

The Impact of Urgency and Timing in Emergency Abdominal Surgery
for Inflammatory Bowel Disease

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Acknowledgements

I have been a surgical research fellow in the NELA project team since August 2021. This role involves attending monthly project team meetings online and in person at the Royal College of Anaesthetists, reviewing and inputting into the NELA annual report and attending and speaking at conferences and meetings as required. As a member of the project team, I was able to perform secondary analysis of the NELA dataset. This thesis would not have been possible without the combined efforts of surgical, anaesthetic, and administrative teams in hospitals in England and Wales recording data for NELA. I am incredibly grateful to the NELA project team for the mentoring and guidance throughout.

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Declaration

I hereby declare that the work presented in this thesis is my own and has been completed at the Division of Medical Sciences and Graduate Entry Medicine, School of Medicine, University of Nottingham.

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Thesis Abstract

There have been significant improvements in the quality of care of patients having emergency abdominal surgery over the last decade.

This is partly due to processes like the National Emergency Laparotomy Audit (NELA) and the National Confidential Enquiry into Patient Outcomes and Death (NCEPOD). NELA and NCEPOD publications have recommended changes to improve patient care, both clinically and at organisational levels.

There has never been a particular focus on patients with inflammatory bowel disease (IBD) in NELA and, as a result, there is a lack of high quality, data driven, evidence-based guidance regarding their care in the emergency surgery setting.

This thesis aims to summarise the published evidence on outcomes in emergency abdominal surgery for IBD and use data from NELA and NCEPOD to investigate how clinical urgency may be used to guide patient care.

The first study chapter is a scoping review of the factors which affect the outcomes of patients having emergency abdominal surgery for IBD. After abstract and full paper screening, 17 articles were included in the study. Allowing for significant heterogeneity within the reported cohorts, it is likely that increasing age, increasing ASA grade, comorbidity and organ dysfunction contribute to adverse outcomes in this cohort. The more significant finding of this study was that only six authors defined what was considered an emergency operation. This study highlights the importance of accurate and detailed reporting of cohort studies, especially in IBD patients who can vary significantly in their presentations.

Chapter four investigates the significance of clinical urgency with regards to patient characteristics, presentation, and outcomes. In published literature, post-operative mortality after emergency surgery for Crohn's disease or Ulcerative Colitis is cited at four to five percent. This study found that post-operative mortality is better represented as a range from one to fifteen percent depending on clinical urgency and that patients having emergency surgery for IBD should not be considered one single cohort.

Chapter five focusses on risk stratification whilst adjusting for clinical urgency. It asks the question whether the elective specialist interest of the operating surgeon has an impact on the clinical outcomes in the different urgency categories. This study found that in the lowest urgency category, there was significantly reduced mortality and post-operative length of stay in patients with IBD having emergency abdominal surgery when operated on by a colorectal surgeon, mortality OR 2.99 (CI 1.2 – 7.8) $P=0.025$ and length of stay IRR 1.18 (CI 1.02 – 1.4) $P=0.025$.

The final study chapter, six, investigates timeliness in emergency abdominal surgery for Crohn's disease and reports on the factors associated with delays in making the decision to operate. This study uses data from both NELA and the 2023 NECPOD report 'Making the Cut'. There is a significant delay in the decision to operate in patients admitted under the care of a gastroenterologist in comparison to a general surgeon, IRR 5.05 (CI 2.37-10.77) $p<0.001$. This study also highlights delays in surgery for patients presenting with sepsis as a complication of Crohn's disease, waiting on average 30.1 hours for the decision to operate.

This thesis has provided evidence that we should not consider patients having emergency abdominal surgery for IBD a single cohort, but their

reporting in cohort studies, and risk stratification should be according to clinical urgency. It provides data to help shape the discussion regarding timeliness and emergency surgery for patients with IBD which may ultimately improve outcomes for these patients.

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III List of abbreviations

APCs Antigen Presenting Cells

ASA American Association of Anaesthetists

bpm Beats Per Minute

CD Crohn's Disease

CI Confidence Intervals

CRP C-Reactive Protein

CT Computed Tomography

GI Gastrointestinal

HES Hospital Episode Statistics

XIX

HQIP	Healthcare Quality Improvement Partnership
IBD	Inflammatory Bowel Disease
ICD-10	International Classification of Diseases
IL	interleukin
IQR	Inter-Quartile Range
IRR	Incident Rate Ratio
JCST	Joint Colleges of Surgical Training
LOS	Length of Stay
MDT	Multi-Disciplinary Team
XX	

MeSH	Medical Subject Headings
MIS	Minimally Invasive Surgery
NCAPOP	National Clinical Audit and Patient Outcomes Programme
NCEPOD	National Confidential Enquiry into Patient Outcomes and Death
NELA	National Emergency Laparotomy Audit
NEWS	National Early Warning Score
NHS	National Health Service
OPCS	Operating Procedure Code Supplement
OR	Odds Ratio
XXI	

PRISMA	Preferred Reporting Items for stematic Reviews and Meta-Analyses
PRISMA-SCR	Preferred Reporting Items for systematic Reviews and Meta-Analyses Extension for Scoping Reviews Checklist
RCoA	Royal College of Anaesthetists
STROBE	Strengthening the Reporting of Observational studies in Epidemiology
TACs	Timing of Acute Care Surgery
Th0	Helper T Cells
TNF	Tissue Necrosis Factor
UC	Ulcerative Colitis

UK

United Kingdom

WCC

White Cell Count

WSES

World Society of Emergency Surgery

IV Prizes, Publications and Presentations

Prizes

University of Nottingham Sue Watson Oral Presentation Judges Choice
4th June 2024.

Publications

Bunce JA, Doleman B, Lund JN, Tierney GM. The Impact of Surgeon Speciality Interest on Outcomes of Emergency Laparotomy in IBD. World J Surg. 2023 Sep;47(9):2287-2295. doi: 10.1007/s00268-023-07051-z. Epub 2023 May 24. PMID: 37222782; PMCID: PMC10387454.

Bunce JA, Lund JN, Tierney GM. Urgency adjusted outcomes of emergency abdominal surgery for inflammatory bowel disease. World J Surg. 2024 Aug;48(8):1883-1891. doi: 10.1002/wjs.12257. Epub 2024 Jun 30. PMID: 38944811.

Bunce JA, Wall JJS, Lund JN, Tierney GM. A call for clarity: a scoping review of predictors of poor outcome after emergency abdominal surgery for inflammatory bowel disease. Colorectal Dis. 2023 Dec;25(12):2317-2324. doi: 10.1111/codi.16783. Epub 2023 Oct 23. PMID: 37872854.

Presentations

Oral presentation “The Impact of Subspecialty Surgeon on Outcomes After Emergency Laparotomy for Inflammatory Bowel disease” ASGBI International Surgical Congress 17th May 2023.

Oral presentation “Delays in Decision Making for Emergency Abdominal Surgery in Crohn’s Disease” WSES International Congress in Rhodes 27th June 2024

1. Introduction

Inflammatory Bowel Disease

Inflammatory bowel disease (IBD) has been recognised as a condition for almost 200 years and until recent years was thought to be a disease of the industrialised western countries. Documented cases followed quickly after the industrial revolution and were thought to be associated with changes in lifestyle, pollution, and diet. Abercrombie, in 1838 describes chronic inflammatory ulcerating conditions of the gastrointestinal (GI) tract upon post-mortem but it was not for another 100 years that IBD would be split into two distinct diseases: Crohn's Disease (CD) and ulcerative colitis (UC) (Abercrombie, 1830; CROHN, 1932). Whilst they share some similarities, they are distinct conditions with different disease phenotypes, complications and treatments.

Pathophysiology

Inflammation is the body's response to a damaging stimulus. It serves several purposes; to remove the noxious stimulus, to liquify and remove dead or damaged tissue and either restore normal function of the damaged tissue or replace damaged cells with scar tissue. Where the damaging stimulus cannot be neutralised but can be held at bay, a balance between immune response and damage exists. This is chronic inflammation (Stevens et al., 2008).

Inflammation can be initiated in several ways; cell death through trauma, cell death resulting from infection by pathogenic micro-organisms, or presentation of antigens, proteins, on the surface of

cells which the body recognises as foreign, the last of which is most relevant to IBD.

The luminal surface of the GI tract is highly populated with non-pathogenic micro-organisms, otherwise known as gut flora. These micro-organisms express antigens on their surface which, under normal circumstances do not trigger an immune response. This tolerance between flora and host is essential for the normal functioning of the gut. In IBD this tolerance is lost, and the gut flora present a perpetual source of stimulation for the host immune system (Bär et al., 2013). In this way, IBD is a chronic inflammatory condition.

One of the ways that the human immune response can be categorised is by how it is initiated, either anti-body mediated (humoral), or cell mediated. Cell mediated is the predominant driver of inflammation in IBD. Here, antigens are absorbed into antigen presenting cells (APCs) and appear on their cell surface. They are recognised by naïve CD4+ helper T cells (Th0), which through the production of cytokines (interleukins, chemokines, interferons, lymphokines and tissue necrosis factor), recruit T killer cells, differentiated Th cells and macrophages and begin the process of inflammation. Anti-body mediated inflammation does also have a role in IBD. Here, B cells are activated by the Th0 cells, and produce a range of chemicals, including anti-bodies to offset the effect of the pathogen (Romagnani, 1999).

The luminal surface of the GI tract is lined with epithelial cells, held together by tight junctions, and interspersed with dendrites of dendritic cells. There are several cell types in the human body which can present foreign antigens on their surfaces to trigger an immune response; these are called APC. Both intestinal epithelial cells and dendritic cells are APCs. When the antigens present on the surface of commensal micro-organisms of the gastrointestinal tract meet APCs,

the antibodies are encapsulated and presented on the APC cell surface. Here they initiate an immune response as outlined above. Whilst this stimulus is present in healthy populations, it does not cause disease as the body has several protective mechanisms. These mechanisms are disturbed, or dysregulated, in IBD. The specific disturbances go some way to dictating the disease phenotype, whether CD or UC (Orda^ls et al., 2012; Torres et al., 2017; Ungaro et al., 2017).

Common to both UC and CD is loss of a protective barrier of mucin, because of a mutation to MUC2 gene, and a diet high in emulsifiers. Without the mucinous layer, the epithelium is subject to higher levels of abrasion and permeability is increased. This is coupled with a dysregulation of epithelial tight junctions. The outcome is a higher-than-normal level of gut flora antigens being presented by APCs to the host CD4⁺ Th0 cells (Orda^ls et al., 2012; Petagna et al., 2020; Torres et al., 2017; Ungaro et al., 2017).

T cells can either be regulatory or effector, i.e. they can down regulate, or contribute to, the hosts immune response. In both UC and CD, there is relative hyperactivity of effector T cells. Up regulation of the subtype Th1, responsible for the production of interferon-gamma (IFN- γ), interleukin (IL)-2 and tissue necrosis factor beta (TNF - β), is found in patients with CD. Th2, upregulated in UC, is responsible for the production of IL -4, IL -5, IL-10 and IL-13, resulting in the activation of eosinophils and antibody production. IL-13 is especially cytotoxic against epithelial cells. Th 1 and 2 cells activate T killer cells which release a further range of cytokines, amplifying the inflammatory process (Orda^ls et al., 2012; Petagna et al., 2020; Torres et al., 2017; Ungaro et al., 2017).

In CD, there is also anti-body mediated inflammation. In the presence of cytokines, particularly IL-21, naïve B cells, activated by Th cells, express granzyme-B, which is cytotoxic to mucosa (Torres et al., 2017).

The bowel wall is supplied by blood vessels which are found in the layer of the bowel wall called the muscularis. As a result of the inflammatory cytokines released by Th0, Th1 /2, macrophages or B cells, there is upregulation of adhesion molecules on the endothelial surfaces in the muscularis. Specifically, mucosal addressin cellular adhesion molecule-1 (MadCAM-1) is found upregulated in both CD and UC. This feeds the cycle of inflammation by promoting recruitment of leucocytes. The damage to the gut mucosa caused by ongoing inflammation leads directly to the symptoms and signs of IBD (Ordaì et al., 2012; Torres et al., 2017; Ungaro et al., 2017).

Epidemiology

Since first described, the epidemiology of CD has changed, initially increasing sharply in industrialised western countries then, in more recent years, reaching a plateau. Until recently CD was thought to be a condition of industrialised western countries, but cases are now rising in China and Japan. Prevalence is highest in Europe and North American countries, ranging from 50 – 320 / 100000, whilst in Asia prevalence ranges from 6 – 25 / 100000. An increased consumption of processed food, including a diet high in emulsifiers may explain the geographical distribution of IBD. Peak onset for CD and UC is in early adulthood, between 15 and 40 years old, with a second small peak in the 6th decade. Most of the surgery for IBD takes place within the first ten years of diagnosis. There is no variation in distribution of CD by

sex. Cigarette smoking is associated with a twofold increase in risk for developing CD. Other risk factors include non-steroidal anti-inflammatories and oral contraceptives (Torres et al., 2017).

Incidence of UC is increasing globally but highest in Westernised countries, particularly those of Northwest Europe, North America and Australia. Prevalence is 200 – 500 per 100000 in these areas. Incidence is similar in immigrants from low-risk countries to non-immigrants, suggesting environmental factors to be the highest driver of risk, however as Ashkenazi Jewish ethnicity had a 3-5 times increased risk of developing IBD, there is clearly a genetic component to the disease too. Approximately 10% of patients with IBD have a first degree relative with the same condition. One of the strongest risk factors for UC is having previously smoked cigarettes, but being a current smoker is protective. Oral contraceptives and non-steroidal anti-inflammatory drugs are also associated with developing UC. There is no sex specific distribution (Ordals et al., 2012; Ungaro et al., 2017).

Emergency Presentations of Crohn's Disease

Affecting the entire gastrointestinal tract, from mouth to anus, CD is a chronic, relapsing remitting, transmural, autoimmune inflammatory condition. Most commonly it affects the terminal ileum, as initially described by Crohn et al (Crohn, 1932). CD is usually segmental, with areas of mucosal sparing between affected sections of bowel. As a result of these characteristics, CD is heterogenous in presentation. This thesis is focussing on the emergency surgical management of IBD, disease presentations outlined below will be limited to those requiring emergent surgical management.

Transmural inflammation can result in perforations of the gastrointestinal tract and the presence of free bowel contents within the peritoneal cavity. Perforations can also be partially or completely sealed off by adjacent intra-abdominal structures. In these cases, the patient may develop an abscess, a local collection of inflammatory exudates with or without bowel content (Clark, 2019).

Chronic inflammation, as described above, results in the replacement of normal tissue with scar tissue. Circumferential scar tissue can form a fibrous stricture; narrow, rigid, non-expansile section of bowel that can become blocked. While the symptoms may be the same, a fibrous stricture is different from a stricture resulting from acute inflammation of the bowel where once the inflammatory response ebbs the obstruction may resolve (Clark, 2019).

If transmural inflammation occurs where the bowel wall becomes adherent to an adjacent structure, a fistula may occur. A fistula is an abnormal connection between two epithelialized surfaces. This could be between the bowel and any hollow intra-abdominal or pelvic organ, or the abdominal wall (Clark, 2019).

Inflammation in both UC and CD, as described above, involves the muscularis, the layer of the bowel wall containing blood vessels. Whilst uncommon in ileal CD, in Crohn's and Ulcerative colitis bleeding per rectum can be significant enough to warrant surgical intervention.

Emergency Presentations of Ulcerative Colitis

UC is also a chronic inflammatory condition limited to the colon and terminal ileum. Inflammation in UC usually extends proximally from

the rectum with a pattern of continuous inflammation and no patches of mucosal sparing as seen in CD. Inflammation is limited to the mucosa and submucosal layers (Clark, 2019).

Because UC is a chronic condition, presentation is often insidious and managed as an outpatient. However, emergency presentations, or deteriorations occur and are referred to as fulminant, toxic, acute severe or medically refractory colitis. This thesis will use the term acute severe colitis from this point and will focus on the emergency surgical management of UC, disease presentations outlined below will be limited to those requiring emergency surgery.

Acute severe ulcerative colitis was first defined by Truelove and Witts in 1954 (Truelove & Witts, 1954). UC is considered severe when the patient is passing more than 5 bloody stools a day and has at least one symptom of systemic illness including a temperature of greater than 37.8 degrees Celsius, a heart rate of over 90 beats per minute, a serum haemoglobin of less than 10.5 g/dL or an erythrocyte sedimentation rate of greater than 30mm/h. An admission with acute severe ulcerative colitis results in emergency surgery in approximately 20% of cases (Arnott et al., 2010). Complications of acute severe colitis include life threatening haemorrhage, colonic perforation and toxic megacolon; a rare condition of pathological radiographic dilatation of the colon, there are few cohort studies of IBD patients with toxic megacolon and reported mortality ranges from six to eighty percent (Argyriou et al., 2024; Arnott et al., 2010; Travis et al., 1996).

Gastrointestinal perforation, be it in CD or UC, presents with signs and symptoms of infection with varying degrees of severity. A dysregulated inflammatory response to the infection caused by gastrointestinal perforation can result in life threatening organ dysfunction. This is known as sepsis (Singer et al., 2016). Sepsis in the presence of

hypotension and tachycardia which does not respond to intravenous fluid boluses is known as septic shock (Singer et al., 2016).

Emergency Abdominal Surgery

In this thesis, an emergency abdominal operation is defined as either a laparotomy or a laparoscopy in which the peritoneal cavity is opened and explored during an unplanned hospital admission. A laparotomy (derived from the Greek words lapara, meaning flank, and tomy, meaning cut) is a procedure dating from the early 19th century and is most often performed in the modern era via a midline incision, dividing the abdominal wall through the linea alba before entering the peritoneal cavity (Ellis, 2008). Laparoscopy is a more modern procedure where the peritoneal cavity is entered via a small incision to allow insufflation of gas, usually carbon dioxide. A laparoscope is inserted, and surgical exploration can proceed via instruments placed through further ports inserted through the abdominal wall. Vision is achieved through the laparoscope. Since the advent of digital cameras, the laparoscope is connected to a camera which displays an image of the peritoneal cavity on a screen.

Depending on the indication for surgery, the availability of equipment, the experience of the surgeon and patient factors, a variety of operations can be performed via laparotomy or laparoscopy. In most cases the affected bowel, or abdominal organ can be removed, repaired, the flow of bowel contents diverted, cause of obstruction removed, or the source of infection drained. Historically laparotomy was used as a diagnostic as well as therapeutic procedure. Advances in pre-operative radiological imaging means that diagnostic procedures are becoming less common.

Emergency abdominal surgery may involve the formation of a stoma. A stoma (from the Greek for mouth) is an artificial connection between a hollow viscus and the skin. A stoma of the gastrointestinal tract is formed by suturing an open end of the bowel to the patient's skin to allow passage of its contents directly into a bag. This is used in instances where all the distal bowel is removed, where it is not safe to perform a bowel anastomosis following a resection, or where the flow of bowel contents needs to be diverted to allow resolution of obstruction or inflammation. In some cases, a stoma may be temporary. A patient may be more likely to need a stoma in an emergency operation in comparison to an elective setting as the risk of non-healing of an anastomosis is increased in emergency surgery.

Risk in Emergency Abdominal Surgery

Emergency abdominal surgery, or specifically emergency laparotomy, is one of the most common emergency procedures performed in the UK. Prior to 2011, the outcomes of this specific patient cohort were not well reported on. European, multicentre data suggested worse outcomes from emergency surgery in comparison to elective, measuring mortality at 5.4% in emergency surgery and 0.4% in elective cohorts (Pearse et al., 2012). However, this was not specific to abdominal surgery. Between 1987 and 2003 the National Confidential Enquiry into Patient Outcomes and Death (NCEPOD) gathered evidence showing a poor standard of care for patients having emergency surgery. The concerns ranged from poorly supervised junior clinicians, lack of critical care support for patients on surgical wards and lack of recognition of critically unwell or high-risk patients.

In 2010, NCEPOD carried out a one-week snapshot prospective study of all patients having surgery in the UK (Alleway et al., n.d.). Patients having day case, obstetric, transplant or neurosurgery were excluded from the study. This report concluded that the majority (79%) of deaths were in high-risk patients which made up approximately 10% of the cohort. They also reported the degree of surgical urgency was closely linked to mortality in high-risk patients and there was a general lack of risk stratification particularly in the non-elective cohort. They also noted delays in non-elective patients going to theatre.

In 2010, the Emergency Laparotomy Network was formed. This was a collaborative initiative of over 40 hospitals in the UK and represented the combined work of over 200 clinicians. The first report, published in 2012, showed an unadjusted 30-day mortality of nearly 15% for patients having an emergency laparotomy (Saunders et al., 2012). This rose to approximately 20% in patients having colonic resections and 24.4% in patients aged 80 or over. The emergency laparotomy network concluded that a national audit should be conducted for patients having unplanned abdominal surgery.

In 2011 the Royal College of Surgeons of England and the Department of Health published guidance on the management of the higher risk surgical patient. This document highlighted ways of reducing complications and established standards of care for high-risk patients. It advocated for the 24-hour availability of an emergency operating theatre, first proposed by NCEPOD, the input of consultant surgeon and anaesthetists and the documentation of risk. A second iteration of this document was published in 2018 recognising a changing surgical landscape and aiming to provide updated recommendations (The High-Risk General Surgical Patient: Raising the Standard, n.d.). Among other things this guideline gave specific recommendations regarding the management of sepsis; for patients with sepsis, source control

should take place within 6 hours of diagnosis. For patients with septic shock the target time for source control is 3 hours from diagnosis.

Risk stratification is a vital component of national and local service quality improvement. This thesis is based upon data collected by two key organisations concerned with risk stratification in the UK, NCEPOD and the National Emergency Laparotomy Audit (NELA)

[Risk in Emergency Abdominal Surgery for IBD](#)

Patients with IBD are relatively poorly represented in reports on risk stratification and national quality improvement projects. Burns et al published a report on data from NELA in 2020, describing outcomes of 1204 patients having subtotal colectomy or pan proctocolectomy for either UC or CD (Burns et al., 2020a). They reported inpatient mortality rate of 2.9% which is in line with other international studies reporting mortality after emergency subtotal colectomy of approximately 5%. Also in 2020, King et al published an analysis of all patients admitted to hospital in England for UC between 2007 and 2017 (King et al., 2020a). The study was based on Hospital Episode Statistics (HES) data and included a multivariable analysis of those having subtotal colectomy during their emergency admission. The reported in-patient mortality was 1.4%. In 2021 MacFarlane et al published a multivariable analysis of HES data from the North of England between 2002 – 2016 (MacFarlane et al., 2021). They reported a 30-day mortality for patients with UC ranging from 5 – 9% depending on the year and for patients with CD a 30-day mortality ranging from approximately 2 - 4%.

The published evidence regarding outcomes for patients having emergency surgery for IBD in the UK is sparse and often limited to

those having a subtotal colectomy. The reported mortality for these patients, whilst inconsistent is likely to be significantly higher than that of the elective population which is reported at less than 1%.

National Emergency Laparotomy Audit

Following the first report of the National Emergency Laparotomy Network, NELA the National Emergency Laparotomy was launched in 2012. Run by the Royal College of Anaesthetists (RCoA), commissioned by the Healthcare Quality Improvement Partnership (HQIP) and part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP), participation in NELA is mandatory for hospitals in England and Wales. Since 2024 the remit has extended to Northern Ireland. The project is run by a group of clinicians including anaesthetists, surgeons, nurse practitioners, statisticians, project facilitators and research fellows known collectively as the project team. The aim of the audit is to improve the quality of care for patients undergoing emergency laparotomy.

