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Original Article

Elective Colectomy after Acute Diverticulitis: An international comparison

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Abstract

Aim: Routine elective colectomy after acute diverticulitis is not recommended, yet significant numbers are still performed. Amidst global concern over rising costs of surgery and the value of healthcare, acute diverticulitis is a disease amenable to optimization of strategies for operative intervention. We aim to compare elective colectomy rates after acute diverticulitis in USA, England and Australia.

Method: Index unplanned admissions for acute diverticulitis were found from an international administrative dataset between 2008 and 2012 for hospitals in USA, England and Australia. Recurrent unplanned admissions for acute diverticulitis and any subsequent elective admissions for colectomy were found between 2008 and 2014 to allow a minimum two-year follow-up period. The primary outcome measured was elective colectomy rate. Secondary outcomes included rates of emergency operative intervention and recurrence. Multivariable analysis was performed to control patient and disease factors.

Results: There were 7842 index unplanned admissions for acute diverticulitis over four years in selected hospitals from USA, England and Australia. The elective colectomy rates were 13%, 5.4% and 3.4% for USA, England and Australia. The propensity for elective colectomy was higher in USA (OR 4.2, $p < 0.001$) and England (OR 1.8, $p < 0.001$) than in Australia. The recurrence rate in all patients with acute diverticulitis was 10% across the countries.

Conclusion: There is a higher propensity for elective colectomy after acute diverticulitis in the USA than in England and Australia. This highlights the possibilities for a less aggressive surgical approach to reduce resource utilisation, but prospective analysis of quality of life information is required to support this.

Key Words: diverticulitis, administrative data, surgical treatment, health service, outcomes

What does this paper add the the literature?

Elective colectomy rates following acute diverticulitis are rarely measured. This international study from hospitals in USA, England and Australia is the first to measure these rates and find a difference. This highlights the potential for performing fewer elective operations after acute diverticulitis, with implications for resource utilisation in healthcare.

Introduction

Acute diverticulitis costs an estimated \$1.8 billion annually in the United States of America (USA)[1, 2]. Surgical management for this increasingly common condition remains varied and controversial. Elective prophylactic colectomy after acute diverticulitis is no longer recommended routinely[3, 4], but it is still commonly practiced in USA[5, 6], and the rate is rising[7].

Rising healthcare costs due to increased resource utilisation have led to global interest in improving the efficiency and therefore value of healthcare[8, 9]. International variation in surgical practice and outcomes can highlight

differences in the value of healthcare systems around the world. The value of surgical care can be improved through the use of the most efficient surgical practices.

There is a greater propensity for emergency operative intervention for acute diverticulitis in USA hospitals[10]. Whilst the majority of these emergency operations were probably necessary, this is not as clearly the case with subsequent elective diverticular resections. Given that these were traditionally performed to prevent future episodes of acute diverticulitis, elective colectomy is a discretionary procedure.

Rates of elective colectomy after acute diverticulitis are rarely measured, which precludes international comparison. It is unclear how differences in international health care systems influence this rate of elective colectomy, or how elective colectomies impact on the recurrence rate of acute diverticulitis.

This study aimed to compare elective operative intervention rates after acute diverticulitis among health services at an international level, using administrative data. Together with overall recurrence rates of acute diverticulitis, this international comparison could highlight an area for optimization of surgical strategy in the management of acute diverticulitis.

Methods

Administrative data from 22 health networks that participate in the Dr Foster Global Comparators Dataset was studied retrospectively. This international dataset was started by the Dr Foster Global Comparators Project to study international clinical variation[11]. These health networks represented large tertiary level hospitals with access to emergency departments and specialist colorectal care. Only health networks in USA, England and Australia were studied because of their similar financial incentives for secondary diagnostic coding.

Administrative data were used as they represented a practical method of international comparison. Large numbers, high inclusion rate and availability are the key strengths of such data. The diagnostic and procedural coding used to

define and compare cases of acute diverticulitis have been studied and verified previously[10, 12, 13] (Supplementary Fig.1). In brief, coding systems used in each country differ: ICD-10-AM (Australia), ICD-10 (England) and ICD-9-CM (USA). Logic algorithms combining primary and secondary codes were constructed to allow matching of the three coding systems into clinically relevant cohorts of uncomplicated and complicated diverticulitis. In ICD-9-CM (USA) the algorithms distinguished complicated from uncomplicated diverticulitis. In ICD-10 (England), they filtered out cases of diverticular bleeding from acute uncomplicated diverticulitis. They also excluded cases of colorectal cancer and inflammatory bowel disease.

