74.6 Other and unspecified cirrhosis of liver	9375	17.1%	9.9%
K76.5 Hepatic veno-occlusive disease	6	16.7%	16.7%
K03.0 Excessive attrition of teeth	6	16.7%	0.0%
K92.2 Gastrointestinal haemorrhage, unspecified	74539	16.1%	21.1%
K73.8 Other chronic hepatitis, not elsewhere classified	104	14.4%	8.7%
K74.2 Hepatic fibrosis with hepatic sclerosis	14	14.3%	21.4%
K70.9 Alcoholic liver disease, unspecified	46101	14.2%	4.3%
K74.5 Biliary cirrhosis, unspecified	393	14.0%	12.5%
K74.3 Primary biliary cirrhosis	2299	13.4%	16.7%
K26.4 Duodenal ulcer, chronic or unspecified with haemorrhage	16246	13.2%	25.8%
K28.4 Gastrojejunal ulcer, chronic or unspecified with haemorrhage	186	12.4%	28.0%
K26.0 Duodenal ulcer, acute with haemorrhage	6514	12.2%	23.5%
K71.5 Toxic liver disease with chronic active hepatitis	17	11.8%	5.9%
K73.2 Chronic active hepatitis, not elsewhere classified	574	11.5%	9.6%
K76.9 Liver disease, unspecified	4470	11.1%	21.0%
K70.1 Alcoholic hepatitis	11039	9.8%	6.8%
K25.4 Gastric ulcer, chronic or unspecified with haemorrhage	11661	9.3%	16.6%
K76.4 Peliosis hepatis	11	9.1%	18.2%
K25.0 Gastric ulcer, acute with haemorrhage	4802	8.5%	15.2%
K75.4 Autoimmune hepatitis	1012	7.8%	10.2%
K22.8 Other specified diseases of oesophagus	1905	6.7%	16.2%
K74.4 Secondary biliary cirrhosis	105	6.7%	18.1%
K90.8 Other intestinal malabsorption	93	6.5%	11.8%

K71.9 Toxic liver disease, unspecified	240	6.3%	5.0%
K52.8 Other specified noninfective gastroenteritis and colitis	2396	6.2%	29.5%
K70.0 Alcoholic fatty liver	1162	6.2%	11.9%
K92.8 Other specified diseases of digestive system	453	6.2%	20.1%
K71.0 Toxic liver disease with cholestasis	183	6.0%	16.9%
K92.0 Haematemesis	184841	6.0%	9.1%
K76.6 Portal hypertension	964	5.9%	10.7%
K29.0 Acute haemorrhagic gastritis	3355	5.8%	14.3%
K90.9 Intestinal malabsorption, unspecified	297	5.7%	12.8%
K75.8 Other specified inflammatory liver diseases	574	5.6%	14.5%
K73.0 Chronic persistent hepatitis, not elsewhere classified	18	5.6%	0.0%
K22.5 Diverticulum of oesophagus, acquired	491	5.5%	17.1%
K71.6 Toxic liver disease with hepatitis, not elsewhere classified	285	5.3%	7.7%
K52.0 Gastroenteritis and colitis due to radiation	1039	5.2%	32.9%
K73.9 Chronic hepatitis, unspecified	507	5.1%	8.1%
K75.0 Abscess of liver	4984	5.0%	46.1%
K92.1 Melaena	78398	5.0%	15.1%
K74.0 Hepatic fibrosis	223	4.9%	22.0%
K40.3 Unilat or unsp inguin hernia with obstruct without gangrene	19822	4.8%	97.3%
K31.8 Other specified diseases of stomach and duodenum	5414	4.7%	30.9%
K76.1 Chronic passive congestion of liver	213	4.7%	22.5%
K63.9 Disease of intestine, unspecified	1949	4.7%	69.0%
K41.2 Bilateral femoral hernia, without obstruction or gangrene	65	4.6%	95.4%
K86.8 Other specified diseases of pancreas	2076	4.6%	67.1%
K63.2 Fistula of intestine	4430	4.5%	89.7%
K51.1 Ulcerative (chronic) ileocolitis	133	4.5%	46.6%
K85.X Acute pancreatitis	135059	4.4%	90.8%
K38.3 Fistula of appendix	23	4.3%	95.7%
K90.2 Blind loop syndrome, not elsewhere classified	24	4.2%	33.3%
K55.2 Angiodysplasia of colon	2777	4.0%	25.1%
K59.2 Neurogenic bowel, not elsewhere classified	75	4.0%	40.0%
K90.3 Pancreatic steatorrhoea	25	4.0%	56.0%
K22.2 Oesophageal obstruction	13872	3.9%	26.1%
K22.9 Disease of oesophagus, unspecified	875	3.8%	14.9%
K63.3 Ulcer of intestine	890	3.7%	70.9%
K83.8 Other specified diseases of biliary tract	6709	3.7%	64.1%
K59.1 Functional diarrhoea	2842	3.6%	16.5%
K86.9 Disease of pancreas, unspecified	1370	3.6%	66.2%
K52.9 Noninfective gastroenteritis and colitis, unspecified	384128	3.5%	18.2%
K83.9 Disease of biliary tract, unspecified	570	3.5%	45.4%
K83.3 Fistula of bile duct	176	3.4%	78.4%
K90.4 Malabsorption due to intolerance, not elsewhere classified	149	3.4%	18.1%
K22.0 Achalasia of cardia	1924	3.3%	23.8%
K42.0 Umbilical hernia with obstruction, without gangrene	14322	3.3%	97.2%