NELA has been collecting data since 2013 and has published nine reports (*Ninth Patient Report of the National Emergency Laparotomy Audit*, 2024). The prospectively maintained database represents over 250,000 patients and is one the largest of its kind in the world. Data are available to download with varying degrees of granularity. Clinical leads can download their local, patient level data from the webtool for the purpose of local quality improvement work. Aggregate data can be applied for directly from the NELA project team. National patient level data are available for extended analysis by members of the project team subject to approval by HQIP. This analysis must be in line with NELAs commissioning mandate. These data are also available to

external researchers via submission of a Data Access Request Form to HQIP.

National Confidential Enquiry into Patient Outcomes and Death

NCEPOD was initially founded as the National Confidential Enquiry into Peri-operative Deaths in 1988 as a collaborative study between the Association of Surgeons and Anaesthetists investigating the care of patients who died within 30 days of surgery. In 2002 it evolved to review the care of patients in all healthcare specialties and includes other outcomes as well as death. NCEPOD is an independent organisation commissioned by HQIP and mandated as a part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP) for hospitals in England, Wales and Northern Ireland. NCEPOD is run by a team of researchers, clinical co-ordinators, advisors, managers and administrators, overseen by a board of trustees, and includes a steering group of stakeholders from different organisations.

NCEPOD invite study proposals from organisations and individuals, these are reviewed and agreed upon by the steering group. Stakeholders with specialist expertise are invited to join a study advisory group who determine the key aims and objectives of each study. Hospitals across England, Wales and Northern Ireland are asked to provide a list of cases which fit the inclusion criteria across the study period. From these, cases are randomly selected for inclusion. Data are collected via clinician, organisational and case note reviewers' questionnaires, which are refined by the study advisory group. Case notes reviewers are independent specialists. In comparison to audit, NCEPOD do not compare patient care against

predetermined standards, but comment on the overall standard of care achieved by an organisation.

Data collected include both qualitative and quantitative data. Cases included undergo notes review which accompanies the clinician and organisational questionnaire. The opinions of case notes reviewers are included in the reports as qualitative data. The quantitative data are stored in a database and include patient demographics, patient disease profiles, time and date stamps and information pertinent to key events in the patient journey.

Since inception NCEPOD has published over fifty reports making recommendations for the improvement of care for a range of patient cohorts. They continue to promote change in through local quality improvement projects and national policy. In 2021 NCEPOD began a study into patients who have surgery for Crohn's disease (Aleboyeh et al., 2023).

Timing of Emergency Surgery

The presentations of patients who require emergency surgery varies from those requiring immediate lifesaving intervention, to those who have failed to improve with conservative inpatient management over the preceding days. It is well established in the UK that patients who require an operation during an emergency admission should be triaged according to clinical urgency. This facilitates both efficient use of theatre space and is a helpful communication tool for clinicians.

NCEPOD Classification of Intervention

In 2004 NCEPOD defined four categories of operation according to clinical urgency. They recommend that clinical urgency be decided by the surgeon who will perform the intervention at the time of the decision to operate (Cullinane, 2003). These categories are:

Immediate; The most urgent operations should happen within minutes of the decision to operate. These cases typically include major bleeding or loss of blood supply which pose an immediate threat to life or limb and should be operated on in the next available theatre.

Urgent; These cases require an operation within hours of the decision to operate. Conditions include those where there is an acute deterioration which threatens life, limb or an organ and should be operated on in the emergency theatre.

Expedited; This category describes patients who are stable, but at risk of acute deterioration. There is currently no threat to life or limb, and they should be operated on within days of the decision to operate. These patients should be operated on in daytime hours either in the emergency theatre or in an elective theatre with extra capacity.

Elective; These are cases that are planned for patients who will be admitted to hospital specifically for that procedure. They will be operated on in a dedicated elective theatre.

NELA Urgency

Seventy percent of patients who have emergency abdominal surgery fall into the 'urgent' category as defined by NCEPOD. NELA have further sub categorised this group of patients according to the target time interval between the decision to operate and the patient arriving in the operating theatre. These categories are a target time of greater than 18 hours, 6 to 18 hours, 2 to 6 hours, and less than 2 hours (*Ninth Patient Report of the National Emergency Laparotomy Audit, 2024*).

WSES Timing of acute care surgery

In 2023 the World Society of Emergency Surgery (WSES) published an updated guidance on the urgency of unplanned surgery called 'The New Timing in Acute Care Surgery' (new TACS)(De Simone et al., 2023). This was an international Delphi consensus study designed to produce a concise triage tool for use in emergency general surgery. New TACS includes five categories based on the ideal time to surgery from diagnosis. These time categories are immediate surgery, within one hour, within 6 hours, within 12 hours and within 24 to 48 hours. The guidance includes possible clinical scenarios and diagnosis for each urgency category.

In recent years recommendations from NELA, NCEPOD and The Royal College of Surgeons England have focussed on the ideal time to surgery following diagnosis, or the decision to operate. However, the pathological process which requires emergency surgery does not begin at diagnosis. Patients suffering from an ischaemic stroke, for example, are considered for different therapeutic options depending on the time of symptom onset, not the time of diagnosis. The focus of attention is beginning to move to the potential delays incurred before

the decision to operate is made. The ninth NELA report describes patients who require an operation within two hours of the decision to operate waiting over ten hours for that operation when starting the clock at the time of admission (*Ninth Patient Report of the National Emergency Laparotomy Audit*, 2024).

As a result of their wide range of emergency clinical presentations, patients with IBD may occupy any of the clinical urgency categories outlined above. As well as their heterogenous presentation, patients with IBD also may have a more nuanced and complex diagnostic pathway and may experience delays in their care as a result.

Observational Research

Over the last thirty years evidence-based medicine has become the paradigm of clinical decision making (Guyatt, 1992). Within this framework, randomised control trials provide the highest level of evidence and are required to demonstrate a causative effect of a treatment or exposure. Whilst not impossible, there are several barriers to randomised control trials in emergency surgery and they are often an inappropriate method for investigating research questions (J. A. Cook, 2009; Morley et al., 2018). Emergency laparotomy for ulcerative colitis made up less than 2% of the total number of emergency laparotomies in the UK in 2020, citing a 30-day mortality of approximately 3% (NELA Project Team, 2023).

Investigating factors contributing to mortality in this patient cohort by a randomised control trial would require an extremely large sample size, multicentre involvement, and long data collection period. For many research groups this would present an insurmountable challenge, and that is without considering the ethical implications of

treatment allocation. Equipoise is the state of genuine uncertainty about an outcome. It is essential in randomised control trials but is rare within the field of emergency surgery.

Observational research uses data on a cohort of patients without randomisation and without subjecting groups to different treatment options. NELA is an example of a prospective observational cohort study and NCEPOD is a retrospectively populated observational cohort study. Analysis of this data can show associations between variables and outcomes and can overcome many of the issues associated with randomised control trials including dealing with rare events, ethical limitations and logistical challenges.

Use of Databases

Observational research using large databases, such as the NELA database, has become a key driver of change in healthcare over recent decades (Jepsen et al., 2004). Large amounts of data are now available and more importantly can be processed by widely available software leading to an increasing number of findings discovered *in silico* (a term used to describe computer-based experiments or simulations, from 'in silicon'). However, the use of large databases and observational research is not without challenges. Data sharing agreements, secure storage, use of confidential data and ethical permissions are important considerations when working with large population data. As with all forms of research, reproducibility remains an important hallmark of working with large amounts of data. Code used to clean and analyse data should be saved to record the processes used to obtain results. The process of data handling and cleaning will be covered in thesis methods.

Summary, Aims and Objectives

Emergency abdominal surgery for IBD is significantly higher risk than elective surgery. NELA and NCEPOD have played an important role over the last decade in stratifying and reducing risk for emergency laparotomy patients however those with IBD are relatively poorly represented in large UK studies. Patients who require abdominal surgery for IBD do so across the full spectrum of clinical urgencies. Timeliness of surgical intervention is a key component of risk reduction but is so far considered only from the point of the decision to operate.

Therefore, this thesis aims to:

1. Summarise the published evidence on risk stratification in emergency abdominal surgery in IBD by performing a scoping review on factors affecting outcome from emergency surgery in IBD.
2. Investigate the impact of clinical urgency on outcomes of surgery in patients with IBD by analysing the NELA data on patients with IBD.
3. Investigate the relationship between clinical urgency and operating surgeon specialist interest on post-operative outcomes in IBD by performing statistical analysis of the NELA data on patients with IBD.
4. Investigate the factors associated with delays in the decision to operate by interrogating both the NELA and NCEPOD data on patients with Crohn's disease.

2. General Thesis Methods

NELA and NCEPOD data have been chosen for this analysis because they include clinical urgency as a variable and have greater granularity in patient specific factors than other databases in the UK, such as HES.

NELA Data Approvals, Access and Handling

NELA is an observational study with standards derived from external published sources. Data collection for the study makes no change to patient care and collects routinely available information. Collaborators register the study with local audit departments, and it has been granted exemption from the NHS digital national data opt out of March 2020. Use of the data does not require ethical approval.

An 'Extended Output' request form was submitted to HQIP for their approval. This form outlines the proposed data analysis and provides evidence that it falls within the scope of work for which NELA was commissioned. The extended output request for the data used in this thesis was approved by HQIP on 1st November 2021 and is available in appendix 2.

The NELA data required for this thesis were downloaded to a secure server at the Royal College of Anaesthetists, accessible by Microsoft Remote Desktop with two factor authentication, on 23rd February 2022. The original raw data, formatted as Microsoft comma separated values, were imported into the most up to date available version of STATA. At the time of downloading the data this was STATA version 17, and later version 18 (StataCorp, 2021, 2023). All data analysis was performed via Microsoft Remote Desktop, using STATA version 17 or 18, on the Royal College of Anaesthetists secure server.

NELA Methodology

NELA collects patient and organisational level data according to nine key standards. These externally sourced standards refer to timeliness and reporting of CT scans, the management of infection and sepsis, the timeliness of surgical intervention, risk assessment, the involvement of elderly and critical care specialists and the involvement of consultants in patient care. The standards of care are shown in detail in appendix 1.

Each hospital participating in NELA should nominate a clinical lead responsible for the local running of the audit. This includes registration with local audit departments and accountability to local Caldicott guardians. Data is entered via an online webtool and includes metrics reporting on patient demographics, time and date stamps at key events in the admission and treatment pathways, physiological and biochemical markers, indications for and findings during surgery, post-operative events such as return to theatre or critical care, and discharge destination. The histological findings of resection specimens were included until the end of 2016. The data are pseudo-anonymised, meaning they are assigned an identity number specific to NELA.

To determine the case ascertainment, data are compared to those contained in the hospital episode statistics (HES) database. HES data includes records of all NHS hospital admissions in England and patients who meet the inclusion criteria for NELA can be identified using International Classification of Disease (ICD-10) and Operating Procedure Code Supplement (OPCS) codes. This gives an attained versus actual number of cases ratio from which a percentage case ascertainment can be presented. This figure is used as an indicator of confidence that the presented data are representative of practice across the included hospitals.

NELA Inclusion and Exclusion criteria

Patients were included in the NELA database if they had an open or laparoscopic procedure involving the stomach, small or large bowel, drainage of intra-peritoneal collections, a bowel resection during a hernia repair or adhesiolysis. Patients who had emergency surgery as a return to theatre after an elective operation were also included.

Patients were excluded if; they were aged less than 18 years old at the time of surgery, had a laparotomy for vascular, obstetric, gynaecological, trauma or transplant pathologies, underwent diagnostic procedures where no subsequent procedure was performed. Procedures for appendicitis or cholecystitis as primary pathologies, hernia repair without bowel resection or adhesiolysis and trephine stoma formation were also excluded.

Categorisation of Variables

During statistical analysis, some continuous data from the NELA database were transformed into categorical variables to aid clinical interpretation. For example, modelling serum white cell count as a continuous variable may risk misinterpretation as the normal limits sit within the full range of represented data. The normal values are the following: Serum white cell count $4 - 11 \times 10^9/L$, Serum sodium 135 – 145 (mmol/L), serum potassium 3.5 – 5.0 (mmol/L), serum creatinine 60 – 100 (mmol/L) and anaemia defined as mild ($>110 \text{ g/dL}$), moderate (80 – 110 g/dL) and severe ($<80 \text{ g/dL}$) (Copeland et al., 1991).

NCEPOD Data Approvals, Access and Handling

NCEPOD is an independent organisation commissioned by HQIP to evaluate the standards of healthcare provision. During the process of data collection, they do not propose new treatments or investigations and do not allocate or randomise patients. Therefore, the Health Research Authority have agreed that ethical approval is not needed for their work. They are also approved to continue without patient consent under section 251 of the NHS Act 2006. On the 31st of August 2023 I entered a data sharing agreement with NCEPOD allowing access to the password protected Microsoft Excel database. The data sharing agreement is included in appendix 3. NCEPOD data required for this thesis were downloaded on the 2nd of January 2024 and imported into STATA version 18. All further data handling and analysis was performed using STATA version 18(StataCorp, 2023).

NCEPOD Methodology

The NCEPOD study on Crohn's disease was steered by a study advisory group which consisted of colorectal surgeons, gastroenterologists, acute and emergency physicians, anaesthetist and intensivists, clinical psychologists, radiologists, dieticians, pharmacists and specialist nurses as well as lay and patient representatives. The study aimed to identify areas in the care of patients with Crohn's disease who have abdominal surgery which could be improved. All NHS hospitals in England, Wales and Northern Ireland were invited to participate in the study and a maximum of six patients were selected from each hospital.

A local reporter identified patients who met the study criteria during the two time frames; 1st September 2019 to 29th February 2020, and

1st September 2020 to 28th February 2021. From these patients, the sampling for inclusion took place. Two questionnaires were used to collect data via the hospital local reporter. The clinician questionnaire was sent to the named consultant responsible for the care episode in question. The organisational questionnaire was sent to trust management to provide information on guidelines, facilities and provision of service. Case notes were requested for each included patient which were reviewed by senior clinicians in the appropriate speciality. These three data collection processes resulted in a database used in this thesis.

NCEPOD Inclusion criteria

Inclusion criteria for the NCEPOD report were a diagnosis of Crohn's disease and an elective or emergency admission of greater than 48 hours during which the patient underwent intestinal surgery. Patients were excluded if they were aged less than 16 years old or had surgery which did not relate to Crohn's disease.

Data Management

Prior to beginning data processing, I completed a University of Nottingham Researcher Academy course titled 'Basic Statistics with Stata'. From this point STATA was used for all data handling and analysis either on a computer provided by the University of Nottingham or via Microsoft Remote Desktop to the Royal College of Anaesthetists secure server. STATA is an accessible data management programme used in this thesis for data management, statistical analysis, graphics and recording code. User inputs are either done via

the user interface or by entering commands as typed code. STATA has an extensive library of user manuals available for troubleshooting.

Data were imported into STATA in a raw format which required processing before it could be understood correctly by the software and accurately analysed. Time and dates are often entered as HH:MM DD/MM/YYYY, for example 13:45 12/08/2015. To determine the length of time between two events, this 'string' variable must be converted into an integer. These integers increase at millisecond intervals starting on the 1st of January 1960. The conversion is achieved by a specific code. This process, amongst others, is known as cleaning.

Another example of data cleaning is where there are multiple options to choose from in each variable, or where data is entered as free text. For example, a list of patients' co-morbidities. These variables need to be converted into numerical values to be included in quantitative analysis.

Specific statistical methods will be described in detail in each relevant chapter, including how missing data or data inaccuracies are handled.

Bias

All forms of research are subject to bias whether known or unknown. Due to the lack of randomisation and blinding, observational studies are at particular risk of bias which must be acknowledged and accounted for to draw conclusions on associations between variables and outcomes. Most bias can be summarised in three main types: selection, information and confounding bias.

Selection bias occurs when the population sample included in the research is not representative of the population as a whole.

Retrospective data, where the outcome is known prior to the data being entered, is at particular risk of this form of bias. NELA is a prospectively maintained database where the patients are registered for the study at or around the time of their index operation. Outcome data cannot influence the sample. The risk of introducing selection bias in NELA data through sample size can be monitored through the measurement of case ascertainment and by highlighting hospitals who contribute fewer than expected cases. By comparing cases with HES data, we know NELA includes 70% - 80% of emergency laparotomies performed in England and Wales. NCEPOD relies on a retrospective data collection but introduces an element of randomisation when making the study selection. Individual hospitals do not have a choice regarding which patients are included. Data is collected by local hospital clinicians but also by independent case note reviewers which reduces the selection bias in recording qualitative data (Millard et al., 2023).

Information bias can occur for several reasons. Observational database research relies on pre-existing variables which often cannot be supplemented with additional data fields. Assumptions regarding outcome must be made from available data which may not include all

known confounding variables. This will be addressed in subsequent chapters as a study limitation using both NELA and NCEPOD data. Variables and outcomes can be misclassified at the point of data entry, which often relies on interpretation of patients records by coders. Binary data recorded as 1 or 0 indicating mortality, for example, is subject to human error. This is non differential misclassification and will lead to bias towards the null hypothesis. When the error in classification depends on exposure, it is known as differential misclassification which can tend towards or away from the null hypothesis. Information bias can also occur because of missing data which must be accounted for during statistical analysis (Morshed et al., 2009).

Confounding

Confounding exists where multiple variables can affect the outcome. In an observational study the effect of an exposure upon an outcome is investigated, but the observed change in outcome may be the result of another variable which is related to both the exposure being studied and the outcome. For example, when investigating surgical outcomes, one might observe that patients having operations over night have worse outcomes than those having operations during the day and conclude that operating at night is higher risk. A confounding factor may be that only the most unwell patients have operations over night which accounts for their poorer outcomes. Adjustments must be made in statistical analysis to account for differences in these variables. Two of the statistical techniques used in this thesis are outlined below (Jepsen et al., 2004; Morshed et al., 2009).

Stratification

Where the confounding variable is in few distinct categories, the study sample can be grouped and analysed as separate cohorts. This eliminates heterogeneity in that one confounding factor but also has the benefit of being able to observe the consistency of an effect across different categories of a variable. For example, to remove the confounding effect of comorbid physical health status, the population could be stratified according to American Association of Anaesthetists (ASA) grade and analysed as five separate cohorts (Mayhew et al., 2019). This approach requires a large enough study population to form adequate size groups (Jepsen et al., 2004; Morshed et al., 2009).

Regression analysis

A regression model is used to describe an association between an outcome, or dependent variable, and a predictor, or independent variable. Where multiple independent variables, or co-variables exist, they can be added to the model in multivariable regression. In this form, the strength of association between the independent and dependent variables can be adjusted for confounding factors. For example, the strength of association between patient sex and a given adverse outcome can be investigated whilst controlling for other known causes of poor outcome. The outcome under investigation dictates the type of regression model used (Swinscow, 1997).

Logistic regression is used when the outcome variable is binary, for example mortality. In this case relationship is presented as an odds ratio (OR). This is the comparison of the odds of the outcome in presence of the predictor variable, versus the odds of the outcome in the absence of the predictor variable. Odds are the probability of an

outcome divided by the probability of not having that outcome (Swinscow, 1997).

Continuous dependent variables are investigated using generalised linear models, where the independent variable is plotted on the x axis and dependent variable on the y. Simply put, a line of best fit is applied to the data and strength of association observed. Generalised linear models include, but are not limited to, linear, Poisson and binomial regression depending on the distribution of the data. The specific methodology used in each study in this thesis will be outlined in the chapter methods section (Swinscow, 1997).

3. A Scoping Review of Predictors of Poor Outcome After Emergency Abdominal Surgery for IBD

Chapter Focus

This chapter describes the current evidence base on predictors of adverse outcome following emergency abdominal surgery for IBD. Furthermore, it highlights a flaw in how many cohort studies are described and makes recommendations for improving the quality of observational research in the IBD cohort.

Abstract

Introduction

The medical management of inflammatory bowel disease (IBD) is rapidly progressing, however many patients with the disease still require surgery. Often this is done as an emergency. Initiatives such as the national emergency laparotomy audit (NELA) have shown how evidence-based emergency surgery improves outcomes for the patient. The aim of this scoping review is to describe the current evidence base on risk stratification in emergency abdominal surgery for IBD

Methods

A literature search, abstract and full paper screening resulted in 17 articles representing 63472 patients from 7 countries.

Results

It is likely that age, ASA grade, comorbidity and organ dysfunction play a similar role in risk stratification in IBD patients as in other emergency abdominal surgery cohorts. However, the reporting of what is considered an IBD emergency is variable. Six authors include clear definitions of emergency in our study. The range of what is considered an emergency is operation, within 12 hours of admission, to anytime within an unplanned admission.

Conclusion

To have data driven, evidence-based emergency surgical practice in IBD consistency of reporting, including definitions of emergency and urgency are needed. Core descriptor sets in IBD should be developed.

Introduction

Crohn's disease (CD) and ulcerative colitis (UC) are chronic inflammatory conditions of the gastrointestinal tract. They are significant health conditions, the worldwide incidence of which is increasing.

Advances in the medical management of these conditions, including the introduction of immunomodulating drugs have had an impact on the need for, timing of and potential complications of surgery. Approximately 1 in 5 of CD patients and 1 in 20 of those with UC will require surgery within 10 years of presentation (Kaplan et al., 2012; Kayal et al., 2019; Lowe et al., 2020; Ma et al., 2017; Slattery et al., 2009; Worley et al., 2021). Some of these operations are performed as an emergency procedure, laparotomy or laparoscopy. Emergency abdominal surgery in IBD requires complex multi-disciplinary decision making which should be evidence based.

In England and Wales, since 2013, the National Emergency Laparotomy Audit (NELA) has focused on this intervention and demonstrated an improvement in survival and other outcome metrics for adult patients who have an emergency laparotomy. A recommendation of NELA has been the identification and formal documentation of high-risk adult patients before surgery. There are several guidelines for the surgical management of IBD in the elective setting, including the World Society of Emergency Surgery, The Association of Coloproctology of Great Britain and Ireland and the European Crohn's and Colitis Organisation but there is a lack of evidence-based guidance regarding risk stratification in the emergency setting (De Simone et al., 2021; Lamb et al., 2019; Spinelli et al., 2022). IBD patients who present as an emergency do so with a variety of

disease phenotypes. Interpretation of data is challenging due to the heterogeneity of the patient group and the procedures performed.

The aim of this scoping review is to describe the current evidence base on risk stratification in emergency abdominal surgery for IBD for the purpose of consolidating what is known, identifying areas suitable for meta-analysis and identifying areas for future study.

Methods

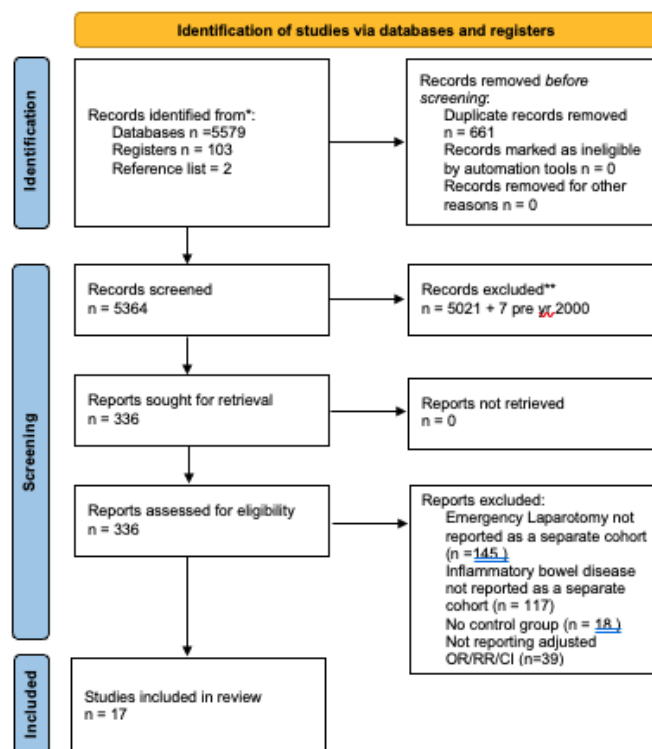
This review follows the methodological protocol proposed by Arksey and O'Malley (Arksey & O'Malley, 2005). The research question identified was 'What is known from the existing literature about factors which affect the outcomes of emergency laparotomy/laparoscopy in inflammatory bowel disease?'

A librarian-reviewed search strategy was drawn up and online databases searched between the dates 1st January 1974, to 5th January 2022. Papers from before 1998 were subsequently excluded as they came before the era where biologics became standard practice and so were not comparable, nor relevant to today's practice. Embase and Medline were searched based on the following terms, adjusted for specific Medical Subject Headings (MeSH): Colitis, Crohn's, Inflammatory bowel disease, IBD, urgent, unplanned, emergency, laparotomy, laparoscopy and surgery. EU Clinical Trials Register, Clinicaltrials.gov and the Cochrane Library were also searched, as were reference lists. Results were limited by resources to the English language; the full search strategies can be found in *Appendix 4*.

Exclusion criteria for abstracts were operations in children, peri-anal procedures alone, case reports, pilot or preliminary studies reporting novel techniques or outcomes, elective populations, pregnancy, narrative reviews, opinion articles and non-clinical outcome measures. Abstracts were reviewed using the online software Rayyan (Ouzzani et al., 2016).

Full papers identified by the above search criteria were excluded if: Inflammatory bowel disease outcomes were not reported as a separate cohort from other emergency patients, emergency laparotomy outcomes were not reported as a separate cohort from

elective laparotomy patients, the impact of post-operative medication alone was described, or descriptive papers lacking a control or analysis of factor affecting outcome. The aim of this review was to identify predictors of poor outcome, as such only papers reporting adjusted odds, or risk ratios with confidence intervals were included. The remaining papers included in this review were organised according to subject theme and charted as per Ritchie & Spencer using Microsoft Excel into groups according to which clinically applicable factor was being discussed (Ritchie & Spencer, 1994). The PRISMA-SCR checklist describes the abstract and full paper screening process in detail.



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

Figure 1. The PRISMA-SCR checklist to show the abstract and full paper screening process for the scoping review.

To most comprehensively present the evidence on this topic, the inclusion criteria do not include specific measures of poor outcome. All studies reporting negative outcomes have been considered. The aim is that the results will not present a biased opinion on what is considered a poor outcome, but rather a summary of what has been published in the literature as a poor outcome.

Results

The literature search produced 5682 abstracts, of which 341 remained after the abstract screening stage. After full paper review, 17 articles fulfilled the inclusion criteria representing 63,472 patients from 7 countries. Many studies were excluded because they did not report emergency IBD patients as a separate cohort from elective IBD patients or did not separate emergency surgery patients by underlying medical condition. Only studies reporting outcomes for patients with inflammatory bowel disease who had emergency abdominal surgery (laparotomy or laparoscopy) were included. A PRISMA flow chart is available in appendix 6.

Of the included 17 studies, two reported on CD and UC separately and so have been charted twice. As a result, we have charted 19 studies; 13 reporting on outcomes in UC, 3 in CD and 3 not distinguishing between IBD subtypes (referred to as IBD). The 19 studies can be seen in table 1. All included papers are cohort studies. To aid clinical application, the studies are reported by each reported factor affecting the outcome of emergency laparotomy in IBD patients.

Author	Publication Year	Country	Number of patients	Data source	Data collection period	Operation	Population
Bartels (Bartels et al., 2013a)	2013	Netherlands	71	Single centre retrospective cohort	1999-2012	Colectomy	UC
Singh (J. C. Singh et al., 2012a)	2012	UK	43	Single centre prospective cohort	2007-2010	Colectomy	UC
Ananthakrishnan (Ananthakrishnan & McGinley, 2013a)	2013	USA	1864	Nationwide Inpatient Sample	2006-2007	Laparotomy	UC
Ananthakrishnan (Ananthakrishnan & McGinley, 2013b)	2013	USA	5248	Nationwide Inpatient Sample	2006-2007	Laparotomy	CD
Burns (Burns et al., 2020b)	2020	UK	1204	National Emergency Laparotomy Audit	2013-2016	Colectomy	UC

Dayama (Dayama et al., 2015)	2015	USA	148	National Surgical Quality Improvement Project	2005-2012	Colectomy	UC
Galata (Galata et al., 2018)	2018	Germany	17	Single centre prospective cohort	2010-2016	Right hemi-colectomy	CD
Kaplan (Kaplan et al., 2008)	2008	Canada	2488	Nationwide Inpatient Sample	1995-2005	Colectomy	UC
King (King et al., 2020b)	2020	UK	709	Hospital Episode Statistics	2007-2017	Colectomy	UC
Leeds (I. L. Leeds et al., 2017)	2017	USA	2650	Nationwide inpatient sample	2002-2014	Colectomy	UC
Leeds (I. Leeds et al., 2018a)	2018	USA	573	National Surgical Quality	2005-2015	Colectomy	UC

				Improvement Project			
Lo (Lo et al., 2020)	2020	USA	819	National Surgical Quality Improvement Project	2006-2018	Colectomy	UC
Lowe (Lowe et al., 2020)	2020	USA	29653	Nationwide Readmission Database	2010-2017	Laparotomy	CD
Lowe (Lowe et al., 2020)	2020	USA	14796	Nationwide Readmission Database	2010-2017	Laparotomy	UC
MacFarlane (MacFarlane et al., 2021)	2020	UK	913	Hospital Episode Statistics	2002-2016	Bowel resection	IBD

Skancke (Skancke et al., 2018)	2018	USA	209	National Surgical Quality Improvement Project	2012-2015	Colectomy	UC
Tiu (Tiu et al., 2020)	2020	USA	921	National Surgical Quality Improvement Project	2013-2016	Colectomy	UC
Uchino (Uchino et al., 2013)	2013	Japan	90	Single centre prospective cohort	2008-2010	Colectomy	UC
Tøttrup (Tøttrup et al., 2012)	2012	Netherlands	1056	Danish National Registry of Patients	1996-2010	Colectomy	UC

Table 1. The studies included in the scoping review showing publication date, country, number of patients included, data source and collection period, procedure and IBD subtype reported on.

Definition of an emergency operation

Of the 16 included studies, six stated how an emergency operation was defined in this cohort of patients. These are shown in table 2.

Author	Year	Definition of emergency
Uchino (Uchino et al., 2013)	2013	Within 12 hours of unplanned admission
Ananthakrishnan (Ananthakrishnan & McGinley, 2013b)	2013	Within 2 days of unplanned admission
Burns (Burns et al., 2020b)	2020	By NCEPOD codes
Leeds (I. Leeds et al., 2018a)	2018	During the same unplanned admission
Lowe (Lowe et al., 2020)	2020	Within 2 days of unplanned admission
Tiu (Tiu et al., 2020)	2020	Within an unplanned admission, less than or greater than 48 hours.

Table 2. The studies included in the scoping review which reported their definition of emergency, or how they classified urgency within their study.

Time to theatre

Six authors comment on the effect of timeliness to theatre on patient outcomes.

Bartels et al, observing a population of 71 UC patients, found a significant association between increased time to theatre and post-operative complications (OR 5.5, CI 1.6-19.0, P=0.007)(Bartels et al., 2013b). This was supported by Leeds et al in 2017 in a population of 2650 UC patients (OR 1.46, CI 1.17-1.83, P=0.001)(I. L. Leeds et al., 2017). In 2018, Leeds et al also found that early surgery, within 2 days of admission, was protective against complications in a population of 573 UC patients (OR 0.65, CI 0.44-0.97, P=0.034)(I. Leeds et al., 2018a).

King et al found no significant association between mortality and increasing time to theatre in a population of 709 UC patients (OR 0.05, CI 1.0-1.19, P=0.064)(King et al., 2020b). However, Kaplan et al found increasing time to theatre beyond six days was associated with increased mortality (OR 2.23, CI 1.13-3.97)(Kaplan et al., 2008). This was also found by Leeds et al 2018 who demonstrated early surgery to be associated with decreased mortality (OR 0.18, CI 0.08-0.43, P<0.001)(I. Leeds et al., 2018a).

Tiu et al reported on the outcomes in patients waiting more or less than 48 hours for their colectomy for UC. They found no significant association between delayed surgery and return to theatre (OR 0.97, CI 0.57-1.65, P=0.912), readmission (OR 1.09 CI 0.72-1.64, P=0.998), sepsis (OR 1.03, CI 0.6-1.74, P=0.924) and surgical site infections (OR 0.95, CI 0.34-2.65, P=0.927)(Tiu et al., 2020).

Minimally Invasive Surgery (MIS)

Five authors report the effect of MIS on patient outcomes.

Singh et al found a significant reduction in post-operative complications in patients having colectomy via MIS (OR 0.237, CI

0.082-0.68, $P=0.007$) (J. C. Singh et al., 2012b). This was corroborated by Skancke et al (OR 0.439, CI 0.206-0.933, $P=0.032$) (Skancke et al., 2018). However, Leeds et al 2018 did not find significant reductions in complications associated with MIS (OR 1.11, CI 0.63-1.95, $P=0.727$) (Leeds et al., 2018a).

Burns et al found MIS was not associated with significantly decreased mortality in patients undergoing colectomy (OR 0.59, CI 0.19-1.83, $P=0.36$) (Burns et al., 2020b).

Lo et al investigated a subgroup of patients taking steroids and found that MIS was associated with decreased mortality (OR 0.5, CI 0.28-0.92, $P=0.026$) and incidence of sepsis (OR 0.5, CI 0.28-0.92, $P=0.026$) (Lo et al., 2020).

Weekend effect

Ananthakrishnan et al were the only authors to report the outcomes of patients who had emergency surgery at the weekend versus during the weekdays. In UC, they found significantly increased risk of post-operative complications (OR 1.71, CI 1.01-2.9, $P=0.03$) and re-operation within the same hospital episode (OR 11.5, CI 2.32- 57.1, $P=0.008$) in those having an operation at the weekend (Ananthakrishnan & McGinley, 2013b). However, in the same cohort, they found no association between having an operation at the weekend and increased mortality (OR 1.31, CI 0.42-4.05, $P=0.64$) (Ananthakrishnan & McGinley, 2013b).

In CD, they found no association between a weekend operation and mortality (OR 1.51, CI 0.42-5.48, $P=0.61$), post-operative complications (OR 1.05, CI 0.75-1.49, $P=0.91$) and re-operation within the same

hospital episode (OR 1.1, CI 0.34-3.53, P=0.92)(Ananthakrishnan & McGinley, 2013b). The authors suggested surgical expertise may have contributed to the difference in findings in patients with CD versus UC, but they acknowledge there is no reliable explanation for the differences.

Subspecialty of surgeon

MacFarlane et al investigated the impact of the specialty interest of the operating surgeon on the outcomes of all IBD patients having bowel resection using hospital episode statistics data in the UK. They found no significant association with mortality (OR 0.62, CI 0.31-1.21, P=0.16) (MacFarlane et al., 2021).

Hospital volume

Kaplan et al investigated the effect of hospital volume on adverse outcomes and found an increase in post-operative complications associated with smaller hospital case volume (OR 1.38, CI 1.04-1.82), however no significant increase in mortality (OR 1.87, CI 0.87-4.01)(Kaplan et al., 2008). In an analysis of a large American database, Lowe et al found no significant association between hospital size and mortality in UC (OR 1.08, CI 0.96-1.22, P=0.19) or CD (OR 1.06, CI 0.9-1.25, P=0.47) (Lowe et al., 2020).

Disease and operation characteristics

Uchino et al were the only authors to report on the impact of disease duration, wound contamination and duration of surgery and the association with surgical site infections. They found a significant

increase in surgical site infections in patients with contaminated wounds (OR 10.04, CI 2.91, $P < 0.001$) (Uchino et al., 2013). However, they identified no significant association between increased disease duration and the incidence of surgical site infections (OR 0.73, CI 0.18-2.91, $P = 0.65$), or duration of surgery and incidence of surgical site infections (OR 0.34, CI 0.3-5.95, $P = 0.85$) (Uchino et al., 2013). Leeds et al (2018) reported on the impact of sepsis on outcomes. They found sepsis to be a significant predictor of post-operative complications (OR 2.18, CI 1.4-3.38, $P = 0.001$), but not of mortality (OR 1.64, CI 0.52-5.2, $P = 0.397$) (I. Leeds et al., 2018a).

Comorbidity

Five authors reported the effect of comorbidities on mortality; these are shown in Table 3. In addition to these, Leeds et al 2017 found significant association between increasing comorbidity index and post-operative complications (OR 1.36, CI 1.17-1.58, $P < 0.001$) (I. L. Leeds et al., 2017).

Author	Year	Population	Operation	OR/ MRR*	Confidence intervals	P Value
Lowe (Lowe et al., 2020)	2020	UC	Laparotomy	1.51	1.38-1.66	<0.01
Lowe (Lowe et al., 2020)	2020	CD	Laparotomy	1.66	1.42-1.94	<0.01
MacFarlane (MacFarlane et al., 2021)	2020	IBD	Bowel resection	4.32	1.82-10.2	0.001
King (King et al., 2020b)	2020	UC	Colectomy	12.33	2.24-67.9	0.004
Tøttrup (Tøttrup et al., 2012)	2012	UC	Colectomy	2.56*	1.42-4.61	N/A

Table 3. The studies included in the scoping review reporting the predictive value of increasing patient comorbidity on mortality. Tøttrup et al reported mortality rate ratios (MRR) as denoted by the asterisk. P <0.05 was considered significant in all studies.

American Society of Anaesthesiologists (ASA) Grade

Three authors reported the effect of increasing ASA grade on outcomes. Uchino et al reported on the incidence of surgical site infection, and found no significant association (OR 2.55, CI 0.58-11.2, $P=0.22$) (Uchino et al., 2013). Burns et al, however, found increasing ASA grade to be associated with significantly increased mortality (OR 37.43, CI 2.72-51.4, $P=0.007$), this was supported by Leeds et al (2018) (OR 2.73, CI 1.07-6.97, $P=0.036$) (Burns et al., 2020b; I. Leeds et al., 2018a). Leeds et al (2018) also found increasing ASA grade was associated with increased post-operative complications (OR 2.24, CI 1.63-3.09, $P<0.001$) (I. Leeds et al., 2018a).

Age

Seven authors reported on the impact of increasing age on outcomes, with Lowe et al reporting CD and UC separately. Table 4 shows the studies reporting the effect of increasing age on increasing risk of mortality. King et al were the only ones to not report significant association. Leeds et al 2017 reported significantly increased risk of postoperative complications in increasing age (OR 3.77, CI 2.75-5.18, $P<0.001$) (I. L. Leeds et al., 2017). This was reinforced by Leeds et al 2018 (OR 1.52, CI 1.14-2.03, $P=0.004$) (I. Leeds et al., 2018a)

Author	Year	Population	Operation	OR/ MMR*	Confidence intervals	P Value
Dayama (Dayama et al., 2015)	2015	IBD	Colectomy in toxic colitis	22.22	5.72-86.3	<0.001
Leeds (I. Leeds et al., 2018a)	2018	UC	Colectomy	3.6	2.18-5.95	<0.001
Burns (Burns et al., 2020b)	2020	UC	Colectomy	3.59	1.05-12.2	0.0041
Lowe (Lowe et al., 2020)	2020	UC	Laparotomy	1.04	1.04-1.05	<0.01
Lowe (Lowe et al., 2020)	2020	CD	Laparotomy	1.05	1.04-1.06	<0.01
MacFarlane (MacFarlane et al., 2021)	2020	IBD	Bowel resection	1.08	1.06-1.12	<0.01
King (King et al., 2020b)	2020	UC	Colectomy	5.48	0.53-56.6	0.154
Tøttrup (Tøttrup et al., 2012)	2012	UC	Colectomy	17.8*	7.3-43.1	N/A

Table 4. The studies included in the scoping review reporting the predictive value of increasing patient age on mortality. Tøttrup et al reported mortality rate ratios (MMR) as denoted by the asterisk. $P < 0.05$ was considered significant in all studies.

Race

Leeds et al 2017 were the only authors to report the effect of patient race on their post-operative outcomes. They found no significant difference in outcome in Caucasian patients (OR 1.06, CI 0.82-1.36, $P=0.647$) (I. L. Leeds et al., 2017).

Patient sex

Several authors reported on the effect of female patient sex on post-operative outcomes. These are listed in table 5 below. In addition, MacFarlane et al reported the effect of male sex, and found significantly reduced mortality (OR 0.41, CI 0.18-0.96, $P=0.041$) (MacFarlane et al., 2021). Leeds et al 2017 reported the effect of female sex on post-operative complications, and found no significant association (OR 1.01, CI 0.83-1.22, $P=0.929$) (I. L. Leeds et al., 2017).

Author	Year	Population	Operation	OR	Confidence intervals	P Value
Dayama (Dayama et al., 2015)	2015	IBD	Colectomy in toxic colitis	4.069	1.512-10.948	0.005
Leeds (I. Leeds et al., 2018a)	2018	UC	Colectomy	0.64	0.26-1.54	0.314
Burns (Burns et al., 2020b)	2020	UC	Colectomy	2.88	1.27-6.52	0.011
Lowe (Lowe et al., 2020)	2020	UC	Laparotomy	1.01	0.87-1.19	0.87
Lowe (Lowe et al., 2020)	2020	CD	Laparotomy	1.0	0.82-1.24	0.96
King (King et al., 2020b)	2020	UC	Colectomy	6.73	1.18-38.05	0.032

Table 5. The studies included in the scoping review reporting the predictive value of female patient sex on mortality, in comparison to male sex. $P < 0.05$ was considered significant in all studies.

Medication

Three authors reported on the impact of steroids on outcomes. Uchino et al found the incidence of surgical site infections in UC patients who had colectomy was not significantly elevated in those taking steroids (OR 3.06, CI 0.94 -10, P=0.06), Leeds et al (2018) also found no significant association between steroid use and post-operative complications (OR 0.72, CI 0.48-1.1, P=0.125) and mortality (OR 2.08, CI 0.81-5.32, P=0.128) (I. Leeds et al., 2018a; Uchino et al., 2013). However, Dayama et al did find significantly increased mortality in those taking pre op steroids (OR 3.943, CI 1.5-5.4, P=0.004) (Dayama et al., 2015).

Malnutrition

The effect of malnutrition on post-operative outcomes was measured by two authors. Lowe et al published CD and UC patients as separate cohorts. In CD, Lowe et al report significantly increased mortality in patients with preoperative malnutrition (OR 2.2, OR 1.73-2.8, P<0.01)(Lowe et al., 2020). However, this effect was not seen in UC patients by Lowe et al (OR 0.93, CI 0.8-1.08, P=0.34)(Lowe et al., 2020). Leeds et al 2018 reported on weight loss as a measure of nutritional status. They found no significant association with mortality (OR 1.57, CI 0.58-4.27, P=0.374) or post-operative complications (OR 1.08, CI 0.63-1.83, P=0.79) (I. Leeds et al., 2018a).

Biochemical and haematological abnormalities

Two authors reported the effect of hypoalbuminaemia on outcomes. Uchino et al reported no significant association with surgical site infections (OR 2.74, CI 0.63-12.0, $P=0.18$) (Uchino et al., 2013). This was supported by Galata et al who found no significant association with post-operative complications (OR 0.773, CI 0.59-1.0, $P=0.0624$) (Galata et al., 2018).

Dayama et al reported on the effect of decreased renal function and coagulopathy in patients undergoing colectomy for toxic colitis in all IBD patients. They found significantly increased mortality in both decreased renal function (OR 4.099, CI 1.626-10.335, $P=0.003$) and coagulopathy (OR 7.728, CI 1.909-31.365, $P=0.004$) (Dayama et al., 2015).

Leeds et al (2018) found pre-operative anaemia was not predictive for increased risk of post-operative complications in patients undergoing colectomy for UC (OR 1.49, CI 0.79-2.79, $P=0.218$). They also investigated the effect of preoperative red blood cell transfusion, and found no significant association with mortality (OR 0.52, CI 0.1-2.71, $P=0.441$) or post-operative complications (OR 1.49, CI 0.79-2.79, $P=0.218$) (I. Leeds et al., 2018a).

Respiratory Insufficiency

Reporting on their cohort of IBD patients who had colectomy for toxic colitis, Dayama et al found respiratory insufficiency to be a predictor of increased mortality (OR 2.713, CI 1.052-7.001, $P=0.039$) (Dayama et al., 2015).

Discussion

This scoping review has summarised the current evidence base for predictors of poor outcome in patients having emergency abdominal surgery for IBD. The poor outcomes described by the included studies are mortality, post-operative length of stay, readmission, re-operation and post-operative complications including surgical site infections and sepsis.

Lowe and Ananthakrishnan reported separate outcomes for UC and CD from large datasets. They demonstrate that predictors of poor outcome differ according to diagnosis. For example, malnutrition appears to be a significant predictor of poor outcome in CD but not in UC. Another example is the increased risk of having an operation at the weekend may only apply to patients with UC and not to those with CD. For many authors it may be challenging to have sufficient data on rare outcomes to analyse CD and UC separately. But this scoping review highlights the importance of considering these two groups as separate cohorts rather than grouping them together as a single cohort of IBD patients.

This review included papers explicitly reporting on the emergency IBD cohort using broad literature search terms to capture as many studies as possible. Despite this, we were only able to include 17 papers in this review. During the full paper screening phase, many papers were excluded because they did not clearly define their cohort as emergency, or unplanned, with regards to the timing of surgery. Terms such as 'medically refractory disease' were commonly used, but the reviewer's perception was that many papers included a mix of elective, or semi-elective patients with those who were truly surgical emergency cases.

Some authors stated that their cohort included both emergency and elective cases but did not report separately on the two groups. The likelihood is that there are more than 17 papers reporting outcomes for IBD emergency operations, but it is not possible to identify these results accurately due to descriptive terms used in the papers. For example, we identified three papers reporting adjusted odds ratios of poor outcome from emergency surgery after taking steroids in the pre-operative period. We could identify no studies specifically reporting on the effects of biologic drugs or anti TNF-alpha medication on emergency surgery.

Of the 16 papers included, 6 clearly stated how they defined an emergency operation as shown in table 2, with a wide variety of definitions. The variation in how a patient is classified as an emergency was also found by Udholm et al in a systematic review of the difference in outcome comparing emergency and elective operations for CD (Udholm et al., 2021). The range of urgencies in these 6 papers, classified as “an emergency”, was from an operation within 12 hours of admission, to anytime within an unplanned admission. The patients represented in this spectrum may be very different.

An operation within 12 hours of admission is defined by NCEPOD as ‘urgent’ or ‘immediate’ and is required for patients with peritonitis, septic shock or major haemorrhage (Cullinane, 2003). An operation described as “within the same unplanned admission” may include this unstable patient cohort, but also includes a category described by NCEPOD as ‘expedited’. These operation timings are suitable for stable patients in whom there is no threat to life, for example in those stable patients with small bowel obstruction, with no concerning features, or those with medically refractory colitis.