K26.3 Duodenal ulcer, acute without haemorrhage or perforation	2675	3.3%	23.6%
K52.1 Toxic gastroenteritis and colitis	1987	3.2%	9.4%
K27.3 Peptic ulcer, acute without haemorrhage or perforation	250	3.2%	36.0%
K57.5 Divertic dis both sml and lge intest without perf or absces	313	3.2%	84.7%
K51.8 Other ulcerative colitis	1544	3.2%	34.8%
K31.9 Disease of stomach and duodenum, unspecified	1457	3.2%	24.2%
K62.4 Stenosis of anus and rectum	1030	3.1%	86.6%
K57.1 Diverticular dis of small intestine without perf or abscess	934	3.1%	70.6%
K22.1 Ulcer of oesophagus	16335	3.1%	15.4%
K91.1 Postgastric surgery syndromes	267	3.0%	42.3%
K92.9 Disease of digestive system, unspecified	1960	2.9%	44.9%
K66.0 Peritoneal adhesions	11358	2.9%	90.9%
K26.9 Unspec as acute or chronic w/out haemorrhage or perforation	12382	2.8%	26.7%
K91.3 Postoperative intestinal obstruction	3861	2.8%	90.1%
K59.9 Functional intestinal disorder, unspecified	644	2.8%	55.4%
K26.7 Duodenal ulcer, chronic without haemorrhage or perforation	3093	2.7%	26.0%
K31.4 Gastric diverticulum	114	2.6%	54.4%
K60.4 Rectal fistula	305	2.6%	86.9%
K62.5 Haemorrhage of anus and rectum	141445	2.6%	76.9%
K31.2 Hourglass stricture and stenosis of stomach	39	2.6%	35.9%
K51.5 Mucosal proctocolitis	398	2.5%	49.7%
K25.7 Gastric ulcer, chronic without haemorrhage or perforation	2907	2.5%	20.7%
K25.9 Unspec as acute or chronic w/out haemorrhage or perforation	16019	2.5%	23.1%
K91.8 Other postprocedural disorders of digestive system NEC	10919	2.4%	57.3%
K45.8 Other spec abdom hernia without obstruction or gangrene	717	2.4%	89.8%
K81.0 Acute cholecystitis	34806	2.4%	87.7%
K51.4 Pseudopolypoidosis of colon	127	2.4%	42.5%
K75.2 Nonspecific reactive hepatitis	85	2.4%	12.9%
K71.2 Toxic liver disease with acute hepatitis	129	2.3%	9.3%
K90.0 Coeliac disease	1594	2.3%	18.7%
K11.2 Sialoadenitis	6056	2.2%	3.3%
K75.9 Inflammatory liver disease, unspecified	3410	2.2%	12.9%
K06.9 Disorder of gingiva and edentulous alveolar ridge, unspec	91	2.2%	0.0%
K29.4 Chronic atrophic gastritis	733	2.2%	28.0%
K83.5 Biliary cyst	47	2.1%	72.3%
K25.3 Gastric ulcer, acute without haemorrhage or perforation	2713	2.1%	22.3%
K76.0 Fatty (change of) liver, not elsewhere classified	1732	2.1%	35.9%
K82.9 Disease of gallbladder, unspecified	587	2.0%	74.8%
K62.2 Anal prolapse	99	2.0%	77.8%
K11.3 Abscess of salivary gland	2312	2.0%	5.2%
K91.4 Colostomy and enterostomy malfunction	23228	2.0%	88.9%
K80.4 Calculus of bile duct with cholecystitis	6503	2.0%	80.8%
K62.9 Disease of anus and rectum, unspecified	868	2.0%	79.4%
K82.8 Other specified diseases of gallbladder	2503	1.9%	84.3%