The NCEPOD urgency classification system has been adopted and adapted by the National Emergency Laparotomy Audit (NELA) and is recommended for acute hospitals in the UK (NELA Project Team, 2023). Every case booked for an emergency operation has a clinical urgency registered as either requiring an operation within 2 hours, 2-6 hours, 6-18 hours or 18-24 hours. NCEPOD recommend that this urgency is decided by the consultant performing the procedure. Whilst there is scope for bias within this subjective system, it may also capture intangible patient factors, the 'end of the bed' assessment for example. Clinical urgency at the time of booking helps facilitate prioritisation of emergency theatre and has been widely adopted in the UK. A benefit of this classification which has not yet been explored is how it might improve the reporting of outcomes in IBD patients having "emergency" surgery.

Within a single cohort study, multivariate regression analysis can adjust for differences in individual patient clinical presentation, but the greater value of cohort studies is the pooling of data for meta-analysis. For this to be accurate the cohorts must be comparable, and for them to be comparable the patient cohort must be comprehensively described. The STROBE guidelines on reporting of cohort studies include the characteristics of study participants (von Elm et al., 2007a).

This review highlights a particular challenge in following STROBE guidelines for cohort studies of IBD patients as there is no single widely accepted way of defining an emergency IBD operation in the reviewed literature.

We recommend consistency of approach in reports of outcomes in the IBD emergency surgery patient group. We particularly recommend a clear description of the urgency of the surgery and would suggest that

the NELA modification of the NCEPOD categories is a requirement of all such publications. Inclusion of these within core descriptor sets would facilitate more accurate classification of procedure urgency, patient subtype and analysis of results.

Conclusion

This review has summarised the current evidence base for emergency abdominal surgery in IBD but, in doing so, identified a significant flaw in the reporting process for emergency IBD patients. Whilst it is likely that age, ASA grade, comorbidity and organ dysfunction play a similar role in risk stratification in IBD patients as in other emergency abdominal surgery cohorts, we cannot make firm conclusions on pre-operative predictors of poor outcome after emergency abdominal surgery for IBD patients because we believe this review might not accurately represent the published data in this area.

It is imperative that future work in the field of emergency surgery for IBD patients accurately defines the urgency cohorts used. We believe that accurate description of clinical urgency for surgery would be a valuable addition to the STROBE reporting standards and would help in the identification of emergency IBD patients for future reviews and meta-analysis.

4. Urgency Adjusted Outcomes of Emergency Abdominal Surgery for Inflammatory Bowel Disease

Chapter Focus

This chapter builds on the conclusions of the scoping review in chapter three of this thesis. By reporting differential patient characteristics and outcomes according to clinical urgency, it highlights important considerations in risk stratification and potential challenges in identifying IBD patients in need of urgent surgical intervention.

Abstract

Introduction

Patients who have emergency abdominal surgery for inflammatory bowel disease (IBD) are a complex cohort who are relatively poorly represented in published literature. This is partly due to the lack of consensus of the definition of the term emergency in IBD surgery. There is on-going and recent work defining clinical urgency for unplanned surgical procedures and categorising the high-risk surgical patient. This paper aims to report the difference in patient metrics and risks as recorded by the National Emergency Laparotomy Audit (NELA).

Methods

Complete patient data, including histology, was available in the NELA database between 2013 – 2016. Urgency categories recorded by NELA are < 2 hours, 2-6 hours, 6-18 hours and >18 hours. Patient characteristics, physiology, biochemistry and outcomes are reported according to these urgency categories with regression analysis used to compare differences between them.

Results

Mortality in Crohn's disease (CD) ranged from 1.4% in the >18-hour urgency, to 14.6% in the most urgent. In Ulcerative Colitis (UC) this range was from 3.1% - 14.8%. In both CD and UC there were significant trends in haemodynamic instability, serum white cell count, serum electrolytes and creatinine, and outcome measures length of stay and unplanned return to theatre.

Conclusions

Patients having emergency surgery for IBD are not a single cohort when considering physiology, blood biochemistry or most importantly, outcomes. Risk counselling and management should reflect this. Haemodynamic changes are subtle and may be missed in this cohort.

Introduction

The National Emergency Laparotomy Audit (NELA), overseen by the Healthcare Quality Improvement Partnership (HQIP), was commissioned in 2012. Its aim was to look at structures, processes and outcome measures for the quality of care received by patients having emergency abdominal surgery. The median in-hospital mortality for this patient cohort has decreased from 11.8% to 9.2% over the course of this audit (NELA Project Team, 2023). A key driver of change at the outset of NELA was simply to understand the problem. To quantify risk and observe patterns and trends.

Patients with inflammatory bowel disease (IBD) are a complex cohort who may require emergency abdominal surgery. The scoping review of the outcomes of emergency abdominal surgery in IBD (chapter 3) has shown a lack of consensus on the definition of the term “emergency” in this patient group (Bunce, Wall, et al., 2023).

Overall mortality after emergency laparotomy for IBD is reported as approximately 5% in ulcerative colitis (UC) and approximately 4% in Crohn’s disease (CD)(S. Singh et al., 2015). This data is from patients having a laparotomy during an unplanned admission, rather than being based on the degree of urgency of surgery. It is reported by several authors that surgical outcomes for patients with IBD are worse in the emergency setting in comparison to elective, but data is lacking on outcomes based on the absolute requirement for surgery and the timing of that surgery.

NCEPOD introduced the concept of clinical urgency to the UK in 2004(Cullinane et al., 2003). The operating consultant surgeon is expected to assign a category of urgency to a procedure for the purpose of triage when scheduling emergency procedures. Since 2004,

this concept has been adopted by NELA, recognising four urgency categories within which the patient should arrive in theatre from the time of booking: less than 2 hours, 2-6 hours, 6-18 hours and >18 hours (NELA Project Team, 2023). In 2023 the World Society of Emergency Surgery (WSES) published an update to the timing in acute care surgery (TACS) classifications defining 6 urgency categories: immediate, within one hour, within 6 hours, within 12 hours, 24-48 hours and within 2-4 days (De Simone et al., 2023). The expert opinion presented in the TACS report suggests haemodynamic instability as the key determinant of urgency in general surgical emergencies (De Simone et al., 2023).

The aim of this study is to report the characteristics and outcomes of emergency abdominal surgery for IBD as recorded by NELA with respect to urgency. We hypothesize that there will be significant differences in outcome, patient physiology and disease characteristics between urgency categories.

Methods

This study was carried out as an extended analysis of the NELA data by the NELA project team and is exempt from UK National Research Ethics Committee approval. The inclusion criteria are adults over 18 years old having emergency laparotomy or laparoscopy. Patients having laparotomy for trauma, vascular emergencies, appendicitis, and gynaecological conditions are excluded. This study is reported according to STROBE guidelines for observational studies (von Elm et al., 2007b).

Patients with UC or CD recorded in the histology domain were extracted from the NELA database. The primary operation during an admission was included, patients returning to theatre for

complications of surgery, or planned 'relook' operations were excluded. Complete data including histology was available for patients between 2013 and 2016. After this point histology was no longer included in the NELA data collection.

Patient characteristics age and sex were compared between urgency categories. Heart rate and systolic blood pressure were chosen as markers of haemodynamic status. Serum potassium, sodium and creatinine used as markers of renal dysfunction and fluid status. Peritoneal contamination and serum haemoglobin and white cell count used as further biochemical markers of pathophysiology. C-Reactive Protein data was not available for this cohort. Lactate could not be included due to missing data in 61% of cases. Outcome measures of interest included in-patient mortality, post-operative length of stay and unplanned return to theatre. Process measures described are length of time between admission, surgical review and arriving in theatre for each of the urgency categories.

Continuous variables have been described as median and interquartile range (IQR), categorical variables as percentages. An abnormal value refers to anything above or below the normal range as defined by NELA (NELA Project Team, 2023). Regression analysis was used to identify statistically significant change between each of the four urgency categories. Trends in binary characteristics or outcomes were analysed by logistic regression using clinical urgency as the predictor variable, reported as odds ratios (OR) with 95% confidence intervals (CI). Linear outcomes were analysed using linear regression, correcting for heteroskedasticity. Length of stay was analysed using negative binomial regression with associations reported as incident rate ratios (IRR). Statistical significance was set at a P-value of <0.05. All analyses were conducted using Stata version 18.0 (StataCorp, 2023).

Results

Between 2013 and 2016 NELA recorded 3356 emergency abdominal operations for IBD within the four urgency categories with characteristics as shown in table 6 (CD) and 7 (UC). The trends in patient age and sex across different urgency categories are shown in figures 1-4.

		<2 hours	2-6 hours	6-18 hours	>18 hours
Number		89	504	776	802
Age [median (IQR)]		45 (27-64)	41 (28-58)	40 (27.5-56.5)	39 (27-55)
Male		52 (58.4)	272 (53.9)	405 (52.2)	374 (46.6)
ASA grade	1	7 (7.9)	58 (11.5)	85 (10.9)	47 (5.9)
	2	27 (30.3)	239 (47.4)	465 (59.9)	504 (56.4)
	3	30 (33.7)	162 (32.1)	204 (26.3)	238 (29.7)
	4	22 (24.7)	44 (8.7)	20 (2.6)	12 (1.5)
	5	3 (3.4)	1 (0.2)	2 (0.3)	1 (0.1)

Table 6. Characteristics of patients undergoing emergency abdominal surgery for CD according to NELA clinical urgency categories. Numbers in parentheses are percentages unless otherwise stated.

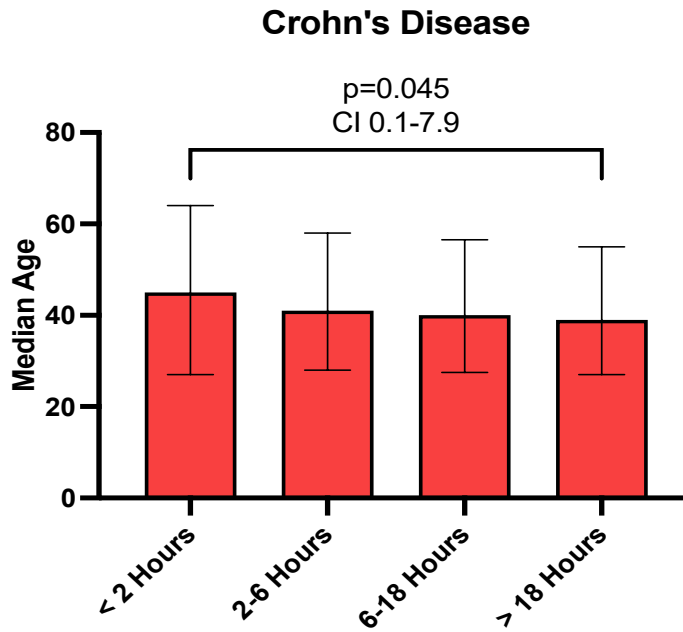


Figure 2. Median age of patients having emergency abdominal surgery for CD with error bars showing interquartile range. Linear regression results showing patient age does not differ significantly at each urgency interval, but between the least urgent and most urgent there is a significant increase.

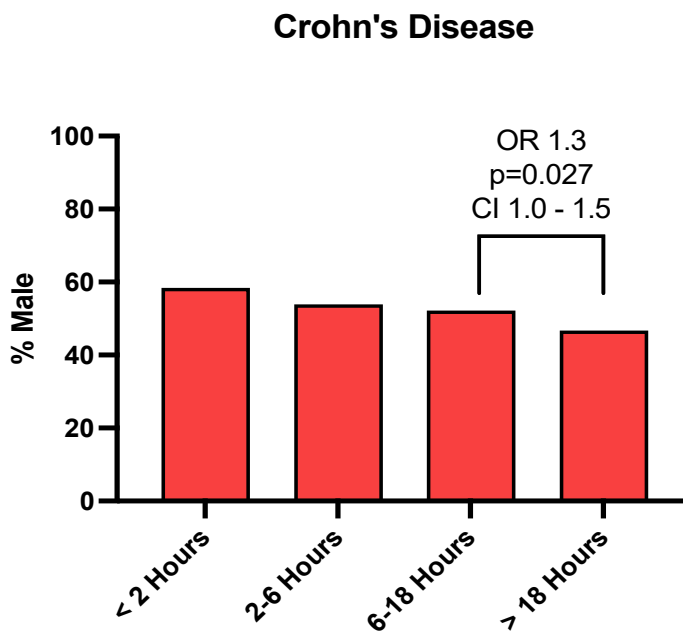


Figure 3. The sex of patients having emergency abdominal surgery for CD. Logistic regression shows there are significantly more female patients in the least urgent category than any other urgency.

		<2 hours	2-6 hours	6-18 hours	>18 hours
Number		54	248	337	546
Age [median (IQR)]		53 (36-66)	51 (33-67)	43 (30-58)	43 (29-60)
Male		28 (51.9)	139 (56.1)	202 (59.9)	288 (52.8)
ASA grade	1	4 (7.4)	8 (3.2)	16 (4.8)	23 (4.2)
	2	12 (22.2)	100 (40.3)	171 (50.1)	308 (56.4)
	3	20 (37.0)	98 (39.4)	135 (40.1)	202 (37)
	4	15 (27.8)	41 (16.5)	15 (4.5)	13 (2.4)
	5	3 (5.6)	1 (0.4)	0	0

Table 7.Characteristics of patients who have emergency abdominal surgery for UC according to NELA clinical urgency categories. Numbers in parentheses are percentages unless otherwise stated.

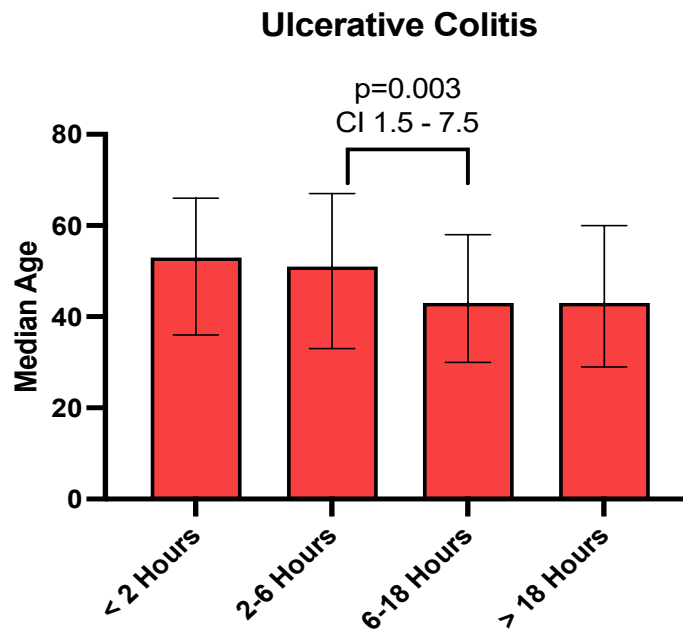


Figure 4.Median age of patients having emergency abdominal surgery for UC with error bars showing interquartile range. Linear regression shows patient age only differs significantly between 2-6 and 6-18 hour urgency categories.

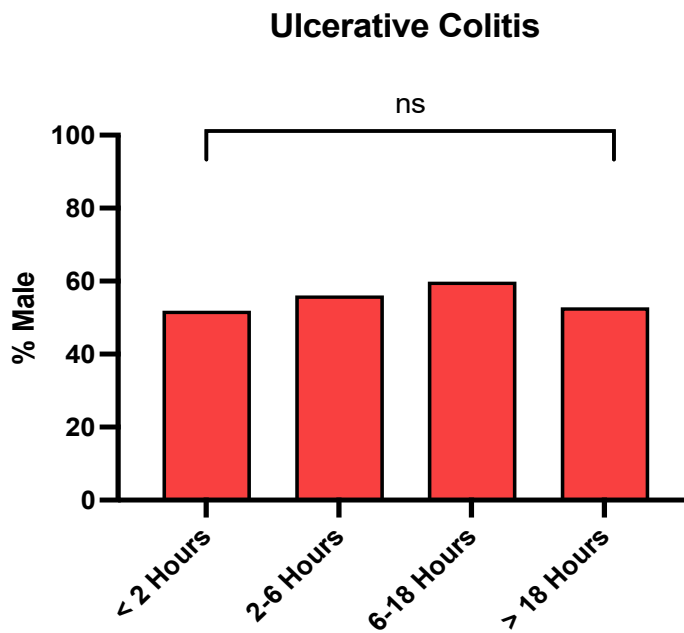


Figure 5. The sex of patients having emergency abdominal surgery for UC. Logistic regression shows there are no significant trends in patient sex across urgency categories.

Physiology and disease characteristics for patients with CD and UC are shown in tables 8 and 9. Trends in heart rate and systolic blood pressure are shown in figures 5, 6, 11 and 12, and trends serum biochemistry and haematology are shown in figures 7, 8, 9, 10, 13, 14, 15 and 16. There was no significant trend observed in moderate to severe anaemia in patients with either UC or CD.

		<2 hours	2-6 hours	6-18 hours	>18 hours
Number		89	504	776	802
Heart rate [median (IQR)]		110 (90-120)	90 (80-108)	86 (75-97)	80 (70-92)
Systolic blood pressure [median (IQR)]		112 (98-129)	117 (107-130)	120 (110-132)	120 (110-130)
Abnormal white cell count		51 (57.3)	331 (65.7)	370 (47.7)	291 (36.3)
Abnormal sodium		15 (16.8)	68 (13.5)	70 (9.0)	53 (6.6)
Abnormal potassium		14 (25.9)	64 (12.7)	85 (10.9)	88 (11.1)
Moderate / severe anaemia		31 (34.8)	170 (22.7)	260 (33.5)	287 (35.8)
Raised creatinine		24 (26.9)	61 (12.2)	62 (8.0)	38 (4.7)
Degree of peritoneal soiling	None	16 (17.9)	134 (26.6)	301 (38.9)	443 (55.4)
	Serous Fluid	9 (10.1)	100 (19.9)	230 (29.7)	178 (22.3)
	Localised Pus	13 (14.6)	125 (24.9)	175 (22.6)	148 (18.5)
	Free pus / blood or bowel contents	51 (57.3)	144 (28.6)	68 (8.8)	30 (3.8)

Table 8. Physiology and disease characteristics in patients who had emergency abdominal surgery for CD according to NELA clinical urgency categories. Numbers in parenthesis are percentages unless otherwise stated.

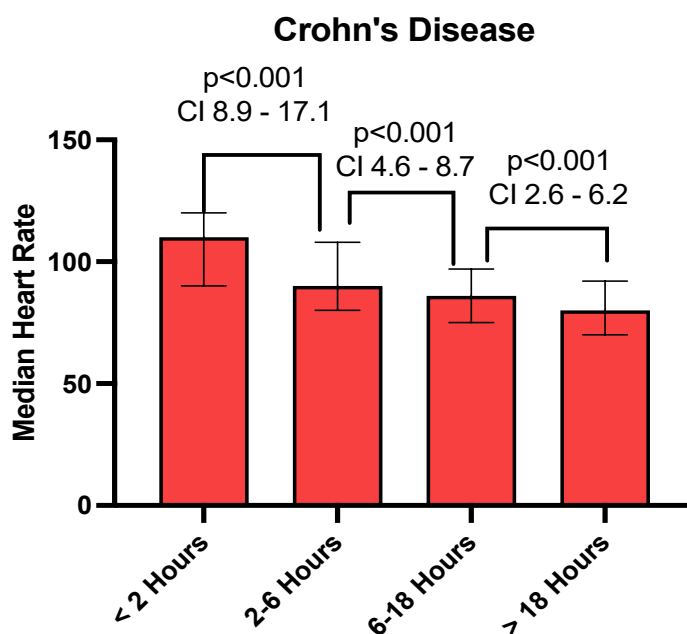


Figure 6. Median heart rate of patients having emergency abdominal surgery for CD with error bars showing interquartile range. Linear regression shows there are small but statistically significant heart rate change at each urgency category.

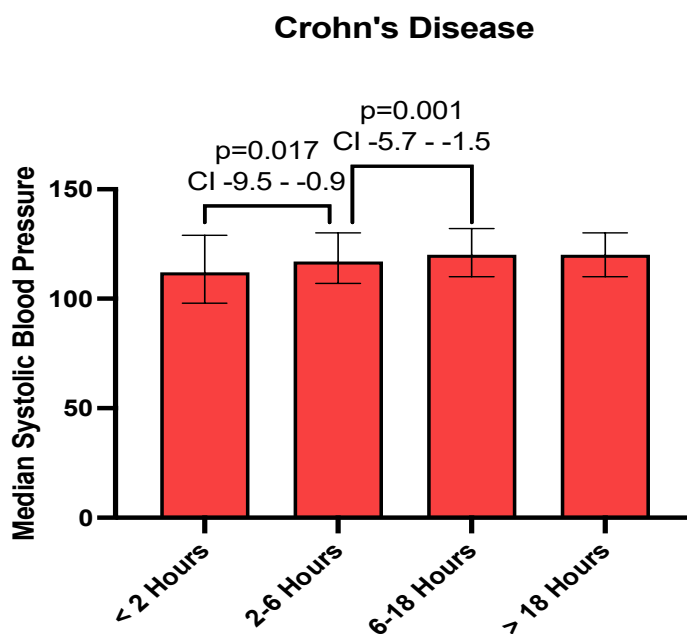


Figure 7. Median systolic blood pressure of patients having emergency abdominal surgery for CD with error bars showing interquartile range. Linear regression shows there are small but statistically significant changes in systolic blood pressure between <2 hour and 2-6 hour, and 2-6 and 6-18 hours.

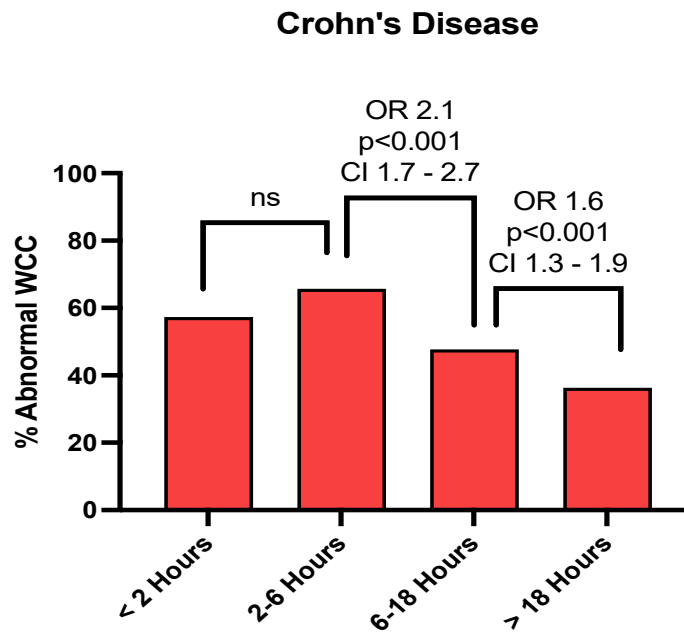


Figure 8. The percentage of patients with abnormal serum white cell count (WCC) having emergency abdominal surgery for CD. Logistic regression shows there is a significant difference between the least three urgent categories.

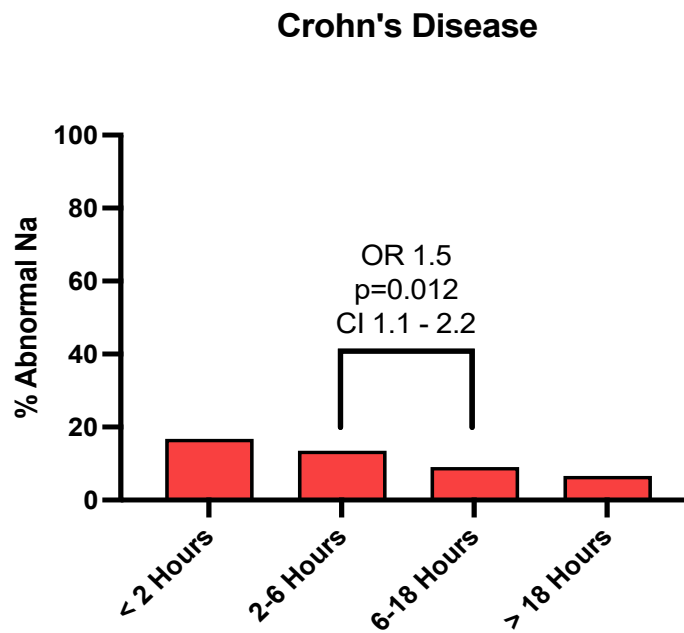


Figure 9. The percentage of patients with abnormal serum sodium (Na) having emergency abdominal surgery for CD. Logistic regression shows there is a significant difference between urgency groups 2-6 hours and 6-18 hours in CD.

Crohn's Disease

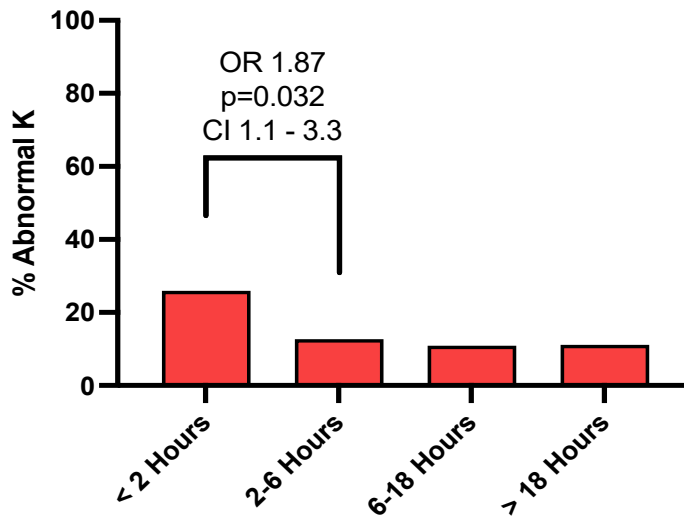


Figure 10. The percentage of patients with abnormal serum potassium (K) having emergency abdominal surgery for CD. Logistic regression shows there is a significant difference between urgency groups <2 hours and 2-6 hours in CD.

Crohn's Disease

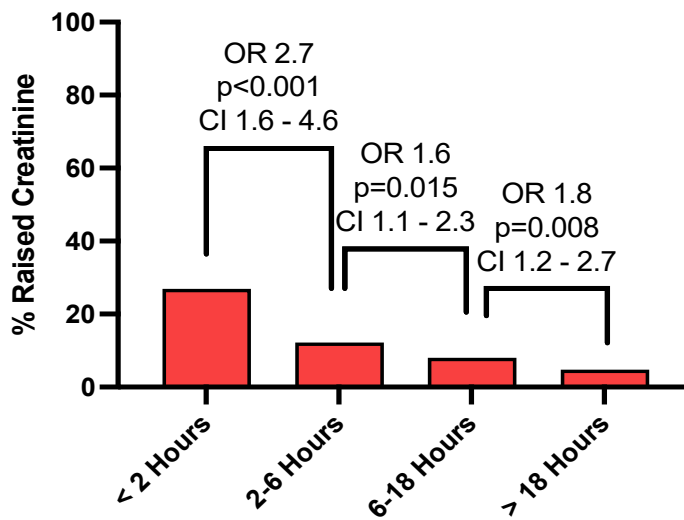


Figure 11. The percentage of patients with raised serum creatinine having emergency surgery for CD. Logistic regression shows the serum creatinine increases significantly between each urgency category in CD.

		<2 hours	2-6 hours	6-18 hours	>18 hours
Number		54	248	337	546
Heart rate [median (IQR)]		105 (90-118)	92 (80-105)	85 (75-96)	82 (72-93)
Systolic blood pressure [median (IQR)]		115 (90-126)	120 (108-132)	122 (110-134)	121 (112-135)
Abnormal white cell count		33 (61)	143 (57.9)	164 (48.8)	226 (41.5)
Abnormal sodium		12 (22.3)	54 (21.7)	52 (15.5)	54 (9.9)
Abnormal potassium		16 (18.6)	60 (24.2)	63 (18.8)	100 (18.4)
Moderate / severe anaemia		27 (50)	128 (51.6)	198 (58.9)	316 (57.9)
Raised creatinine		14 (26.4)	45 (18.2)	24 (7.1)	23 (4.2)
Degree of peritoneal soiling	None	16 (29.6)	82 (33.1)	189 (56.4)	368 (67.5)
	Serous Fluid	14 (25.9)	76 (30.7)	102 (30.5)	138 (25.3)
	Localised Pus	1 (1.9)	18 (7.3)	15 (4.5)	13 (2.4)
	Free pus / blood or bowel contents	23 (42.6)	72 (29.0)	29 (8.7)	26 (4.8)

Table 9. Physiology and disease characteristics in patients undergoing emergency abdominal surgery for UC according to NELA clinical urgency categories. Numbers in parenthesis are percentages unless otherwise stated.

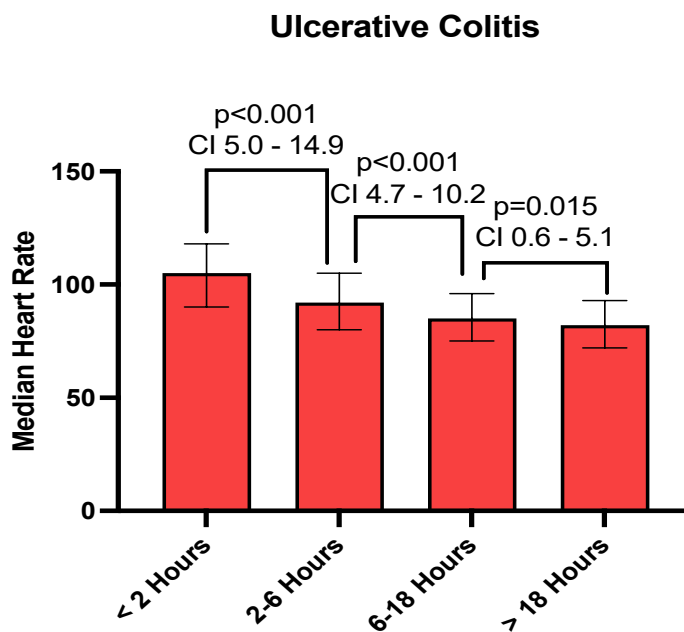


Figure 12. Median heart rate of patients having emergency abdominal surgery for UC with error bars showing interquartile range. Linear regression shows there are small but statistically significant heart rate change at each urgency category.

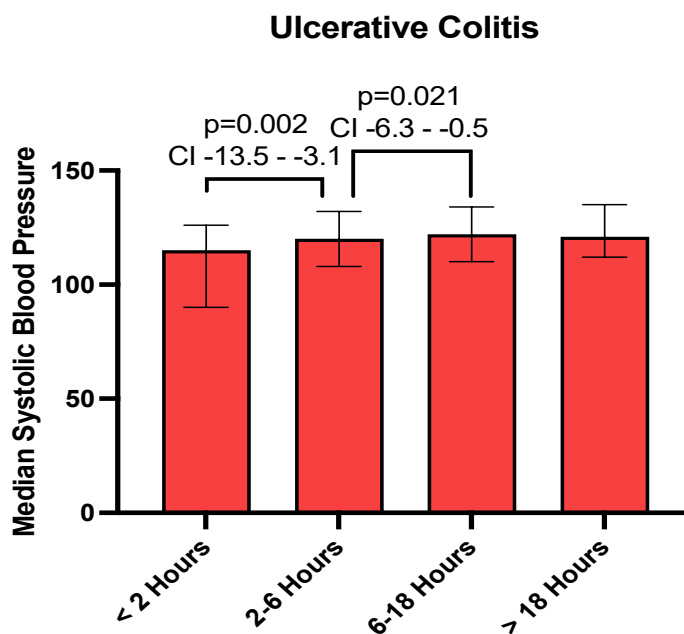


Figure 13. Median systolic blood pressure of patients having emergency abdominal surgery for uc with error bars showing interquartile range. Linear regression shows there are small but statistically significant changes in systolic blood pressure between <2 hour and 2-6 hour, and 2-6 and 6-18 hours.

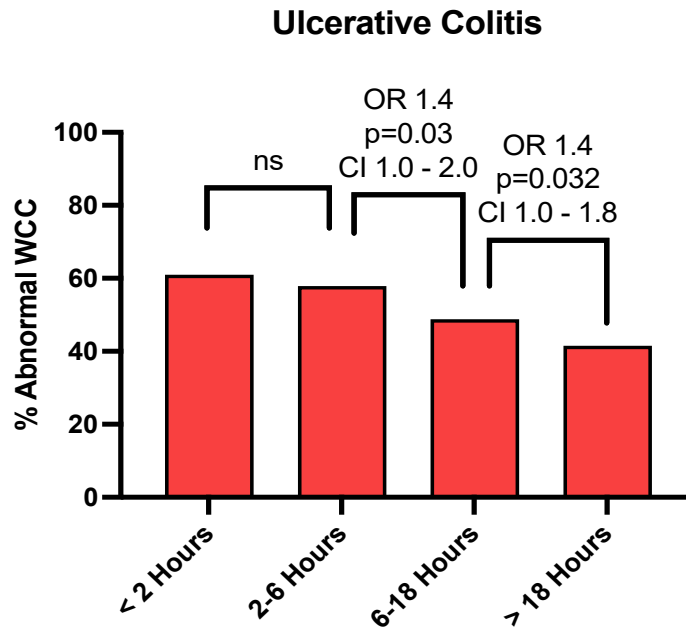


Figure 14. The percentage of patients with abnormal serum white cell count (WCC) having emergency abdominal surgery for UC. Logistic regression shows there is a significant difference between the least three urgent categories.

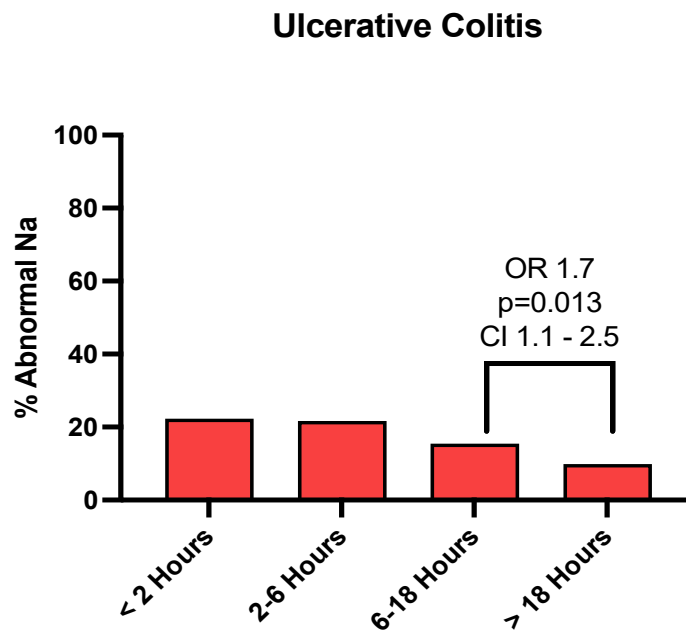


Figure 15. The percentage of patients with abnormal serum sodium (Na) having emergency abdominal surgery for UC. Logistic regression shows there is a significant differences between 6-18 hours and >18 hours

Ulcerative Colitis

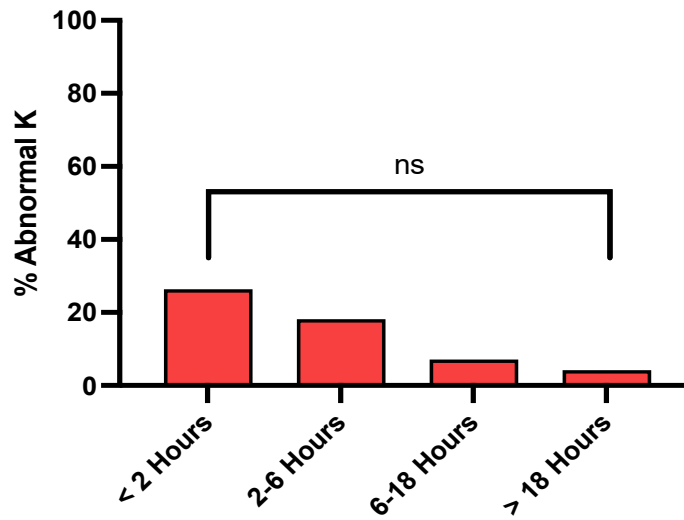


Figure 16. The percentage of patients with abnormal serum potassium (K) having emergency abdominal surgery for UC. There is no significant trend seen on logistic regression.

Ulcerative Colitis

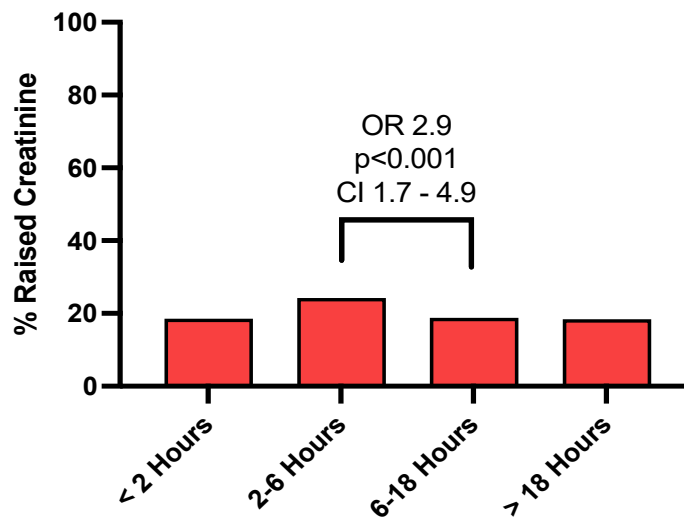


Figure 17. The percentage of patients with raised serum creatinine having emergency surgery for UC. Logistic regression shows the serum creatinine increases significantly between 6-18 hour and 2-6 hour urgency categories.

In CD, the proportion of patients with generalised peritoneal soiling with pus, blood or bowel contents increases significantly at all urgency intervals. Between >18 hour and 6-18 hour the OR= 2.5, $p<0.001$, CI 1.6 - 3.8. Between 6-18 hour and 2-6 hour the OR= 4.2, $p<0.001$, CI 3.0 – 5.7. Between 2-6 hour and <2 hour the OR= 3.4, $p<0.001$, CI 2.1 - 5.3.

In UC, the number of patients with free peritoneal contamination with pus, blood or bowel contents increases significantly between >18 hour and 6-18 hour OR = 1.9, $p=0.024$, CI 1.1 - 3.3, and between 6-18 and 2-6 hour categories OR = 4.3, $p<0.001$ CI 2.7 - 6.9. Despite the observed increase in contamination between 2-6 hour and <2 hour categories, this does not reach statistical significance.

Tables 10 and 11 show the time based process measures per urgency category in UC and CD. In CD, after adjusting for clinical urgency, an increased time from admission to arrival in theatre did not predict higher mortality (OR 1.00 CI 0.99 – 1.00 $P=0.065$) or increased rate of return to theatre (OR 1.00, CI 0.99-1.00, $P=0.509$). In UC, after adjusting for clinical urgency, there was small but statistically significant association between increased time from admission to arrival in theatre and mortality (OR 1.002, CI 1.00 – 1.003, $P=0.005$). This association was not seen with unplanned return to theatre (OR 1.00, CI 0.99-1.00, $P=0.42$).

	<2 hours	2-6 hours	6-18 hours	>18 hours
Time from admission to arrival in theatre in hours (median [IQR])	17.5 (6.4-127.2)	29.5 (12.8-92.1)	49.5 (24 – 119.1)	114.4 (47.5 - 230.9)
Time from the decision to operate to arrival in theatre in hours (median [IQR])	1.8 (0.9 – 2.5)	3.3 (1.9 – 5.7)	6.7 (3 – 19.8)	24.1 (16.3 – 44.1)
Time from admission to consultant review in hours (median [IQR])	12.3 (4.2 – 43.5)	13.3 (6.4 – 26.0)	15.4 (6.9 – 42.3)	18.9 (6.5 – 59.4)

Table 10. Time based process measures for patients having emergency abdominal surgery for CD according to NELA clinical urgency categories.

	<2 hours	2-6 hours	6-18 hours	>18 hours
Time from admission to arrival in theatre in hours (median [IQR])	88.2 (14.8 – 266.0)	129.8 (46 – 244.5)	165.1 (80.9 – 269.8)	190.3 (95.5 – 328.3)
Time from the decision to operate to arrival in theatre in hours (median [IQR])	1.9 (1.0 – 4.1)	3 (2.0 – 6.5)	9.25 (3.8 – 21.2)	23.3 (16 – 40.4)
Time from admission to consultant surgeon review in hours (median [IQR])	24.3 (5.1 – 147.5)	34.6 (8.9 – 146.7)	77.4 (16 – 191.2)	89.3 (21.3 – 187.1)

Table 11. Time based process measures for patients undergoing emergency abdominal surgery for UC according to NELA clinical urgency categories.

Outcomes for emergency abdominal surgery for CD and UC are shown in tables 12 and 13. Trends in post-operative mortality is shown in figures 17 and 18.

	<2 hours	2-6 hours	6-18 hours	>18 hours
Number	89	504	776	802
In-patient Mortality	13 (14.6)	22 (4.4)	24 (3.1)	11 (1.4)
Post-operative length of stay [median (IQR)]	11.9 (7.1-25.7)	9.9 (6.7-17)	9 (6.1-14.4)	8.1 (5.9-12.9)
Unplanned return to theatre	19 (21.6)	39 (7.8)	45 (5.9)	59 (7.4)
Unplanned admission to critical care	3 (3.4)	12 (2.4)	22 (2.8)	25 (3.1)

Table 12. Outcomes of patients undergoing emergency abdominal surgery for CD according to NELA clinical urgency categories. Numbers in parentheses are percentages unless otherwise stated.

Crohn's Disease

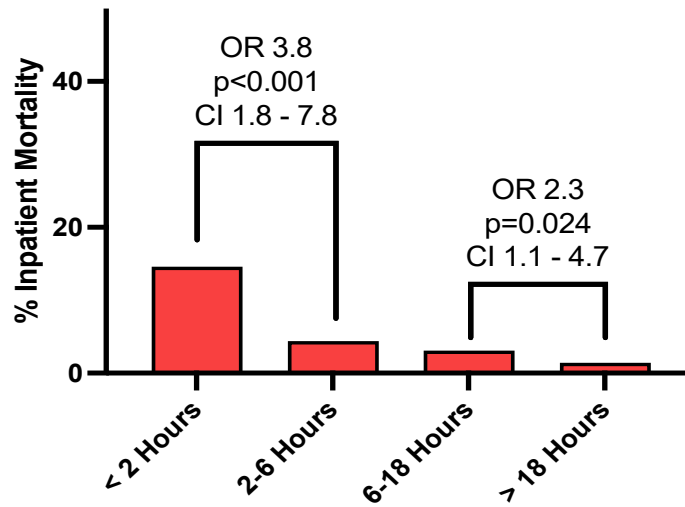


Figure 18. Percentage inpatient mortality for patients having emergency abdominal surgery for CD. Logistic regression shows there is a significant increase in post-operative mortality between >18 hours and 6-18 hours, and between 2-6 and <2 hours.

	<2 hours	2-6 hours	6-18 hours	>18 hours
Number	54	248	337	546
In-patient Mortality	8 (14.8)	34 (13.7)	11 (3.3)	17 (3.1)
Post-operative length of stay [median (IQR)]	21.8 (13.9-44.9)	13.8 (7.9-24)	10.6 (7.1-18.1)	10 (6.9-16.4)
Unplanned return to theatre	9 (17.3)	30 (12.3)	31 (9.3)	54 (9.9)
Unplanned admission to critical care	4 (7.4)	9 (3.6)	21 (6.2)	31 (5.7)

Table 13. Outcomes of patients undergoing emergency abdominal surgery for UC according to NELA clinical urgency categories. Numbers in parenthesis are percentages unless otherwise stated.

Ulcerative Colitis

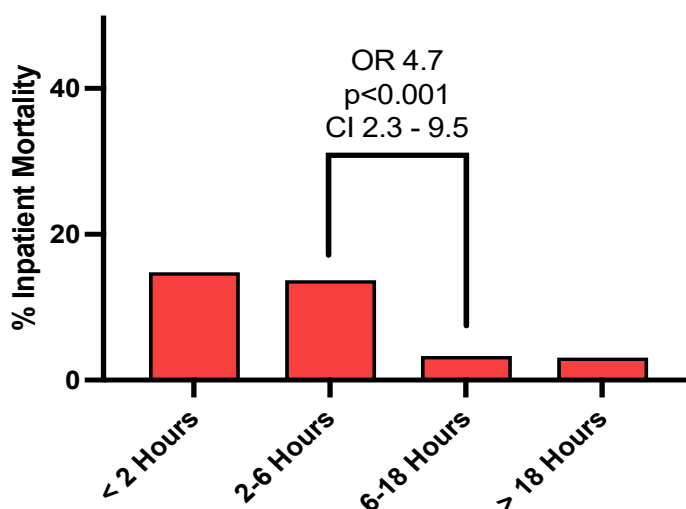


Figure 19. Percentage inpatient mortality for patients having emergency abdominal surgery for UC. Logistic regression shows there is a significant increase in post-operative mortality between 6-18 and 2-6 hours.

In CD we found a significant increase in length of stay comparing 6-18 hours and 2-6 hours, IRR 1.3, $p < 0.001$, CI 1.1 – 1.4. This is also seen between 2-6 hours and <2 hours with an IRR 1.5, $p < 0.001$, CI 1.2 – 1.8. Patients within the <2 hour urgency category were significantly more likely to have an unplanned return to theatre when compared with 2-6 hours (OR 3.3, $p < 0.001$, CI 1.8 – 5.9), 6-18 hours (OR 4.4, $p < 0.001$, CI 2.5 – 7.9) and >18 hours (OR 3.4 $p < 0.001$, CI 1.9 – 6.1). Rate of unplanned return to theatre did not differ significantly between the 2-6, 6-18 and >18 hour categories. There was no significant difference in unplanned admission to critical care across the four urgency categories.

In UC we also found a significant increase in length of stay comparing 6-18 hours and 2-6 hours, IRR 1.3, $p < 0.001$, CI 1.2 – 1.5. This is also seen between 2-6 hours and <2 hours with an IRR 1.8, $p < 0.001$, CI 1.4

– 2.4. The difference in rate of unplanned return to theatre or unplanned admission to critical care did not reach statistical significance between any of the urgency categories.

Discussion

These data show significant variation in patients who have an emergency abdominal operation for IBD. Whilst 40% of cases are of low urgency, the majority required an operation within 18 hours, and more than a quarter within 6 hours. There is significant variation in disease severity and outcome across the urgency categories. This is in keeping with an analysis of the American College of Surgeons National Surgery Quality Improvement Program (NSQIP) database (Mullen et al., 2017).

From our analysis of the patients with CD, we observe three mortality categories. The most urgent have a high mortality (14.6%) associated with significantly elevated incidence of free peritoneal contamination. The middle category is more consistent with published mortality rates for unplanned surgery of approximately 3-4%, and represents patients requiring an operation within 18 hours, but not immediately. The least urgent patients have a mortality of 1.4%, which is similar to the mortality of an elective population for CD (S. Singh et al., 2015). From our data on patients with UC, we observe two mortality cohorts. Those requiring an operation within 6 hours have a mortality approximately 14-15%, whereas those less urgent than 6 hours have a mortality approximately 3%. This is still several percent higher than the observed mortality in an elective population (S. Singh et al., 2015). Similar trends are seen in post-operative length of stay and unplanned return to theatre, with more urgent cases having poorer measured outcomes. When considering the outcomes of an emergency operation for IBD, or reporting these outcomes in published literature, clinical urgency is a relevant and important factor. These more urgent cases could be considered the 'true emergencies' for IBD and represent a high-risk cohort.