K86.2 Cyst of pancreas	1223	1.8%	77.3%
K20.X Oesophagitis	22581	1.8%	17.3%
K46.9 Unspecified abdominal hernia without obstruction or gangrene	1725	1.8%	71.0%
K59.0 Constipation	224572	1.8%	55.1%
K57.3 Diverticular dis of large intestine without perf or abscess	58873	1.7%	87.2%
K86.3 Pseudocyst of pancreas	3868	1.7%	86.1%
K41.9 Unilat or unspec fem hernia without obstruction or gangrene	5543	1.7%	96.8%
K14.3 Hypertrophy of tongue papillae	62	1.6%	4.8%
K75.3 Granulomatous hepatitis, not elsewhere classified	124	1.6%	13.7%
K62.7 Radiation proctitis	931	1.6%	66.2%
K57.9 Divertic dis of intest part unspec without perf or abscess	70825	1.6%	85.9%
K51.0 Ulcerative (chronic) enterocolitis	505	1.6%	35.0%
K62.6 Ulcer of anus and rectum	1278	1.6%	81.1%
K27.9 Unspec as acute or chronic w/out haemorrhage or perforation	4351	1.6%	36.6%
K29.3 Chronic superficial gastritis	324	1.5%	39.8%
K44.9 Diaphragmatic hernia without obstruction or gangrene	13863	1.5%	33.8%
K27.7 Peptic ulcer, chronic without haemorrhage or perforation	395	1.5%	29.4%
K11.7 Disturbances of salivary secretion	133	1.5%	0.8%
K31.7 Polyp of stomach and duodenum	1065	1.5%	30.8%
K21.0 Gastro-oesophageal reflux disease with oesophagitis	22934	1.5%	15.5%
K50.1 Crohn's disease of large intestine	7227	1.5%	41.8%
K29.5 Chronic gastritis, unspecified	4599	1.5%	39.1%
K51.2 Ulcerative (chronic) proctitis	1310	1.5%	36.6%
K51.9 Ulcerative colitis, unspecified	39702	1.4%	28.8%
K12.1 Other forms of stomatitis	2267	1.4%	1.8%
K81.8 Other cholecystitis	466	1.3%	82.6%
K52.2 Allergic and dietetic gastroenteritis and colitis	1183	1.3%	13.0%
K82.1 Hydrops of gallbladder	321	1.2%	92.8%
K63.5 Polyp of colon	2014	1.2%	59.7%
K86.1 Other chronic pancreatitis	23337	1.2%	73.6%
K62.3 Rectal prolapse	9820	1.2%	89.1%
K13.7 Other and unspecified lesions of oral mucosa	2858	1.2%	1.9%
K40.2 Bilateral inguinal hernia, without obstruction or gangrene	1654	1.2%	92.9%
K61.1 Rectal abscess	1493	1.2%	92.2%
K06.8 Oth spec disorder of gingiva and edentulous alveolar ridge	1288	1.2%	0.4%
K51.3 Ulcerative (chronic) rectosigmoiditis	954	1.2%	29.4%
K91.2 Postsurgical malabsorption, not elsewhere classified	350	1.1%	24.3%
K80.0 Calculus of gallbladder with acute cholecystitis	61871	1.1%	90.7%
K81.9 Cholecystitis, unspecified	23161	1.1%	81.5%
K91.9 Postprocedural disorder of digestive system, unspecified	289	1.0%	73.0%
K29.8 Duodenitis	7742	1.0%	33.7%
K50.8 Other Crohn's disease	3192	1.0%	50.9%
K22.6 Gastro-oesophageal laceration-haemorrhage syndrome	17424	1.0%	5.2%
K29.1 Other acute gastritis	6020	0.9%	28.0%