In both UC and CD, heart rate increased with statistical significance between all urgency categories, but blood pressure only showed statistically significant change in patients requiring an operation within 6 hours. This partially supports the statement made in the updated TACS consensus report that haemodynamic stability is the most important indicator of clinical urgency (De Simone et al., 2023). However, we have shown that in IBD the changes in heart rate and systolic blood pressure are subtle and may not be recognised by the early warning score system used in the UK. The second iteration of the national early warning score (NEWS2) was developed by the Royal College of Physicians in 2017 (Indd, 2017). It attributes a value of 0-3 to parameters to identify patients in need of urgent review. These parameters are shown in appendix 7. The upper quartile of elevated heart rate in the most urgent UC and CD cases, 118 and 120 bpm respectively, would not trigger an urgent review despite 57% of cases having gross peritoneal soiling in Crohn's disease. Whilst the changes in haemodynamic status are statistically significant in IBD, they are likely to be missed by a clinician over reliant on scoring systems.

The time from admission to arrival in theatre could be improved, especially in the most urgent cohorts. We can see that once the decision to operate is made the patient arrives in the theatre in a timely manner, but even in the most urgent cases the decision to operate is delayed with a median time from admission to arrival in theatre of over 17 hours. In CD, most of this delay is prior to a consultant surgical review whereas in UC there may be a more deliberate period of non-operative management. IBD emergencies provide a decision-making challenge for several reasons, and these may be reflected in delays in time to theatre. Before proceeding to emergency surgery, patients with IBD may have a period of conservative management. It may be that in the most urgent cases

this period of conservative management is inappropriate. For example, clinicians may delay the decision to operate until a colorectal surgeon is available. Whilst this may be appropriate in the least urgent cohorts, it may be an unnecessary delay in the more urgent patients where the priority is sepsis source control. As is highlighted by the subtle changes in haemodynamic stability between urgency cohorts, recognising the patients most urgently in need of an operation in this cohort is a challenge, but a key area for improvement.

It is possible that the assessment of clinical urgency could be affected by bias. However, these data show how changes in a wide range of patient metrics are represented by clinical urgency. We have found that no single metric reliably predicts rising urgency in both UC and CD which reinforces the requirement for accurate holistic assessment of clinical parameters when booking a patient for theatre. Our analysis also suggests clinical urgency represents less tangible signs, especially in younger patients, which may not trigger standard inpatient alert mechanisms.

Sex disparity in treatment and outcomes is flagged in these data. In Crohn's disease, there is a significant difference in the categorisation of urgency of cases between males and females, with male patients being more likely to be booked as an urgent case and females more likely to be booked with less urgency. There may be several reasons for this, such as differential presentation between male and female sexes. The aims of this study were not to perform adjusted analysis to identify predictors of urgency, but the differential management of patients with Crohn's disease according to sex should be the focus of future study.

Conclusion

We recommend that patients having 'emergency laparotomy or laparoscopy' for IBD should not be considered a single cohort. Patients should be counselled on the risk of their surgery according to data representative of their individual presentation and urgency. The authors stress the need for greater detail in the description of clinical urgency in publications and the removal of the ambiguous term 'emergency'.

We would also recommend caution when relying solely on inpatient alert mechanisms with quantitative cut-offs to decide clinical urgency. As described in the updated WSES TACS consensus, haemodynamic instability is important, but evidence suggests there may be other key determinants of clinical urgency in IBD patients.

Clarifying the exact details of clinical urgency for surgery based on individual clinical variables for patients with IBD is essential to provide best care and allow subsequent accurate analysis of that care.

5. The impact of surgeon specialty interest on outcomes of emergency laparotomy in IBD

Chapter focus

This chapter develops the principle from chapter four that each urgency cohort in IBD may have a different risk profile. It explores how the elective specialist interest of the operating general surgeon may impact outcomes across the different urgency categories.

Abstract

Introduction

Emergency laparotomy may be required in patients with inflammatory bowel disease (IBD). NELA is the largest prospectively maintained database of adult emergency laparotomies in England and Wales and includes clinical urgency of the cases. The impact of surgeon subspecialty on outcomes after emergency laparotomy for IBD is unclear. We have investigated this association, according to the degree of urgency in IBD emergency laparotomy, including the effect of minimally invasive surgery (MIS).

Methods

Adults with IBD in the NELA database between 2013 - 2016 were included. Surgeon subspecialty was colorectal or non-colorectal. Urgencies are 'Immediate', '2-6 hours', '6-18 hours' and '18-24 hours'. Logistic regression was used to investigate in-patient mortality and post-operative length of stay (LOS).

Results

There was significantly reduced mortality and LOS in IBD patients who were operated on by a colorectal surgeon in the least urgent category of emergency laparotomies; Mortality adjusted OR 2.99 (CI 1.2 – 7.8) $P=0.025$, LOS IRR 1.18 (CI 1.02-1.4) $P=0.025$. This association was not seen in more urgent categories. Colorectal surgeons were more likely to use MIS, $P<0.001$ and MIS was associated with decreased LOS in the least urgent cohort, $P<0.001$, but not in the other urgencies.

Conclusions

We found improved outcomes in the least urgent cohort of IBD emergency laparotomies when operated on by a colorectal surgeon in comparison to a non-colorectal general surgeon. In the most urgent cases, there was no benefit in the operation being performed by a colorectal surgeon. Further work on characterising IBD emergencies by urgency would be of value.

Introduction

Emergency laparotomy may be required in patients with inflammatory bowel disease (IBD). Many of these operations are performed out of normal working hours by the on call general surgeon. UK surgical training demands that all trainees obtaining Certification of Completion of Training (CCT) in general surgery are able to manage an unselected surgical take and perform the necessary operations via either an open or minimally invasive approach (T. Cook et al., 2021). However, as a consultant, a general surgeon's elective practice is often within a specialty interest area such as colorectal or hepatobiliary, whilst their emergency work remains general. IBD falls under the specialty interest of colorectal surgeons. This is supported by IBDUK standards which state that elective IBD operations should be performed by a colorectal surgeon (Kapasi et al., 2020). There is evidence that mortality is significantly increased in emergency laparotomy when the pathology encountered is not in the specialty area (upper or lower gastrointestinal tract surgery) of the operating surgeon (Boyd-Carson et al., 2019). However, a recent cohort study of 913 patients suggests this may not be the case in IBD patients (MacFarlane et al., 2021).

Inflammatory bowel disease may present acutely to surgeons in a number of ways. Some, with perforation or peritonitis will require immediate emergency surgery. Others will require expedited surgery through lack of response to maximal medical therapy (Lamb et al., 2019). The previous chapter in this thesis describes how characteristics and outcomes for this cohort of patients differ according to clinical urgency. The hypothesis for this chapter is that predictors of poor outcome may also differ according to urgency and

these patients are different cohorts when it comes to risk stratification.

The aim of this study is to investigate the impact of surgeon subspecialty interest, timing of surgery and surgical approach on outcomes for patients who have urgent or emergency surgery for IBD. It is thought that surgeon's elective speciality interest may have an influence on IBD emergency outcomes through peri-operative decision making in these often-complex patients, as well as through differential experience with surgery of the lower GI tract.

Methods

For this analysis, data from December 2013 – December 2020 was extracted from the NELA dataset.

Patients were classified as having had an emergency laparotomy for inflammatory bowel disease if ulcerative colitis (UC) or Crohn's disease (CD) was recorded in the histology domain of the NELA database. The primary procedure for that admission was the only one included in the analysis; planned or unplanned returns to theatre were not included to avoid increasing heterogeneity in the group. Complete data, including histology, was available between December 2013 and November 2016. After 2016 NELA no longer recorded histology and so data from 2017 to present has been excluded as the authors cannot be sure it accurately represents IBD. Patients with UC or CD were analysed grouped in a single cohort, here-on referred to as 'IBD', and by specific IBD diagnosis.

NELA records the general surgery specialty interest of the consultant surgeon responsible for the case. For the purpose of this study, these were grouped as colorectal and non-colorectal.

The three cohorts; UC, CD and IBD (UC and CD combined) were analysed as groups divided by clinical urgency. NELA records clinical urgency categories as '18-24 hours', '6-18 hours', '2-6 hours', '<2 hours' and 'immediate' (NELA Project Team, 2023). The last two categories have been grouped together as '<2 hours' due to the low numbers and the negative effect this would have on power. Outcome measures included in-hospital mortality and postoperative length of stay.

Descriptive data are presented as median [interquartile range] and proportion (%) as appropriate. Logistic regression models were

adjusted for *a priori* potential confounding variables. These included age, sex, ASA grade, cardiac and respiratory symptoms, ECG findings, systolic blood pressure, pulse rate, white cell count, creatinine, sodium, potassium, Glasgow coma score, high risk indication (perforation or ischaemia), anaemia (moderate or severe) and postoperative destination (ward versus higher level care)(NELA Project Team, 2023). We could not add other *a priori* variables including frailty, CRP or lactate due to a large amount of missing data. Blood loss and soiling were not added as this may be related to surgical skill. Minimally invasive surgery (MIS) in IBD has been reported on in several cohort studies and is included in the NELA data (Udholm et al., 2021). *Post hoc* analysis of MIS has been included, defined as an operation that was completed laparoscopically, using logistic regression, to aid in discussion of the results.

Linear continuous predictors were identified using the lowess command of logit transformed outcomes and the Box-Tidwell test. Nonlinear covariates were added as factor variables in known risk categories as per the NELA risk score publication(NELA Project Team, 2023). This was to aid in the clinical interpretation of the results (as polynomials are difficult to interpret). To analyse binary outcomes, we used a Firth's logistic regression model. This was chosen to overcome the model being compromised by perfect separation. Length of stay was analysed using negative binomial regression with clustered standard errors. Binary outcomes are reported as odds ratios (OR) and length of stay as incident rate ratios (IRR). Estimates are reported with 95% confidence intervals (CIs) and p values. All analyses were conducted using Stata Version V17.0.

Results

We identified 3744 cases of emergency laparotomy for IBD between December 2013 and November 2016 in England and Wales. The patient characteristics by operating surgeon specialty interest are displayed in Table 14. When divided into cohorts according to clinical urgency, the largest group is those requiring surgery within 18-24 hours, the lowest urgency. There is an upward trend in incidence of contamination and perforation as an intraoperative finding, as clinical urgency increases (Table 15).

In general, in-patient mortality rate was higher when the patient was operated on by a non-colorectal surgeon in all urgency cohorts except 6-18 hours. After adjusting for confounding factors, this reached statistical significance for the IBD cohort in the least urgent category of 18-24 hours with a mortality rate for colorectal surgeons of 1.4% and non-colorectal surgeons of 4.8% (adjusted OR 2.9, 95% CI 1.2 to 7.8, $P = 0.025$). This is also true of the least urgent CD cases where the mortality for colorectal surgeons was 0.9% and non-colorectal surgeons 4.1% (adjusted OR 5.39, 95% CI 1.3-21.7, $p=0.017$). This increased mortality is not seen in more urgent cases of IBD, UC or CD cohorts (Table 16-18). However, imprecision was observed in the UC mortality analysis is due to low numbers.

There was an upward trend in post-operative length of stay in patients operated on by non-colorectal surgeons in comparison to colorectal surgeons in almost all cohorts. In IBD patients this reached statistical significance in the least urgent cohort with a median post-operative length of stay for colorectal surgeons of 8.9 days in comparison to 10.1 days for non-colorectal surgeons (adjusted IRR 1.2, 95% CI 1.02 to 1.36, $P = 0.025$). This difference is also seen in the least urgent UC cohort where the post-operative length of stay increases from 9.8 days

for colorectal surgeons to 13.1 days for non colorectal surgeons (adjusted IRR 1.4 95% CI 1.2-1.6, $P<0.001$). We observed no difference in post-operative length of stay for the CD cohorts between colorectal and non-colorectal surgeons.

After adjusting for urgency of operation in regression analysis, more patients operated on by a colorectal surgeon underwent MIS, in comparison to those operated on by a non-colorectal surgeon; In IBD 19.4% MIS when operated on by a colorectal surgeon in comparison to 6.6% when operated on by a non-colorectal general surgeon (adjusted OR 3.06, 95% CI 2.3 to 4.1, $P<0.001$). In UC 31.2% MIS when operated on by a colorectal surgeon in comparison to 8.5% when operated on by a non-colorectal general surgeon (adjusted OR 4.6, 95% CI 2.9 to 7.4, $P<0.001$) and in CD 12.3% MIS when operated on by a colorectal surgeon in comparison to 5.6% when operated on by a non-colorectal general surgeon (adjusted OR 2.03, 95% CI 1.4 to 2.9, $P<0.001$). When adjusting for confounding variables, there was no association between MIS and mortality. There was however a significant association between MIS and postoperative length of stay (LOS) in the least urgent IBD, UC and CD cases; For IBD, LOS after MIS was 7 days in comparison to LOS after open surgery of 9.8 days (adjusted IRR 1.3, 95% CI 1.1-1.4, $P<0.001$). In UC, LOS after MIS was 7.9 days in comparison to LOS after open surgery of 10.9 days (adjusted IRR 1.3, 95% CI 1.1-1.5, $P<0.001$). In CD, LOS after MIS was 6.1 days in comparison to LOS after open surgery of 8.9 days (adjusted IRR 1.2, 95% CI 1.04-1.5, $P=0.02$). This association between MIS and post-operative LOS was not seen in the more urgent cases (Table 19-21)

		UC		CD		IBD	
		Colorectal	Non-Colorectal	Colorectal	Non-Colorectal	Colorectal	Non-Colorectal
Number (n)		909	271	1569	581	2478	852
Age (median[IQR])		43 (29-59)	51 (34-58)	39 (27-57)	42 (29-58)	40 (27-57)	44 (30-61)
Male		494 (54)	159 (59)	786 (50)	292 (50)	1280 (51.7)	451 (52.9)
ASA	1	42 (4.6)	13 (4.8)	132 (8.4)	55 (9.6)	174 (7.0)	68 (8.0)
	2	465 (51.2)	121 (44.6)	876 (55.8)	329 (57.7)	1341 (54.1)	450 (52.8)
	3	349 (38.4)	104 (38.4)	500 (31.9)	145 (25.4)	849 (34.3)	249 (29.2)
	4	50 (5.5)	32 (11.8)	55 (3.5)	40 (7)	105 (4.2)	72 (8.5)
	5	3 (0.3)	1 (0.4)	6 (0.4)	1 (0.2)	9 (0.4)	2 (0.2)
P-POSSUM predicted mortality (median [IQR])		3.9 (2-7.4)	5.3 (2.9-14.6)	3.1 (1.5-6.8)	3.3 (1.7-6.9)	3.2 (1.7-6.6)	3.8 (1.8-7.9)
Urgency	< 2 hours	88 (9.7)	34 (12.5)	125 (8.0)	67 (11.6)	213 (8.6)	101 (11.9)
	2-6 hours	159 (17.5)	74 (27.3)	320 (20.4)	167 (28.9)	479 (19.3)	241 (28.3)

	6-18 hours	240 (26.5)	79 (29.2)	514 (32.8)	192 (33.3)	754 (30.4)	271 (31.8)
	18-24 hours	419 (46.2)	84 (31.0)	606 (38.7)	151 (26.2)	1025 (41.4)	235 (27.6)
Minimally invasive surgery		277 (30.5)	22 (8)	187 (11.9)	33 (5.7)	455 (19.4)	53 (6.6)

Table 14. Characteristics of patients having emergency laparotomy according to IBD subtype and operating surgeon specialty interest. Values in parenthesis represent percentages unless otherwise stated.

		UC				CD				IBD			
		<2 hours	2-6 hours	6-18 hours	18-24 hours	<2 hours	2-6 hours	6-18 hours	18-24 hours	<2 hours	2-6 hours	6-18 hours	18-24 hours
N		123	248	337	546	205	504	776	802	328	752	1113	1348
Contamination	Localised	18 (14.6)	44 (17.7)	28 (8.3)	30 (5.5)	43 (20.9)	147 (29.2)	187 (24.1)	169 (21.1)	61 (18.6)	191 (25.4)	215 (19.3)	199 (14.7)
	Generalised	23 (18.7)	54 (21.8)	17 (5.1)	15 (2.8)	64 (31.2)	137 (27.2)	64 (8.3)	22 (2.7)	87 (26.5)	191 (25.4)	81 (7.3)	37 (2.7)
Intra-operative finding of perforation		28 (22.8)	70 (28.2)	31 (9.2)	24 (4.4)	73 (35.6)	182 (36.1)	116 (14.9)	68 (8.5)	101 (30.8)	252 (33.5)	147 (13.2)	92 (6.8)

Table 15. The number of emergency laparotomies for each clinical urgency in UC, CD and IBD, with the associated incidence of intraoperative findings of peritoneal contamination and perforation. Values in parenthesis are percentages.

	IBD															
	< 2 hours				2-6 hours				6-18 hours				18-24 hours			
	Colorectal	Non-Colorectal	Adjusted OR / IRR	P	Colorectal	Non-Colorectal	Adjusted OR/IRR	P	Colorectal	Non-Colorectal	Adjusted OR / IRR	P	Colorectal	Non-Colorectal	Adjusted OR / IRR	P
In Hospital Mortality (%)	8.2	9.5	1.2 (0.3-4.9)	0.83	5.9	10.1	1.2 (0.5-2.9)	0.59	2.6	1.5	0.6 (0.2-1.9)	0.38	1.4	4.8	2.9 (1.2-7.8)	0.025
Median post op length of stay (Days)	11.1	13.6	0.9 (0.8-1.3)	0.81	11.1	12.4	0.9 (0.8-1.1)	0.31	9.1	10.1	0.99 (0.9-1.1)	0.79	8.9	10.1	1.2 (1.0-1.4)	0.025

Table 16. Firth logistic regression and negative binomial regression showing the difference in outcome between colorectal and non-colorectal surgeon for each urgency group in patients with IBD. Values in parenthesis are 95% confidence intervals.

	CD															
	< 2 hours				2-6 hours				6-18 hours				18-24 hours			
	Colorectal	Non- Colorectal	Adjusted OR / IRR	P	Colorectal	Non- Colorectal	Adjusted OR/IRR	P	Colorectal	Non- Colorectal	Adjusted OR / IRR	P	Colorectal	Non- Colorectal	Adjusted OR / IRR	P
In Hospital Mortality (%)	8.8	6.2	0.27 (0.02-2.5)	0.26	3.9	6.1	1.18 (0.2-5.6)	0.83	2.7	1.6	1.33 (0.3-4.5)	0.65	0.9	4.1	5.39 (1.3-21.7)	0.017
Median post op length of stay (Days)	10.9	11.7	0.99 (0.7-1.3)	0.91	10.7	10.1	0.97 (0.8-1.1)	0.73	8.9	9.1	0.92 (0.8-1)	0.11	8.6	8.9	1.04 (0.8-1.3)	0.73

Table 17. Firth logistic regression and negative binomial regression showing the difference in outcome between colorectal and non-colorectal surgeon for each urgency group in patients with CD. Values in parenthesis are 95% confidence intervals.

	UC															
	< 2 hours				2-6 hours				6-18 hours				18-24 hours			
	Colorectal	Non-Colorectal	Adjusted OR / IRR	P	Colorectal	Non-Colorectal	Adjusted OR/IRR	P	Colorectal	Non-Colorectal	Adjusted OR / IRR	P	Colorectal	Non-Colorectal	Adjusted OR / IRR	P
In Hospital Mortality (%)	7.4	16.7	1.79 (0.2-14.3)	0.58	9.9	18.9	0.89 (0.3-2.8)	0.84	2.6	1.3	0.89 (0.1-13.6)	0.93	2.2	6.1	2.37 (0.4-15)	0.36
Median post op length of stay (Days)	11.8	17.8	1.21(0.8-1.7)	0.24	12.9	16.8	0.85 (0.7-1)	0.11	9.9	14.1	1.1 (0.9-1.4)	0.19	9.8	13.1	1.4 (1.2-1.6)	<0.001

Table 18. Firth logistic regression and negative binomial regression showing the difference in outcome between colorectal and non-colorectal surgeon for each urgency group in patients with UC. Values in parenthesis are 95% confidence intervals.

	IBD															
	< 2 hours				2-6 hours				6-18 hours				18-24 hours			
	MIS	Open	Adjusted OR / IRR	P	MIS	Open	Adjusted OR/IRR	P	MIS	Open	Adjusted OR / IRR	P	MIS	Open	Adjusted OR / IRR	P
Median post op length of stay (Days)	9.9	12.0	0.7 (0.5- 1.1)	0.09	8.0	11.8	1.1 (0.9- 1.4)	0.31	7.9	9.9	1.1 (0.9- 1.2)	0.26	7	9.8	1.3 (1.1- 1.4)	<0.001

Table 19. Negative binomial regression showing the difference in median post-operative length of stay between MIS and open surgery in each urgency group of patients with IBD. Values in parenthesis are 95% confidence intervals.

	CD															
	< 2 hours				2-6 hours				6-18 hours				18-24 hours			
	MIS	Open	Adjusted OR / IRR	P	MIS	Open	Adjusted OR/IRR	P	MIS	Open	Adjusted OR / IRR	P	MIS	Open	Adjusted OR / IRR	P
Median post op length of stay (Days)	9.9	11.6	0.8 (0.5-1.2)	0.33	9.9	10.6	0.9 (0.6-1.3)	0.63	7.1	9.1	1.1 (0.9-1.3)	0.62	6.1	8.9	1.2 (1.04-1.5)	0.02

Table 20. Negative binomial regression showing the difference in median post-operative length of stay between MIS and open surgery in each urgency group of patients with CD. Values in parenthesis are 95% confidence intervals.

	UC															
	< 2 hours				2-6 hours				6-18 hours				18-24 hours			
	MIS	Open	Adjusted OR / IRR	P	MIS	Open	Adjusted OR/IRR	P	MIS	Open	Adjusted OR / IRR	P	MIS	Open	Adjusted OR / IRR	P
Median post op length of stay (Days)	9.4	15.1	0.7 (0.5-1.2)	0.20	7.5	15.7	1.4 (1.1-1.9)	0.007	8.9	11.8	1.2 (0.9-1.4)	0.08	7.9	10.9	1.3 (1.1-1.5)	<0.001

Table 21. Negative binomial regression showing the difference in median post-operative length of stay between MIS and open surgery in each urgency group of patients with UC. Values in parenthesis are 95% confidence intervals

Discussion

This study builds on previous work done in this important area of emergency surgery. Boyd-Carson et al found that an emergency laparotomy performed by a surgeon whose elective special interest is not in the area of the pathology, is associated with significantly increased mortality (Boyd-Carson et al., 2019). This supported the work done by Biondo et al in colorectal patients (Biondo et al., n.d.). However, in 2021 MacFarlane et al found no significant difference in outcome in IBD patients operated on by colorectal surgeons in comparison to non-colorectal surgeons (MacFarlane et al., 2021). That study reported on a broad range of pre-operative factors using hospital episode statistics data which they acknowledge as being limited in a number of ways. This is the first analysis of emergency laparotomy for all patients with inflammatory bowel disease taken from NELA, the largest prospectively maintained database of laparotomy patients in England and Wales. As a result of this large data set, we are able to build on the previous work in this area with a higher level of data granularity. This allowed us to perform subgroup analysis on CD and UC as separate cohorts and look at each clinical urgency independently.

When sub-dividing cases by clinical urgency, we can see the majority fall into the least urgent category. In the published literature, this 18 to 24-hour urgency is a grey area, often classified as urgent, or expedited. Our data shows that this cohort has a relatively low incidence of perforation and peritoneal contamination in comparison to the other urgency categories. These patients may have had a trial of medical management before proceeding to surgery and could be considered 'semi-elective'. They may have been discussed in the IBD multi-disciplinary team meeting (MDT) and had more extensive pre-operative optimisation. In this group, our data shows a significant difference in outcome for patients operated on by a

colorectal surgeon in comparison to a non-colorectal surgeon for both mortality and postoperative length of stay.

It is possible that this reflects peri-operative decision making; colorectal surgeons are more likely to be part of the IBD MDT, have closer working relationships with luminal gastroenterology colleagues and more familiar with the pre and postoperative management of IBD. Another consideration is the role of MIS. Multiple cohort studies have shown benefit in IBD emergencies and our data agrees that there is a benefit to length of stay (Udholm et al., 2021). In our data, this benefit is most significant in the least urgent cohort. We have also demonstrated that colorectal surgeons are significantly more likely to use MIS in IBD emergencies. It may be that the LACES trial will inform further on this (Harji et al., 2020).

Another significant finding is the data showed no difference in outcome according to the operating surgeon in more urgent IBD emergencies, that is surgery required within 18 hours. Table 16 demonstrates the increase in incidence of perforation and contamination in these more urgent IBD cases. A previous study has demonstrated a 6% increase in risk of death per hour delay in source control after a perforated peptic ulcer (Boyd-Carson et al., 2020). Other cohort studies have demonstrated a similar relationship between delays to theatre and outcome in IBD patients (King et al., 2020b; I. Leeds et al., 2018a; I. L. Leeds et al., 2017; Mclean et al., 2015). The likely reason for our observed lack of surgeon specific effect on outcomes in more urgent patients is because the priority in sepsis is source control rather than IBD specific management. This aligns with the 2021 Joint Colleges of Surgical Training (JCST) curriculum requirement that an emergency general surgeon must be able to perform the required surgical management of an acute abdomen (T. Cook et al., 2021).

Current guidelines for elective surgery in inflammatory bowel disease recommend a colorectal surgeon with an interest in IBD and use of MIS

whenever possible(Kapasi et al., 2020). There are, as yet, no such guidelines for emergency procedures in this patient group. Analysis of this NELA data suggests that similar recommendations to those that apply to elective patients, could apply to patients in the low urgency emergency setting. The findings from this analysis that a large number of IBD patients are 'non urgent' emergencies may also indicate a lack of elective colorectal operating lists available for IBD. Recommendations for increased availability of colorectal surgeons on call, or elective operating lists might be impractical for some trusts with limited numbers of surgeons providing emergency care.

To capture clinical urgency, we have used the target time for the patient arrive in theatre which is reflected in the booking urgency. The recommendation by NCEPOD is that the consultant in charge of the care of that patient should decide the booking urgency and it should reflect their clinical condition, we accept that this may be subject to bias (National Confidential Enquiry Into Patient Outcome And Death, n.d.)n the booking urgency. Actual measured time taken to arrive in theatre could also be used however is affected by organisational limitations so may not accurately reflect the patient's clinical condition.

Conclusion

Emergency laparotomy for IBD where there is less clinical urgency is associated with decreased mortality and length of stay when performed by a colorectal surgeon in comparison to a non-colorectal general surgeon. Where there is greater clinical urgency, there is little benefit of MIS or a colorectal surgeon above a non-colorectal general surgeon. This may have significant implications for how emergency IBD cases are classified and how emergency general surgery departments are structured.

6. Timeliness in Emergency Abdominal Surgery for Inflammatory Bowel Disease

Chapter focus

This chapter makes use of data from NELA and NCEPOD and explores factors which may contribute to delays in the decision to operate. This study highlights how patients with IBD face delays in their care and in sepsis management in comparison to the general surgery population.

Abstract

Introduction

Patients who have emergency abdominal surgery for IBD wait significantly longer than patients without IBD for the decision to operate to be made. This is also observed in the most urgent cases. Whilst some patients have an appropriate period of non-operative management, this delay in the decision to operate may represent a significant area for improvement in patient care. This chapter aims to investigate the factors associated with delays in the decision to operate for patients with Crohn's disease using data from NELA and NCEPOD.

Methods

Complete patient data from NELA, including histology, was available between 2013-2016. Patients with a clinical urgency of less than 18 hours were included to reduce the number with deliberate periods of non-operative management. Data from the 2023 NCEPOD report into surgical management of Crohn's disease was sampled from between September 2019 and February 2021. Regression analysis was used to identify factors associated with delays in the decision to operate.

Results

After adjusting for confounders, factors associated with significantly increased time for the decision to operate to be made were being admitted under a gastroenterologist (IRR 5.05), or any medical speciality (IRR 4.05), pre-operative anaemia (IRR 1.87) or increasing ASA grade (IRR range of 2.4 – 9.1), and the operating surgeon being a colorectal specialist (IRR 1.39). Patients who presented with sepsis waited a median 30 hours for the decision to operate to be made.

Discussion

These data highlight areas of potential improvement in the surgical management of IBD emergencies. Patients admitted under the care of medical consultants should have equal access to senior surgical decision makers as those admitted under the surgical consultants. This study also identifies potential deficiencies in the care patients who require surgical source control for sepsis.

Introduction

In 2023 the National Confidential Enquiry into Patient Outcomes and Death (NCEPOD) published 'Making the Cut?', a report investigating the care of patients having abdominal surgery for Crohn's disease in the UK (Aleboyeh et al., 2023). The major findings in the report are that there are delays in patients receiving elective operations for Crohn's disease which result in them having emergency surgery instead. Whilst much of the focus of the report is on elective patients, the reviewers note delays in the decision to operate in the emergency context. They cite irrelevant investigations and inappropriate medical treatment as potential causes for these delays. There was also an almost equal distribution of emergency patients being admitted under surgical and medical gastroenterology consultants. A key message of the report is that surgery should not be considered a failure of medical management and that it should be undertaken sooner.

Analysis of the NELA database carried out in previous chapters of this thesis has shown delays in the decision to operate even in the most urgent cases of inflammatory bowel disease. Patients with Crohn's disease who were considered to need an operation within 2 hours, with an almost 50% rate of faecal peritoneal contamination, have been shown to wait over 17 hours from admission to arrival in theatre. By comparison, when considering all emergency laparotomy cases recorded by NELA presenting with peritonitis, the median time from admission to arrival in theatre was 8 hours (Fourth Patient Report of the National Emergency Laparotomy Audit (NELA), 2016). Most of this delay for both Crohn's disease patients and the undifferentiated NELA cohort occurs before the decision to operate has been made. Early surgical intervention has been shown to be associated with improved post-operative outcomes in ulcerative colitis and analysis of NELA data has shown the significant increase in mortality with delayed surgery in perforated

duodenal ulcers (Boyd-Carson et al., 2020; I. Leeds et al., 2018b; Randall et al., 2010).

Non-discriminatory access to healthcare is a component of the United Nations Sustainable Development Goals and the timing of surgery in Crohn's disease has been raised as a research priority by the James Lind Alliance. This study aims to investigate the predictors of delays in the decision to operate in patients having emergency surgery for Crohn's disease using data from both NELA and NCEPODs report on Crohn's disease.

Methods

The 2023 NCEPOD report titled 'Making the Cut' was written using data sampled between 1st September 2019 and 28th February 2021 from NHS hospitals in England, Wales and Northern Ireland. For this secondary analysis the data were limited to patients having emergency surgery.

JB as a member of the NELA project team applied for access to the pseudo-anonymised data via an extended output request authorised by HQIP. For this analysis, patients with Crohn's disease recorded in the histology domain were extracted from the database. The primary operation during an admission was included, patients returning to theatre for a complication were excluded. Complete data were available between 2013 – 2016, after which histology data was not available.

For both NCEPOD and NELA cohorts, an emergency operation was defined as any non-elective surgery, including expedited, urgent, and immediate surgeries as per the NCEPOD classification of interventions (Cullinane, 2003). In the NELA cohort these are given a target time for the patient to arrive in theatre by the responsible consultant upon booking the patient for surgery. Patients considered to need an operation in greater than 18 hours were excluded to reduce the confounding effect of an appropriate trial of non-operative management.

The time taken to make the decision to operate is the primary outcome measure and is defined as the time from admission to hospital to the time the patient was booked for an operation, or where booking data were unavailable the time the patient was consented for an operation. Time from admission to the decision to operate is presented as a median with interquartile range (IQR).

Confounding factors were decided a priori and included in multivariable negative binomial regression to predict increased time for the decision to

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operate. Variables included in statistical analysis of NCEPOD data are patient sex, admitting specialty, patient age, frailty, use of preoperative steroids, indication for surgery and elective specialist interest of operating surgeon (colorectal or not). Variables included in statistical analysis of NELA data are patient sex, patient age, patient ASA grade, serum white cell count, serum haemoglobin, predicted peritoneal soiling, heart rate, clinical urgency and the elective specialist interest of the operating surgeon (colorectal or not). C-reactive protein and lactate were not included due to large amounts of missing data. Continuous data for haemoglobin and serum white cell count were categorised to aid clinical interpretation. Clinical frailty score was condensed into three categories due to low numbers. Predictors of increased time for the decision to operate are presented as incident rate ratios (IRR) with 95% confidence intervals and significance set at $p < 0.05$. All statistical analyses were conducted using Stata version 18.0.

Results

The NELA database contains complete data for 1041 patients with Crohn's disease who had emergency surgery between 2013 and 2016. The median time from admission to the decision to operate for all included patients was 31.5 hours (IQR 13.5 – 93.4). Table 22 shows the variation in the time taken to make the decision to operate according to the categorical variables and the results of multivariable negative binomial regression analysis. Patient age was modelled as a continuous variable and increasing age showed a very small but statistically significant association with decreased time to make the decision to operate (IRR 0.99, CI 0.98 - 0.99, P=0.01).

NELA data		N	Time from admission to the decision to operate in hours (median [IQR])	Multivariable negative binomial regression
Sex	Male	535	26.2 (11.5 – 85.5)	
	Female	506	37.5 (16.0 – 99.3)	IRR 1.1, CI 0.94-1.28, P=0.24
ASA grade	1	114	16.2 (7.2 – 26.3)	
	2	558	34.9 (14.0 – 83.0)	IRR 2.4, CI 1.87-3.1, P<0.001
	3	305	41.0 (16.0 – 146.9)	IRR 4.6, CI 3.44-6.02, P<0.001
	4	59	55.8 (9.2 – 237.9)	IRR 9.1, CI 6.03-13.67, P<0.001
	5	5	161.0 (19.0 – 170.4)	IRR 6.02, CI 2.03-17.81, P=0.001
Degree of anaemia	None / mild	689	22.9 (11.2 – 65.0)	
	Moderate	328	63.2 (21.9 – 160.3)	IRR 1.87, CI 1.59-2.21, P<0.001
	Severe	24	69.8 (31.1 – 214.0)	IRR 1.98, CI 1.21-3.23, P=0.007
Serum White cell count	Normal	468	42.5 (16.6 – 114.4)	
	High	547	23.8 (11.0 – 73.2)	IRR 0.87, CI 0.75-1.02, P=0.09
	None	366	44.0 (16.5 – 113.7)	

Predicted Soiling	Serous fluid	275	33.6 (16.0 – 96.3)	IRR 0.74, CI 0.61-0.89, P=0.002
	Localised pus	227	23.8 (12.0-64.3)	IRR 0.68, CI 0.55-0.83, P<0.001
	Free bowel contents, blood or pus	173	16.9 (7.4 – 89.9)	IRR 0.57, CI 0.45-0.82, P<0.001
Operating surgeon	Colorectal	711	36.1 (15.0-100.0)	IRR 1.39, CI 1.18-1.63, P<0.001
	Non colorectal general	330	25.9 (10.8 – 69.0)	

Table 22. National Emergency Laparotomy Audit data showing the factors affecting the time taken to make the decision to operate. Multivariable negative binomial regression was used to compare how long it took to make the decision to operate in comparison to the base value shown as blank. $p<0.05$ is considered to be statistically significant.

Complete data were available for 67 patients who had emergency surgery for Crohn's disease between 2019 and 2021, within the NCEPOD database. The median time from admission to the decision to operate for all patients is 29.1 hours (IQR 12.5-115.3. Table 23 shows the variation in the time taken to make the decision to operate according to the categorical variables and the results of multivariable negative binomial regression analysis. Patient age is modelled as a continuous variable and increasing age showed no statistically significant association with the time taken to make the decision to operate (IRR 0.99, CI 0.98 – 1.01, P=0.88). Patients presenting with sepsis waited a median 30.1 hours for the decision to operate (IQR 14.5-119).

NCEPOD		N	Time from admission to the decision to operate in hours (median [IQR])	Multivariable negative binomial regression
Sex	Male	29	25.5 (16.5-68.8)	
	Female	38	30.3 (10.7-125.2)	IRR 0.82, CI 0.47-1.42, P=0.48
Functional status	Fit or well	50	25.1 (14.5-78.7)	
	Vulnerable	8	88.4 (32.7-153.6)	IRR 1.34, CI 0.64-2.84, P=0.44
	Frail	9	41.0 (6.4-214.5)	IRR 0.82, CI 0.33-2.03, P=0.67
Admitting specialty	General surgery	44	20.7 (6.3-42.6)	
	Gastroenterology	13	129.3 (52.8-214.5)	IRR 5.05, CI 2.37–10.77, P<0.001
	Other medical specialty	9	115.3 (93.6-213.8)	IRR 4.05, CI 1.67-9.84, P=0.002
Preoperative systemic steroids	Yes	19	20.2 (6.4-141.3)	IRR 1.13, CI 0.32–2.05, P=0.69
	No	48	29.6 (17.9 – 105.6)	
Indication for surgery	Obstruction	29	34.8 (10.7-115.3)	IRR 0.81, CI 0.43-1.54, P=0.53
	Perforation	16	18.8 (8.0-25.1)	IRR 0.52, CI 0.25-1.07, P=0.07

	Colitis	7	125.2 (17.3-214.5)	IRR 0.58, CI 0.18-1.92, P=0.38
Operating surgeon	Colorectal	51	36.1 (16.5-125.2)	IRR 1.41, CI 0.78-2.55, P=0.26
	Non colorectal general	16	23.9 (5.2-41.7)	

Table 23. National Confidential Enquiry into Patient Outcomes and Death data showing the factors affecting the time taken to make the decision to operate. Multivariable negative binomial regression was used to compare how long it took to make the decision to operate in comparison to the base value shown as blank. $p < 0.05$ is considered to be statistically significant.

Discussion

This chapter presents data describing the factors associated with delays in the decision to operate in patients presenting as an emergency with Crohn's disease. This is the first time data from NCEPOD and NELA have been presented together and provides new insights into the decision making for this underrepresented cohort of patients. There is an inherent bias in a retrospective cohort study investigating the time taken to decide to operate when all included patients ended up having surgery. The point of this study is not to conclude that any one patient should have had a faster journey to surgery, but to highlight factors consistently associated with a longer time to make the decision to operate in order to aid service improvement. This report comes at an important time in the discussion regarding timeliness, and presents the nuances of patients presenting for emergency surgery for Crohn's disease.

After presentation to hospital, patients are admitted to the most appropriate specialty to investigate and manage their condition. These data show patients being admitted under the care of gastroenterologist or other medical specialties wait 4-5 times longer for the decision to operate in comparison to those admitted under the care of a general surgeon. This is adjusted for presentation, use of preoperative steroids, patient sex and frailty. There are several possible reasons for this delay; it may suggest a delay in senior surgical review for patients under the care of medical consultants but it may also represent an appropriate period of conservative management. There are possible explanations in the NCEPOD report 'Making the Cut', as the reviewers note inappropriate investigation or conservative management and how surgery should not be considered a failure of medical management (Aleboyeh et al., 2023). This negative view of surgery may be reflected in the delays encountered by patients admitted under medical specialties. Ultimately, we are not able to deduce the cause from these data.

These data also show patients wait longer for the decision to operate when the operating surgeon is a colorectal specialist. The lack of statistical significance in the NCEPOD data in this area may be due to low numbers. IBDUK guidelines for the surgical management of Crohn's recommends the operating surgeon to be a colorectal specialist and a member of the IBD MDT (IBD UK, n.d.). Some larger centres are able to staff specialist colorectal emergency services, however smaller hospitals in the UK run an unfiltered emergency general surgery service reliant on colorectal and non colorectal general surgeons. Several studies have investigated the impact of the specialist interest of the operating surgeon on outcomes. Analysis performed in chapter five of this thesis suggest the decision to delay surgery to wait for colorectal expertise may be appropriate only in least urgent cases. In more urgent cases, and where sepsis source control is required, the delay may be inappropriate (Bunce, Doleman, et al., 2023).

This study highlights possible delays in the surgical management of sepsis in this cohort. The Royal College of Surgeons of England High Risk Surgical Patient recommends a target time of 6 hours for sepsis source control (The High-Risk General Surgical Patient: Raising the Standard, n.d.). The median time from admission to the decision to operate in the NCEPOD cohort is 30 hours. This is supported by work done in chapter four of this thesis where cases considered clinically very urgent, with high rates of faecal contamination fail to trigger alert mechanisms on the National Early Warning Score (Indd, 2017).

The delays in the decision to operate seen in patients with an increased ASA grade and moderate or severe anaemia may be as a result of appropriate pre-optimisation, for example red blood cell transfusion. There is very limited evidence of the risks of preoperative anaemia in these patients. The single study identified in chapter three of this thesis suggests preoperative anaemia does not confer a higher risk of post-operative complications in a UC cohort.

This study highlights the need for pre optimisation to be expedited when a

patient needs emergency surgery. It suggests there may be delays to patient care because of organisational inefficiencies.

There is an apparent sex discrepancy in the time taken for the decision to operate in both NCEPOD and NELA data. In the NCEPOD data women wait nearly 5 hours longer than men, and in NELA data over 11 hours longer than men. However, on multivariable analysis this difference is not statistically significant. In NCEPOD data women are more likely than men to be admitted under gastroenterology or other medical specialties. In NELA data Women are more likely to present with a moderate to severe anaemia, and less a severe degree of predicted soiling, and are slightly more likely to be operated on by non colorectal specialist surgeons in comparison to male patients. The difference in emergency presentation for Crohn's disease between male and female sexes would be a valuable future study.

Conclusions

This chapter supports the recommendations made by NCEPOD for co-ordinated care between surgeons and gastroenterologist and for local trusts to support the multidisciplinary team process. The data suggest that patients with Crohn's disease need careful consideration in the discussion around timeliness, especially with regards to recognition of sepsis and timely, senior, specialist review.

Conclusions

This thesis shows that patients having emergency abdominal surgery for IBD should not be treated as a single undifferentiated cohort. The findings demonstrate how clinical urgency should be a key factor when considering risk stratification, service provision and reporting of cohort studies in published literature.

The scoping review of existing studies uncovered inconsistencies in how an emergency operation is defined in IBD patients making meaningful risk prediction difficult. This is despite current available guidelines for cohort studies. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines were published in 2007 to provide a framework for authors and promote consistency in published cohort studies (von Elm et al., 2007a). These guidelines aren't specific to surgery and include general recommendations for authors to give characteristics of study participants. In most instances, whether an operation is an emergency or planned is easily defined by the indication for surgery. For example, bowel obstruction presents as an emergency and rarely has more than two or three of days of conservative management before proceeding to surgery. A cohort of patients with bowel obstruction could be safely assumed to have been operated on as an emergency. IBD however can present with the full spectrum of indications for surgery and can be managed as a wide range of clinical urgencies.

As a result of my scoping review and subsequent analysis of NELA data, this thesis has set out a clear argument that current estimates of risk in emergency surgery for IBD are so generalised as to be inaccurate and of limited use in counselling, consent and service delivery. Throughout this thesis it is increasingly clear that clinical urgency matters. Firstly, the high risk of mortality in this relatively young cohort should draw attention to IBD patients. Whilst improvements in patient care, and especially timeliness, may drive down mortality rates the question remains of whether a patient requiring a

high urgency laparotomy for IBD is a failing of primary and secondary care. High mortality rates in the most urgent cases should drive us to try and avoid urgent surgery if at all possible; either by operating sooner before the patient deteriorates, or by employing conservative measures to manage the acute IBD flare.

Descriptive analysis of NELA data shows a concerning large number of patients having abdominal surgery for IBD with an urgency code of less than 18 hours. This thesis should make service providers ask the question why? And what can be done to avoid this level of clinical urgency in a chronic condition? The NCEPOD report “making the cut” identified areas for improvement in that a significant number of patients having emergency surgery were on waiting lists for elective surgery(Aleboyeh et al., 2023). IBDUK standards advocate several components of IBD patient care including dietician input(IBD UK, n.d.). Many smaller centres may not have access to dieticians and specialist members of the IBD MDT seven days a week. The result may be that patients presenting out of normal working hours do not have the same opportunity to explore conservative measures. Exclusive enteral nutrition, specialist medical therapies, per-cutaneous drainage by interventional radiology, and endoscopic stents are examples of therapies with limited availability out of normal working hours in some smaller centres in the UK. The IBD UK guidelines suggest these patients are managed in a tertiary centre by members of the IBD MDT(IBD UK, n.d.). It would be interesting to know the distribution of urgent operations for IBD across the UK comparing organisational structure and service provision. This would be a valuable area of future study.

A recurrent theme in this thesis is the role of colorectal expertise in the surgical management of IBD. In 2019 Boyd-Carson et al published evidence from NELA data that a patient’s outcomes are worse if the emergency operation performed is outside of that of the operating consultant’s elective specialist interest (Boyd-Carson et al., 2019). In 2020 MacFarlane et al

published evidence from HES data that this same principle may not apply to patients having emergency surgery for IBD (MacFarlane et al., 2021). Their analysis was not specific to CD or UC and did not take into consideration clinical urgency. IBDUK standards state that patients having elective surgery for IBD should have their operation performed by a colorectal surgeon who is a member of the IBD multidisciplinary team (IBD UK, n.d.). Such guidelines do not exist for IBD emergency surgery. Chapter five demonstrates the importance of clinical urgency when considering the risk stratification for emergency surgery in IBD. We have demonstrated that in the least urgent cohort of patients, minimally invasive surgery and elective specialist interest of the operating surgeon are important considerations.

This thesis shows how the least urgent cohort of UC and CD patients have a similar risk profile to the elective population. They could be considered semi-elective rather than emergency. It is not surprising that they are the population who would benefit from colorectal expertise. They are more likely to have a longer preoperative inpatient stay where preoptimization and surgical planning have more of an influence on outcome. Colorectal and IBD MDT input here may be more valuable than in the more urgent cases and this may explain the findings in chapter five. This paper advocates for a semi-elective colorectal operating list so that these emergency patients can be operated on in a timely manner by specialist colorectal surgeons.

Analysis of timeliness data showed how patients wait longer for the decision to operate when that surgery is performed by a colorectal surgeon. This is even in the most urgent cases, and despite there being little difference in the outcomes measured in this thesis. Rather than suggest there is no role for colorectal expertise in the more urgent cases, this thesis raises the question of why patients are having their management of, in some cases generalised peritoneal soiling, delayed by waiting for a colorectal surgeon. This is especially true when patients are admitted under the care of medical specialties. This speaks to the organisational structure, and inter-

departmental relationships of centres across the UK. Improving this aspect of patient care means identifying and removing the barriers to timely colorectal input in these patients.