K43.9 Ventral hernia without obstruction or gangrene	16591	0.9%	93.5%
K08.1 Loss of teeth accident extraction or local periodontal dis	108	0.9%	8.3%
K62.1 Rectal polyp	2160	0.9%	73.7%
K50.0 Crohn's disease of small intestine	8347	0.9%	58.6%
K29.6 Other gastritis	7675	0.9%	29.1%
K62.8 Other specified diseases of anus and rectum	11610	0.9%	82.0%
K12.0 Recurrent oral aphthae	678	0.9%	1.2%
K40.9 Unilat or unspec inguin hernia without obstruct or gangrene	30320	0.9%	94.0%
K29.9 Gastroduodenitis, unspecified	3569	0.9%	32.0%
K86.0 Alcohol-induced chronic pancreatitis	24820	0.9%	81.0%
K14.0 Glossitis	2847	0.8%	1.1%
K91.0 Vomiting following gastrointestinal surgery	1094	0.8%	83.1%
K50.9 Crohn's disease, unspecified	43705	0.8%	36.8%
K81.1 Chronic cholecystitis	4795	0.8%	93.1%
K35.0 Acute appendicitis with generalized peritonitis	45413	0.8%	98.4%
K22.4 Dyskinesia of oesophagus	4880	0.7%	4.2%
K42.9 Umbilical hernia without obstruction or gangrene	15895	0.7%	94.7%
K35.1 Acute appendicitis with peritoneal abscess	9833	0.7%	97.2%
K80.1 Calculus of gallbladder with other cholecystitis	47667	0.7%	89.8%
K80.2 Calculus of gallbladder without cholecystitis	115907	0.6%	83.6%
K80.8 Other cholelithiasis	2135	0.6%	76.2%
K29.7 Gastritis, unspecified	68113	0.6%	29.8%
K61.2 Anorectal abscess	337	0.6%	89.9%
K80.5 Calculus of bile duct without cholangitis or cholecystitis	69398	0.6%	79.3%
K60.5 Anorectal fistula	355	0.6%	91.5%
K38.2 Diverticulum of appendix	178	0.6%	97.8%
K11.6 Mucocele of salivary gland	186	0.5%	7.5%
K58.0 Irritable bowel syndrome with diarrhoea	3306	0.5%	31.2%
K61.3 Ischiorectal abscess	12318	0.5%	97.2%
K83.4 Spasm of sphincter of Oddi	199	0.5%	41.7%
K11.8 Other diseases of salivary glands	605	0.5%	2.8%
K11.1 Hypertrophy of salivary gland	812	0.5%	3.6%
K04.0 Pulpitis	204	0.5%	0.0%
K60.3 Anal fistula	7052	0.5%	95.2%
K14.8 Other diseases of tongue	3918	0.5%	0.8%
K13.0 Diseases of lips	1311	0.5%	3.7%
K12.2 Cellulitis and abscess of mouth	6925	0.4%	3.2%
K05.2 Acute periodontitis	770	0.4%	1.2%
K10.2 Inflammatory conditions of jaws	1097	0.4%	7.1%
K61.4 Intraspincteric abscess	838	0.4%	96.4%
K10.8 Other specified diseases of jaws	1466	0.3%	1.4%
K04.8 Radicular cyst	329	0.3%	0.9%
K08.3 Retained dental root	677	0.3%	0.9%
K10.3 Alveolitis of jaws	364	0.3%	2.7%

K08.8 Other specified disorders of teeth and supporting structures	1844	0.3%	1.0%
K11.5 Sialolithiasis	1118	0.3%	3.3%
K05.1 Chronic gingivitis	378	0.3%	3.7%
K30.X Dyspepsia	22030	0.3%	8.7%
K60.0 Acute anal fissure	966	0.2%	93.0%
K14.9 Disease of tongue, unspecified	500	0.2%	0.4%
K04.6 Periapical abscess with sinus	515	0.2%	2.3%
K38.8 Other specified diseases of appendix	3657	0.2%	97.4%
K62.0 Anal polyp	527	0.2%	92.0%
K29.2 Alcoholic gastritis	10962	0.2%	18.4%
K21.9 Gastro-oesophageal reflux disease without oesophagitis	38224	0.2%	6.0%
K38.9 Disease of appendix, unspecified	1220	0.2%	97.5%
K60.2 Anal fissure, unspecified	6781	0.1%	90.9%
K61.0 Anal abscess	100930	0.1%	96.3%
K02.9 Dental caries, unspecified	3602	0.1%	1.0%
K60.1 Chronic anal fissure	952	0.1%	96.1%
K04.7 Periapical abscess without sinus	24201	0.1%	1.6%
K35.9 Acute appendicitis, unspecified	140533	0.1%	98.2%
K37.X Unspecified appendicitis	32797	0.1%	96.4%
K58.9 Irritable bowel syndrome without diarrhoea	10337	0.1%	49.8%
K36.X Other appendicitis	2499	0.1%	96.5%
K38.1 Appendicular concretions	1874	0.1%	97.8%
K00.0 Anodontia	22	0.0%	0.0%
K00.1 Supernumerary teeth	4	0.0%	25.0%
K00.2 Abnormalities of size and form of teeth	6	0.0%	0.0%
K00.5 Hereditary disturbances in tooth structure NEC	5	0.0%	0.0%
K00.6 Disturbances in tooth eruption	59	0.0%	3.4%
K00.7 Teething syndrome	1	0.0%	0.0%
K00.8 Other disorders of tooth development	20	0.0%	0.0%
K00.9 Disorder of tooth development, unspecified	28	0.0%	25.0%
K01.0 Embedded teeth	29	0.0%	6.9%
K01.1 Impacted teeth	845	0.0%	1.1%
K02.0 Caries limited to enamel	5	0.0%	0.0%
K02.1 Caries of dentine	37	0.0%	0.0%
K02.2 Caries of cementum	22	0.0%	4.5%
K02.3 Arrested dental caries	1	0.0%	0.0%
K02.4 Odontoclasia	3	0.0%	0.0%
K02.8 Other dental caries	86	0.0%	1.2%
K03.1 Abrasion of teeth	5	0.0%	0.0%
K03.2 Erosion of teeth	7	0.0%	0.0%
K03.3 Pathological resorption of teeth	5	0.0%	0.0%
K03.5 Ankylosis of teeth	3	0.0%	33.3%
K03.6 Deposits [accretions] on teeth	266	0.0%	0.0%
K03.7 Posteruptive colour changes of dental hard tissues	1	0.0%	0.0%

K03.8 Other specified diseases of hard tissues of teeth	20	0.0%	10.0%
K03.9 Disease of hard tissues of teeth, unspecified	9	0.0%	0.0%
K04.1 Necrosis of pulp	8	0.0%	12.5%
K04.2 Pulp degeneration	5	0.0%	0.0%
K04.3 Abnormal hard tissue formation in pulp	1	0.0%	0.0%
K04.4 Acute apical periodontitis of pulpal origin	222	0.0%	0.0%
K04.5 Chronic apical periodontitis	336	0.0%	0.6%
K04.9 Other and unspec diseases of pulp and periapical tissues	143	0.0%	0.7%
K05.0 Acute gingivitis	109	0.0%	2.8%
K05.3 Chronic periodontitis	611	0.0%	1.3%
K05.4 Periodontosis	16	0.0%	0.0%
K05.5 Other periodontal diseases	41	0.0%	0.0%
K05.6 Periodontal disease, unspecified	116	0.0%	0.0%
K06.0 Gingival recession	8	0.0%	0.0%
K06.1 Gingival enlargement	29	0.0%	0.0%
K06.2 Gingival and edentulous alveolar ridge les assoc with traum	26	0.0%	7.7%
K07.0 Major anomalies of jaw size	17	0.0%	0.0%
K07.1 Anomalies of jaw-cranial base relationship	37	0.0%	2.7%
K07.2 Anomalies of dental arch relationship	40	0.0%	0.0%
K07.3 Anomalies of tooth position	127	0.0%	0.0%
K07.4 Malocclusion, unspecified	77	0.0%	0.0%
K07.5 Dentofacial functional abnormalities	24	0.0%	0.0%
K07.6 Temporomandibular joint disorders	826	0.0%	0.8%
K07.8 Other dentofacial anomalies	21	0.0%	0.0%
K07.9 Dentofacial anomaly, unspecified	20	0.0%	0.0%
K08.0 Exfoliation of teeth due to systemic causes	10	0.0%	0.0%
K08.2 Atrophy of edentulous alveolar ridge	7	0.0%	42.9%
K08.9 Disorder of teeth and supporting structures, unspecified	274	0.0%	1.5%
K09.0 Developmental odontogenic cysts	150	0.0%	2.7%
K09.1 Developmental (nonodontogenic) cysts of oral region	23	0.0%	0.0%
K09.2 Other cysts of jaw	180	0.0%	10.6%
K09.8 Other cysts of oral region, not elsewhere classified	99	0.0%	2.0%
K09.9 Cyst of oral region, unspecified	45	0.0%	4.4%
K10.0 Developmental disorders of jaws	6	0.0%	0.0%
K10.1 Giant cell granuloma, central	14	0.0%	21.4%
K10.9 Disease of jaws, unspecified	74	0.0%	2.7%
K11.0 Atrophy of salivary gland	24	0.0%	4.2%
K11.4 Fistula of salivary gland	42	0.0%	2.4%
K11.9 Disease of salivary gland, unspecified	401	0.0%	4.0%
K13.1 Cheek and lip biting	20	0.0%	5.0%
K13.2 Leukoplakia and oth disturbance oral epithelium incl tongue	242	0.0%	0.0%
K13.3 Hairy leukoplakia	3	0.0%	0.0%
K13.4 Granuloma and granuloma-like lesions of oral mucosa	69	0.0%	1.4%
K13.5 Oral submucous fibrosis	13	0.0%	0.0%