In summary, this thesis presents evidence that we should not consider patients having emergency abdominal surgery for IBD one cohort either in terms of publishing cohort studies, reporting risk profiles and in considering risk stratification. It also promotes IBD patients as a nuanced group within the discussion around timeliness in emergency abdominal surgery.

It is clear from this thesis that there is a range of areas for future study on this topic. These include:

- Investigating the optimum timing for low urgency emergency operations.

The 2023 NCEPOD report on CD concludes that surgery should not be considered failure and should be sought out earlier in the patient treatment pathway. With sufficiently granular data, cohort studies could inform clinical decision making by predicting patients who proceed to surgery. Particularly those with bowel obstruction. This would require a database of emergency or unplanned admissions with patients who both do and don't proceed to surgery.

- Investigating differential presentations between male and female sexes, and how their management may differ.

This thesis provided some evidence that male and female patients with CD have different disease presentations. Degree of peritoneal soiling and degree of anaemia are two significant differences. Sex discrepancy is an important topic in surgery, and we must ensure that male and female patients receive unbiased treatment.

- The outcomes included in this thesis are limited, especially for a relatively young and medically fit cohort. Mortality, length of stay and return to theatre are important outcomes to measure but are relatively rare events in patients with IBD. There are other important outcomes to consider in this cohort, formation of stoma, return to enteral nutrition, future need for surgery, instances of adhesional bowel obstruction or incisional hernias for example. These may provide insights into the nuanced benefits of minimally invasive surgery or conclude that there are other factors which effect outcome which have not yet been considered. These outcomes should be included in future IBD specific surgical databases.

Limitations

The impact and analysis of data in this thesis is limited in several ways. Some of these are due to limitations in the data available for analysis. NELA case ascertainment is estimated at 80%, so this dataset is incomplete. This may increase bias as described in the general thesis methods. NCEPOD data included 198 patients who had emergency surgery, complete time series data was only available for 67 of these. This may have led to over or underestimation of outcomes. NELA data includes physiological and biochemical parameters available at the point of surgery. There are no time or dates included for when these blood tests were taken so may not reflect the patient's true physiology at the time of surgery. NELA does not include indications for surgery within the database so subgroup analysis according to indication was not possible. We were also unable to add other, potentially important confounders such as frailty and lactate because of missing data in the NELA database. After consultation with statistical advisors, non-linear predictors were added as factor variables using NELA defined cut offs for low, normal and high. This was chosen over transformed polynomials as it has easier clinical interpretation but can result in loss of information.

As mentioned in methods, NELA has only recorded histology data from 2013-2016 and do not report IBD – unclassified (IBD – U) as a separate cohort. There continues to be significant improvements in patient care and medical management of IBD, including monoclonal antibiotics. More contemporary data may more accurately represent the current patient cohort. Since 2016 there have been efforts to improve the surgical management of patients with IBD, for example the IBDUK guidelines. These may have had an impact on the emergency surgical care of patients with IBD but would not be captured within the NELA data used in this thesis.

As reported in the study chapters, patients having emergency surgery for IBD are often young. Death is fortunately a rare outcome. Outcomes such as stoma formation rate, readmission with late complications such as adhesional bowel obstruction, disease relapse, time taken to return to normal enteral diet and time taken to return to normal employment may be of more practical use.

Cohort studies are inherently challenging in IBD patients, this is especially true when considering clinical urgency and timeliness to theatre. As noted in the study chapters of this thesis patients with IBD may have an appropriate period of conservative management during their emergency admission before surgery is considered. There also may be a population who have an inappropriate period of attempted conservative management. Trying to distinguish these two cohorts in data is difficult and not always possible. Clinical urgency is determined at the time of the decision to operate; it does not necessarily reflect the inpatient stay up until that point. NELA data does not include admission characteristics or physiology and so the inferences that can be drawn from the data are limited.

The NELA dataset is not IBD specific. As a result, it does not include data on pre-operative medication such as steroids or monoclonal antibodies. There is no data on nutritional status, enteral or parenteral nutrition or psychological factors as per the IBD-UK standards, or organisational factors such as the presence of an IBD MDT. These are likely to be important variables to include in future analysis of this cohort.

This is a retrospective observational study, reporting associations. A randomised control trial would be required to report causation.

Appendices

National Emergency Laparotomy Audit Standards

Appendix 1: National Emergency Laparotomy Audit Standards

Workstream	Standard benchmarked by NELA
CT Scanning and Reporting	Proportion of patients requiring immediate surgery who had a CT scan that was reported by senior radiologist within one hour and communicated with the surgical team before surgery
Infection management	Proportion of patients with suspected infection or sepsis that have antibiotic administration within the correct clinical timeframe
Timeliness to theatre	Proportion of patients with an 'RCS immediate' pathology arriving in theatres within 6 hours of arrival at the hospital/ED
Risk Assessment	Proportion of patients in whom a risk assessment was documented preoperatively AND postoperatively
Consultant-delivered care	Proportion of high-risk patients (risk of death of $\geq 5\%$) with consultant surgeon and consultant anaesthetist present in theatre
Critical Care	Proportion of high-risk patients admitted directly to critical care postoperatively
Elderly Care	Proportion of patients aged 65 or older and frail, or aged 80 and older who receive postoperative assessment and management by a member of a perioperative team with expertise in comprehensive geriatric assessment (CGA)
	Proportion of patients aged 65 or older where a formal assessment of frailty was made
Data Quality/Completeness	Case Ascertainment
Outcomes	Mortality
	Length of stay

Healthcare Quality Improvement Partnership Extended Output Form

Appendix 2: Extended output approval form for chapters 4,5 and 6.

Extended output scope and decision template V1.4

(To be used in conjunction with the 'Decision Aid for Accessing and Publishing Data Commissioned by HQIP')

1. PROPOSAL OVERVIEW: please summarise:

- **Project title**
- **The question(s) to be investigated**
- **The dates for the relevant patient cohort being processed and the associated provider report publication date for that cohort**
- **The sources of data to be used:**
 - **Geographical i.e. England / Wales / other**
 - **From which dataset: i.e. audit dataset / HES / PEDW etc.**
 - **From which third party data provider: none / NHSD / NWIS / other NCA**
- **The methodology proposed**
- **The anticipated outputs and benefits**
- **The anticipated project completion date**

Proposal overview: **provider to complete:**

The Impact of the National Laparotomy Audit on the Surgical Management of Inflammatory Bowel Disease

Aim; This project will improve the quality and safety of the surgical experience for patients with Inflammatory Bowel Disease (IBD) by interrogating the National Emergency Laparotomy Audit (NELA) database with respect to IBD for the first time. There is disparity in the care patients receive between different hospitals in the UK, particularly with respect to the management of IBD which requires a coordinated multi-specialty approach. The majority of patients undergoing surgery for IBD do so as an emergency. The NELA database provides an opportunity to substantiate, or initiate, guidelines on factors affecting their outcome, with data capturing 85% of emergency laparotomies across the country.

The National Confidential Enquiry into Patient Outcome and Death (NCEPOD) has been commissioned by the Healthcare Quality Improvement Partnership to assess and maintain standards of care. The theme of the 2021 NCEPOD enquiry is surgery for IBD, and plan to publish outcomes in the last quarter of 2022. This project plans to capitalize on the appetite for changes to practice in IBD surgery, adding to the work done by NCEPOD in improving patients outcomes, with the following broad aims;

1. Discover areas for improvement in current practice.
2. Develop evidence based guidelines for the emergency surgical management of IBD.

In order to meet these aims, we will;

1. Perform subgroup analysis with regard to mortality, length of stay, complications and return to theatre.
2. Identify areas for improvement in patient pathway, building upon those identified by the 2022 NCEPOD report. Collaboration with NCEPOD will allow for the non surgical aspects of IBD management to be included. Collaboration would be in the form of using NCEPOD data and not sharing NELA data with them.
3. Identify significance in variables and process measures, between centers, which may predict outcome. Low numbers may preclude this level of analysis in order to prevent data from becoming identifiable.

We will disseminate the findings to the general surgical community and this will be written up as an academic paper and submitted to peer reviewed journals. Any findings from year 8 data would not be published until after the NELA report for that year.

Data sources: NELA data set (England and Wales), ONS linked data for mortality and HES linked data for IBD diagnosis if NELA data is inadequate.

Dates included: Years 1-8 of the audit (1 Dec 2013 – 30 Nov 2021); Year 7 of the report is to be published November 2021 and Year 8 expected November 2022. As noted above, no data from Year 8 will be published before the NELA report for that year.

Anticipated completion date: Early 2023

Additional Questions	Provider response
2. Is the purpose of the data processing <i>explicitly</i> included in the HQIP contract specification or tender response? If yes, provide evidence and go to question 4. If no go to question 3.	Yes/No, and if Yes then please provide rationale and detail (initialled and dated) No JB 31/08/2021
3. Is the purpose of the data processing <i>implicit</i> in the contract specification or tender response?	Yes/No, and if Yes then please provide rationale and detail (initialled and dated) Yes The Audit was designed to answer questions relating to short-term patient outcomes relating to inpatient morbidity/ complications and to investigate reasons for variation in outcomes: · "High incidence of adverse outcomes should promote shared decision making which should include discussion of individual risk, implications of critical care admission, alternative treatment options." · "Once identified, those factors in the delivery of care which are shown to reduce rates of morbidity and mortality in patients undergoing EL will be disseminated nationally and standards of care introduced. As a result of this audit and on-going Quality Improvement work, NELA seeks to standardise and continually improve the quality and components of care, reducing overall morbidity and mortality of subsequent patients undergoing EL in the UK" · "Looking forward, the NELA dataset provides a valuable resource to further investigate the relationship between process and outcome" Ref: Tender Documentation for NELA Part 5-Specification and NELA Section 251 Non-Research Application, (July 2013) JB 31/08/2021
4. Regarding the flows and processing locations of all record level data and / or aggregate data for this output which cannot be fully anonymised	☒ I confirm that the data flows and locations for the processing for this output exactly match the normal project pattern as reflected in the project's Data Flow Map? (initialled and dated) Yes. Data flow is the same as the normal project flow as per the NELA dataflow chart v 11. The only people who will be processing/analysing the data will be members of the NELA project team who are included within the NELA data flow chart. JB 31/08/2021
5. Regarding the legal basis, other information governance requirements and any requirements from third party data providers (e.g. NHS Digital, Public Health England, NWIS, other registries and audits)	☒ I confirm that all proposed processing activities have an established legal basis (e.g. within the NCAPOP project's S.251 application (research or non-research), fair processing information and / or consent materials and / or legal requirements outside England and Wales) ☒ I confirm that any proposed processing of data from a third party data controller is permitted under the agreement by which that data has been accessed JB 31/08/2021

Confirmation from the Provider project manager and clinical lead that the information provided is complete and accurate

Provider Project manager: Name.....Christie Taylor.....Signature..........Date...28/10/2021.....

Provider Clinical lead: Name.....Lyndsay Pearce.....Signature..........Date.....28 Sept 2021.....

HQIP position: one option only must be selected

I confirm HQIP's agreement that this proposal for extended analysis and output is approved and does not require HQIP DARG approval

The NCAPOP provider must speak with NCEPOD to ensure any collaboration is within current NCAPOP information governance remits and legal bases for both NCEPOD and NELA.

HQIP Associate director: Name...Mirek Skrypak.....Signature..........Date.....01 Nov 2021.....

National Confidential Enquiry into Patient Outcomes and Death Data Sharing Agreement

Appendix 3: Data sharing agreement for chapter 6.



Data Sharing Agreement

Once completed please return this signed form to mmason@ncepod.org.uk

All sections within this form are mandatory unless specifically stated otherwise.

PLEASE ONLY COMPLETE THIS FORM IF YOU AGREE TO THE FOLLOWING:

1. This is for the purpose of sharing data between NCEPOD and a partner organisation for the purpose of extended dissemination of a report already published by NCEPOD.
2. NCEPOD will be a partner organisation in the work and the NCEPOD team involved in the work will review all drafts of work submitted for publication and be named as authors on the work.
3. No data will be provided until the original NCEPOD report has been published.
4. Any data provided to the person named in this data sharing agreement so for their use only and must not be shared with any other party without consulting NCEPOD.
5. Data will only be provided in an anonymised, aggregated format.

SHOULD YOU REQUIRE ACCESS TO THE DATA WITHOUT NCEPOD'S INPUT, YO WILL NEED TO CONTACT HQIP – WWW.HQIP.ORG.UK

Section 1	Primary applicant information			
Title of project	The Emergency Surgical Management of Crohn's Disease			
Name of primary applicant organisation	James Bunce Royal Derby Hospital			
Name of any partner organisation (s) if applicable <i>(ensure partner form also completed)</i>	Click or tap here to enter text.			
Address of primary applicant organisation	Royal Derby Hospital Uttoxeter Road DE223NE			
Primary contact <i>(must be a permanent senior member of staff)</i>	James Bunce	Job title	Surgical Research Fellow	
Telephone	07464637762	Email	James.bunce@nhs.net	
Organisation type	NHS Healthcare Provider	Academic Institution	Healthcare Regulator	Other Healthcare Body
	☒	☒	☐	☐
	Local Authority	Individual Citizen(s)	Commercial Body	Other (please state)
	☐	☐	☐	☐
NCEPOD study	Please list below the name(s) of the NCEPOD project from which you are requesting data.			
	Crohn's disease; making the cut.			

Section 2		Project type			
Please select the most appropriate answer	Research	Service Evaluation	Clinical Audit	Other (please state)	
	☐	☐	☒	☐ Click or tap here to enter text.	
Is ethics approval required?	If the request is for research <u>purposes</u> you must enclose evidence of NHS ethics approval or evidence that this is not required.				
	YES				☐
	Confirmation of NHS ethics needs to be submitted with this application.				
	NOT REQUIRED				☒
	Confirmation needs to be submitted with this application from the HRA decision tool http://www.hra-decisiontools.org.uk/ethics/ or confirmation from your local Research and Development Department that NHS ethics is not required.				

Section 3		Project details	
Please provide full details of the project below. You should describe and justify the project's objectives, <u>rationale</u> and methodology.			
Proposed completion date of the project	Spring 2024		
Lay Title and Summary	Please provide a lay summary of your project (max 300 words). The lay summary should be written in plain English and must enable a non- medical audience to understand the research question and aims of the project.		
	We aim to perform an <u>in depth</u> secondary analysis of the emergency cohort of patients having surgery for Crohn's disease. The timescale for an emergency operation for Crohn's disease is loosely defined in the literature despite the NCEPOD classification of urgency being widely adopted. Our primary point of interest focusses on the timing of emergency surgery in Crohn's; how decisions are made regarding timing, how the cohorts and outcomes differ by urgency. IBDUK standards are clearly defined for the elective population, we wish to examine the care of the less urgent emergency cases, investigating how their care differs from the elective populations.		

Section 4		Publications and other outputs	
Please include all intended outputs of the project including publications. Outputs include all types of disseminations produced from the project data. For each output include the highest level of detail of data/information that will be displayed.			
Outputs including publications (add more rows if required)	What is the highest level of detail that will be displayed in the output? (e.g. case record, unit, hospital, trust, network, regional, national, whole study, study group) <i>If unit, hospital, trust or network is selected, will these be identified by name in the publication?</i>	Will this output be published?	Expected Date of Publication
Peer reviewed publication	Aggregate data only. No trust, hospital, or patient identifiable data.	Yes	Spring 2024
Presentation at national meeting	Aggregate data only. No trust, hospital, or patient identifiable data.	Yes	Spring / Summer 2024

Section 5		Commercial interest, including pharma companies
Please indicate whether there is a commercial interest in the project, either by funding or direct input into project design or team.		
Commercial interest	No ☒	
	Yes ☐	If yes, please provide the name of the organisation and the nature of any interest into the project design below. Click or tap here to enter text.

Section 6		Declaration of Interest
Please indicate whether any individuals named in this application have an interest to declare about this application. All interests that might unduly influence an individual's judgement and objectivity in the use of the data being requested from NCEPOD are of relevance. Particular consideration should be given to declaring interests involving payment or financial inducement for use of the data being requested.		
	No ☒	

Declaration of interest (please select one answer)	Yes ☐	If yes, please provide the name and details of the declaration for each individual below Click or tap here to enter text.
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Section 7		Data Fields
<i>Please note – NCEPOD will only provide anonymised, aggregated, clinical data. Organisational data may be available at a Trust/Health board/hospital level, but only with permission granted by the provider.</i> <i>Please list the questionnaire and question number that you would like the data from, and why</i>		
Questionnaire	Question number	Justification
Clinical (CQ) Organisational (OQ) Reviewer assessment form (RAF)		Please justify your use of each data item requested.
Reviewers' questionnaire	All of section E	Data pertaining to the extended output
Clinicians' questionnaire	- All section B - Section C 1a, 1b, 7a, 7b, 7c, and all of 10 - Section E 1c, 4b, 5d, e, f, g, 6a & b, 7a, b, c, d, e, 8a & b, 9, 10a & b, 11 and 12 - All of section G H and I.	Data pertaining to the extended output
CASE NOTES ONLY: Case notes will be destroyed as soon as practicable and no later than 3 months after publication, so any request has to be planned in advance or made quickly. Secondary review of notes to extract data in a different way for the purpose of extended work on the same study must only be undertaken in the NCEPOD office under the supervision of a Senior Clinical Researcher.		

Section 8	Processing locations
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Please list all locations where processing will be undertaken, for the avoidance of doubt storage is considered processing.			
Processing location	Organisation name	Processing or storage	How will data be transferred to this location?
Derby Medical School Campus	The university of Nottingham	Processing and storage	Secure NHS email
Will data be transferred outside of the UK? <i>If yes please state to where and give details of how that will be in compliance with the Data Protection Act 2018.</i>		☒ No	☐ Yes
		If yes, please provide details: Click or tap here to enter text.	



CERTIFICATE OF DESTRUCTION

Section 9: Certificate of Destruction	
This form must be completed by applicants at the end of their data retention period and a copy sent to mmason@ncepod.org.uk .	
Organisation	Click or tap here to enter text.
Method of destruction	Click or tap here to enter text.
Please detail the method used for destruction of the data	Click or tap here to enter text.
Date of destruction	Click or tap to enter a date.
Name:	Click or tap here to enter text.
Position:	Click or tap here to enter text.
Signature:	

Data sharing agreement August 23

Section 10		Authorised signatories	
Please note that this agreement is not valid until all parties have signed and agreed this document.			
Applicant	Name	James Bunce	
	Position	Clinical Research Fellow	
	Signature		
	Date of signature	31/08/2023	
Clinical lead of the original NCEPOD work	Name	Click or tap here to enter text.	
	Position	Click or tap here to enter text.	
	Signature		
	Date of signature	Click or tap to enter a date.	
NCEPODN SIRO or DPO	Name	Click or tap here to enter text.	
	Position	Click or tap here to enter text.	
	Signature		
	Date of signature	Click or tap to enter a date.	
Date of signature:		Click or tap to enter a date.	

Search Strategy

Appendix 4: Literature search strategy used in chapter 3.

Embase <1974 to 2022 November 21>

Ovid MEDLINE(R) ALL <1946 to November 21, 2022>

Journals@Ovid Full Text <November 21, 2022>

1 inflammatory bowel disease.tw. 227904

2 crohn*.tw. 235731

3 coliti*.tw. 307674

4 ulcerative coliti*.tw. 177335

5 laparotom*.tw. 213386

6 surg*.tw. 7828210

7 laparoscop*.tw. 516594

8 colectom*.tw. 64028

9 resection.tw. 1200569

10 emergen*.tw. 2132859

11 unplanned.tw. 84504

- 12 urgen*.tw. 713439
- 13 IBD.tw.149997
- 14 1 or 2 or 3 or 4 or 13 550821
- 15 5 or 6 or 7 or 8 or 9 8339347
- 16 10 or 11 or 12 2737214
- 17 14 and 15 and 16 26138
- 18 limit 17 to english language 25650
- 19 limit 18 to yr="2000 -Current" 24177

Embase <1974 to 2022 November 21>

- 1 exp ulcerative colitis/ or exp inflammatory bowel disease/ 183300
- 2 exp Crohn disease/ 105460
- 3 exp surgery/ 5528687
- 4 exp laparotomy/ 91757
- 5 exp laparoscopy/ or exp laparoscopic surgery/ 187967
- 6 exp colon resection/ 49525
- 7 exp emergency/ 54864
- 8 unplanned.mp. 28837

9	urgen*.mp.	232012
10	exp colitis/ or exp acute severe ulcerative colitis/	231516
11	1 or 2 or 10	259625
12	resection.mp.	620413
13	3 or 4 or 5 or 6 or 12	5610096
14	7 or 8 or 9	309819
15	11 and 13 and 14	2331
16	limit 15 to yr="2000 -Current"	2160

Ovid MEDLINE(R) ALL <1946 to November 21, 2022>

1	exp Inflammatory Bowel Diseases/su [Surgery]	11439
2	exp Colitis, Ulcerative/su [Surgery]	5899
3	exp Colitis/su [Surgery]	6873
4	exp Crohn Disease/su [Surgery]	5753
5	surg*.mp.	3545783
6	exp Laparotomy/	20086
7	exp Laparoscopy/	113994
8	exp Colectomy/	23026
9	resection.mp.	334970

10	exp Emergencies/ or exp Emergency Medical Services/	202563
11	urgen*.mp.	161341
12	unplanned.mp.	17308
13	1 or 2 or 3 or 4	12236
14	5 or 6 or 7 or 8 or 9	3616051
15	10 or 11 or 12	368253
16	13 and 14 and 15	469
17	limit 16 to yr="2000 -Current"	287

EU Clinical Trials Register

(crohn OR crohns OR colitis OR "inflammatory bowel") AND (emergency OR emergent OR unplanned OR urgent) AND (Surgery OR laparotomy OR laparoscopy)

(No relevant results)

Clinical Trials .gov

Inflammatory bowel disease & emergency surgery

(No relevant results)

Cochrane library search

"inflammatory bowel disease" in Title Abstract Keyword OR "Crohns disease"
in Title Abstract Keyword OR "ulcerative colitis" in Title Abstract Keyword AND
"surgery" in Title Abstract Keyword AND "emergency" in Title Abstract
Keyword

103 Cochrane Reviews added

Appendix 5: Preferred Reporting Items for stematic Reviews and Meta-Analyses Extension for Scoping Reviews Checklist used in chapter 3.

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	2
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	2
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	2
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	2,3
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	2
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	2
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	2
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	2
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	2,3
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	2,3



SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	appendix 3, page 2
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	3
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	3-9
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	3-9
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	10-11
Limitations	20	Discuss the limitations of the scoping review process.	10-11
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	11
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	1

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med*. 2018;169:467–473. doi: 10.7326/M18-0850.



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NEWS 2 Parameters

Appendix 7: The National Early Warning Score (NEWS 2) from the Royal College of Physicians.

Physiological parameter	3	2	1	Score 0	1	2	3
Respiration rate (per minute)	≤8		9–11	12–20		21–24	≥25
SpO ₂ Scale 1 (%)	≤91	92–93	94–95	≥96			
SpO ₂ Scale 2 (%)	≤83	84–85	86–87	88–92 ≥93 on air	93–94 on oxygen	95–96 on oxygen	≥97 on oxygen
Air or oxygen?		Oxygen		Air			
Systolic blood pressure (mmHg)	≤90	91–100	101–110	111–219			≥220
Pulse (per minute)	≤40		41–50	51–90	91–110	111–130	≥131
Consciousness				Alert			CVPU
Temperature (°C)	≤35.0		35.1–36.0	36.1–38.0	38.1–39.0	≥39.1	

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