K13.6 Irritative hyperplasia of oral mucosa	64	0.0%	0.0%
K14.1 Geographic tongue	9	0.0%	11.1%
K14.2 Median rhomboid glossitis	2	0.0%	0.0%
K14.4 Atrophy of tongue papillae	16	0.0%	6.3%
K14.5 Plicated tongue	3	0.0%	0.0%
K14.6 Glossodynia	87	0.0%	1.1%
K23.8 Disorders of oesophagus in other diseases classified elsewhere	5	0.0%	0.0%
K31.3 Pylorospasm, not elsewhere classified	24	0.0%	45.8%
K38.0 Hyperplasia of appendix	1066	0.0%	97.8%
K59.4 Anal spasm	170	0.0%	78.2%
K67.3 Tuberculous peritonitis	1	0.0%	0.0%
K71.4 Toxic liver disease with chronic lobular hepatitis	3	0.0%	33.3%
K73.1 Chronic lobular hepatitis, not elsewhere classified	19	0.0%	26.3%
K77.8 Liver disorders in other diseases classified elsewhere	1	0.0%	0.0%
K82.4 Cholesterolosis of gallbladder	143	0.0%	95.1%
K87.1 Disorders of pancreas in diseases classified elsewhere	2	0.0%	100.0%
K90.1 Tropical sprue	14	0.0%	7.1%
K91.5 Postcholecystectomy syndrome	543	0.0%	90.1%
K93.0 Tuberculous disorders of intestines, peritoneum and mesenteric glands	1	0.0%	0.0%

APPENDIX D: ROUND 1 DELPHI QUESTIONNAIRE, CHAPTER 9

Demographics

Your Name:

Date:

Speciality:

Background

Thank you for completing this Delphi process.

We aim to identify the processes that will have the greatest impact on outcome for EMERGENCY GENERAL SURGERY patients. In the absence of clear evidence we want to get expert opinion on the relative importance of a variety of processes to patient outcome. If there are any processes you feel would have a large impact but are missing from the survey please record them at the end and we will include them in round 2.

Please score the following processes from 1 to 9, where 9 corresponds to a major impact on outcome and 1 a minor impact on outcome, assuming that the process is not performed by the time of the post-take ward round.

Teamwork

	Minor	Major
The initial assessment of patients should include a doctor of sufficient experience and authority to implement a management plan.	1 2 3 4 5 6 7 8 9	
Patients admitted as an emergency should be seen by a consultant at the earliest opportunity. Ideally this should be within 12 hours and should not be longer than 24 hours.	1 2 3 4 5 6 7 8 9	
If a significant concurrent medical illness is apparent then the appropriate medical team should be involved.	1 2 3 4 5 6 7 8 9	
A clear handover should be made to the incoming surgical team, including patient name, location, diagnosis and investigations.	1 2 3 4 5 6 7 8 9	

Hospital Systems

	Minor	Major
Emergency surgical admissions should be to a ward which is appropriate for their clinical condition in terms of required specialty, level of care and presenting complaint.	1 2 3 4 5 6 7 8 9	
Excessive transfers both within and outside the hospital should be avoided.	1 2 3 4 5 6 7 8 9	

Monitoring

	Minor	Major
A clear physiological monitoring plan should be made and documented for each patient (e.g. 4 hourly obs).	1 2 3 4 5 6 7 8 9	
Vital signs observations, including fluid balance, should be recorded in line with the physiological monitoring plan and not less than twelve hourly.	1 2 3 4 5 6 7 8 9	

Investigations										
	Minor					Major				
Basic bloods (U&E, FBC, CRP where appropriate) should have been performed.	1	2	3	4	5	6	7	8	9	
Patients who are bleeding or at risk of bleeding should have a group and save sample taken.	1	2	3	4	5	6	7	8	9	
Appropriate plain radiology should be complete.	1	2	3	4	5	6	7	8	9	

Clinical Processes										
	Minor					Major				
Adequate IV access should be secured.	1	2	3	4	5	6	7	8	9	
All suitable patients should have appropriate DVT prophylaxis.	1	2	3	4	5	6	7	8	9	
If NBM, important oral medications should be converted to an alternative route.	1	2	3	4	5	6	7	8	9	
All patients with severe sepsis or septic shock should have blood cultures taken and antibiotics administered within 3 hours of admission.	1	2	3	4	5	6	7	8	9	
Resuscitation or maintenance with IV fluid should be instigated where appropriate.	1	2	3	4	5	6	7	8	9	
Appropriate analgesia should be administered and titrated as necessary.	1	2	3	4	5	6	7	8	9	
Patients with haemodynamic instability should have a urethral catheter placed to monitor fluid balance.	1	2	3	4	5	6	7	8	9	
Patients with persistent vomiting and signs of obstruction should have an NG tube placed.	1	2	3	4	5	6	7	8	9	

Documentation										
	Minor					Major				
Casene entries should be legible, dated, timed and signed.	1	2	3	4	5	6	7	8	9	
By the time of the post-take ward round a preliminary diagnosis should have been made.	1	2	3	4	5	6	7	8	9	
Documentation of the first consultant review should be clearly indicated in the casenotes.	1	2	3	4	5	6	7	8	9	
A clear treatment plan should be documented in the casenotes.	1	2	3	4	5	6	7	8	9	
A plan for oral intake should be documented in the casenotes.	1	2	3	4	5	6	7	8	9	
Patient's allergy status and routine medication should be transcribed onto the medication chart unless contraindicated.	1	2	3	4	5	6	7	8	9	
Casenotes for patients previously treated at the hospital should be obtained.	1	2	3	4	5	6	7	8	9	

Additional Processes

If there are any additional processes that you feel would have a significant effect on the outcome for emergency surgery patients, if performed prior to the post-take ward round, please note them here:

APPENDIX E: DELPHI FEEDBACK QUESTIONNAIRE, CHAPTER 9

Demographics

Your Name: Dr XXXXXXXX

Date:

Speciality: Anaesthetics

Background

Thank you for completing round 1. Processes for which the scores had a interquartile range less than or equal to 1.5 have been excluded as consensus has been reached. For the remaining processes your score in round 1 (shaded number) and the median (solid dot) and range (arrows) of the other participants' scores have been included for your information.

Please rescore the following processes from 1 to 9, where 9 corresponds to a very large impact on outcome and 1 a very minor impact on outcome, assuming that the process is not performed by the time of the post-take ward round.

In addition a few processes suggested by participants have been added for your opinion. Many thanks again for your participation.

Teamwork

	Minor	Major
Patients admitted as an emergency should be seen by a consultant at the earliest opportunity. Ideally this should be within 12 hours and should not be longer than 24 hours.	1 2 3 4 5 6 7 8 9	
		

Hospital Systems

	Minor	Major
Excessive transfers both within and outside the hospital should be avoided.	1 2 3 4 5 6 7 8 9	
		

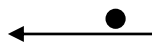
Monitoring

	Minor	Major
A clear physiological monitoring plan should be made and documented for each patient (e.g. 4 hourly obs).	1 2 3 4 5 6 7 8 9	
		

Clinical Processes

	Minor	Major
All suitable patients should have appropriate DVT prophylaxis.	1 2 3 4 5 6 7 8 9	
		

Documentation

	Minor	Major
Casenote entries should be legible, dated, timed and signed.	1 2 3 4 5 6 7 8 9	
		
Patient's allergy status and routine medication should be transcribed onto the medication chart unless contraindicated.	1 2 3 4 5 6 7 8 9	
		

Additional Processes

	Minor	Major
Patient's exercise tolerance and functional status should be clearly documented in the casenotes.	1 2 3 4 5 6 7 8 9	
Patients with reduced oxygen saturation or PaO² (usually less than 95%) should have supplemental oxygen administered.	1 2 3 4 5 6 7 8 9	

APPENDIX F: DATA COLLECTION SHEET, CHAPTER 10

Study #:	Hospital #:	Name:
DoB:	Time of data collection:	
Diagnosis:	pMHx:	
Ward and Team:		
Date + Time of Arrival:	Procedures/operations:	
Time seen by surgical team:		
Date of Discharge:	Complications:	

Processes	
Patient	Please mark as tick, cross or not applicable
A clear handover should be made to the incoming surgical team (written or verbal)	
Admission should be to a ward which is appropriate for their clinical condition (i.e. surgical)	
Seen by a consultant within 24hrs	
Adequate IV access should be secured (i.e. one or 2 for v.sick/GI bleed +- CVP line)	
Resuscitation or maintenance with IV fluid should be instigated where appropriate.	
Patients with haemodynamic instability should have a urethral catheter placed	
Patients with vomiting and signs of obstruction should have an NG tube placed	

Charts	
Vital signs observations, including fluid balance according to plan or > 6 hourly	
Severe sepsis or septic shock: blood cultures and antibiotics within 3 hours	
Appropriate analgesia should be administered and titrated as necessary	
Patients with reduced oxygen saturation (usually <95%) should have oxygen administered	
Allergies and routine medication should be transcribed onto the medication chart	
Appropriate DVT prophylaxis should be prescribed and given	

Casenotes	
Casenote entries should be legible, dated, timed and signed	
Doctor of sufficient experience to implement a management plan (seen by SpR within 4 hrs)	
By the post-take ward round a preliminary diagnosis should have been made	
A clear treatment plan should be documented in the casenotes	
A clear physiological monitoring plan should be made and documented (i.e. 4 hourly obs)	
Basic bloods should have been performed (U+E, FBC etc. as appropriate)	
Patients bleeding or at risk of bleeding should have a group and save sample taken	
Documentation of the first consultant review performed.	
Casenotes for patients previously treated at the hospital should be obtained	

APPENDIX G: PEER REVIEWED PUBLICATIONS DURING THESIS

Symons, N. R., Almoudaris, A. M., Nagpal, K., et al. 2013. An observational study of the frequency, severity, and etiology of failures in postoperative care after major elective general surgery. *Ann Surg*, 257, 1-5.

Symons, N. R., Moorthy, K., Almoudaris, A. M., et al. 2013. Mortality in high-risk emergency general surgical admissions. *Br J Surg*, 100, 1318-25.

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

Symons, N. R., Wong, H. W., Manser, T., et al. 2012. An observational study of teamwork skills in shift handover. *Int J Surg*, 10, 355-9.

Brigic, A., **Symons, N. R.**, Faiz, O., et al. 2013. A systematic review regarding the feasibility and safety of endoscopic full thickness resection (EFTR) for colonic lesions. *Surg Endosc*, 27, 3520-9.

Aiken, A. M., Haddow, J. B., **Symons, N. R.**, et al. 2013. Use of antibiotic prophylaxis in elective inguinal hernia repair in adults in London and south-east England: a cross-sectional survey. *Hernia*, 17, 657-64.

Symons, N. R., Purkayastha, S., Dillemans, B., et al. 2011. Laparoscopic revision of failed antireflux surgery: a systematic review. *Am J Surg*, 202, 336-43.

APPENDIX H: CONFERENCE PRESENTATIONS DURING THESIS

International

The effects of resource availability on mortality for emergency general surgical admissions. American College of Surgeons Annual Clinical Congress, Washington, USA. 8th October 2013.

Teamwork skills in surgical shift handover. Swiss Patient Safety Foundation International Congress, Basel, Switzerland. 29th November 2011.

Teamwork and communication failures in post-operative care. American College of Surgeons Annual Clinical Congress, San Francisco, USA. 26th October 2011.

National

Mortality in high-risk emergency general surgical admissions: the implications of resource availability in the NHS. ASGBI, Glasgow, 2nd May 2013. **Moynihan Prize Session.**

Omissions in the process of care for emergency general surgical admissions. ASGBI, Glasgow, 2nd May 2013.

Patients' experience of communication during elective and emergency surgical admissions, ASGBI, Liverpool, 9th May 2012.

Preventable failures in post-operative care: a potential target for quality improvement. ASGBI, Bournemouth, 12th May 2011. **Moynihan Prize Session.**

Non-technical skills in surgical shift handover: it's not just the content that matters. ASGBI, Bournemouth, 11th May 2011.

Errors and adverse events following major elective general surgery. North British Patient Safety Conference, Bradford, 19th November 2010.

Developing an assessment tool for emergency surgical admissions. North British Patient Safety Conference, Bradford, 19th November 2010.

Post-operative trigger events – an innovative method of quality of care analysis in surgical patients. ASGBI, Liverpool, 14th April 2010.