All unplanned inpatient admissions for acute diverticulitis were found from the database between 1st January 2008 until 31st March 2012. Unique patient identifiers allowed the determination of index admissions. Recurrent episodes of acute diverticulitis, defined as a subsequent unplanned admission, were found within this period and also up to two years later to 31st March 2014. This timeframe was chosen because most recurrences occur in the first two years after the index episode[14]. The number of cases available for study was determined by the number of hospitals actively participating in the Dr Foster database at the end of March 2014; this can vary across different studies from this database.

The emergency operative intervention rate for index admissions was measured in the three countries using procedure codes (**Supplementary Table 1**). Emergency operation was defined as a specified procedure occurring during an unplanned admission. Basic demographics such as mean age, median length of stay (LOS) and gender were also measured. Rates for recurrent admissions were studied separately to examine individual country attitudes towards recurrent disease.

The primary outcome measured was the rate of subsequent elective colectomy. This was defined as a planned admission with a primary diverticular diagnostic code in conjunction with a colectomy procedure code (**Supplement Table 2**) occurring after an index admission for acute diverticulitis. Colectomies up to 31st March 2014 were considered to allow a follow-up period of two years.

No admissions could be used beyond 2014 due to a change in USA coding systems.

Secondary outcomes included the rate of stoma use and the proportion of minimally invasive procedures. In Australia, specific codes for laparoscopic procedures were introduced midway through the study period, so they were excluded from analysis.

Parametric data were compared using T-test or ANOVA, and non-parametric data were compared using Mann-Whitney U test or Kruskal-Wallis test. Categorical variables were compared using the χ^2 -test. All tests were two-sided. Differences were considered significant when the probability was less than 0.05. Statistical testing was undertaken using the software R (version 2.15.0 from CRAN at <http://CRAN.R-project.org/>).

Multivariable logistic regression analysis was performed to determine the country propensity for elective colectomy. Covariates included were age (<60, 60-80, >80), gender, complicated diverticulitis (in any admission), comorbidity index and year. Elixhauser comorbidity index was used for comorbidity [15, 16].

Results

Over four years and across participant hospitals from USA, England and Australia, there were 7842 index admissions for acute diverticulitis (**Table 1**). The rate of emergency operative intervention was 14%, 13% and 12% in USA, England and Australia respectively. Rates of complicated diverticulitis and length of stay (LOS) were similar among the countries, although the patients were younger in USA compared with England.

The number of patients with recurrent diverticulitis was similar among the countries: around 10% ($p=0.52$). These patients had an average of 2 emergency admissions. The emergency operative intervention rate for patients admitted with recurrent diverticulitis was significantly higher in USA (29%) than in England (15%) and Australia (13%). These rates in England and Australia were similar to the emergency operative rates in index admissions, unlike in the USA.

The elective colectomy rate after acute diverticulitis was significantly higher in the USA (13%) compared with England (5.4%) and Australia (3.4%). Despite differences in operative rate among countries, the patients in each country had the same average number of emergency admissions for acute diverticulitis prior to their operation. These patients were younger on average than the total cohort of patients. Of all patients with acute diverticulitis, 30% in the USA ultimately underwent operative intervention, compared with 20% in England and 16% in Australia (**Figure 1**).

On multivariable logistic regression analysis, after controlling for the potential confounding effects of age, sex, year of diagnosis, comorbidity score and the presence of complicated diverticulitis on the index admission, the propensity for elective colectomy was just over 4-fold higher in the USA ($p < 0.001$), and just under 2-fold higher than England ($p < 0.001$) compared with Australia (**Table 2**). Considering the entire cohort of patients with acute diverticulitis, patients were significantly less likely to receive an elective colectomy with increasing age, comorbidity score and with increasing year. Patients presenting with complicated diverticulitis in their index admission were twice as likely to undergo elective colectomy.

Discussion

A comparison of elective colectomy after acute diverticulitis demonstrates significantly higher rates in the USA (13%) than in England (5.4%) and Australia (3.4%), even after risk adjustment. This propensity for operative intervention also extends to patients with emergency admissions for recurrent acute diverticulitis. There appears to be a significant systemic difference in these countries' approaches towards operative intervention for diverticulitis.

Guidelines once recommended elective colectomy after two episodes of uncomplicated diverticulitis, or after one episode if complicated, with the assumption that it would prevent future complicated episodes[17]. However, the greatest risk for complicated diverticulitis is in the first rather than subsequent episodes[3, 18, 19]. Also, the recurrence rate is 10% to 35% in patients managed non-operatively[1, 14, 20, 21], which compares with 10% in our cohort. The

most cost effective strategy for utilizing elective colectomy as a recurrence prevention intervention has been found to be after three or four attacks rather than one or two[22, 23]. Therefore, since 2006, guidelines have recommended an individual case-based approach to elective colectomy, with risk of disease recurrence as a key consideration[3, 24].

Assuming similar disease patterns, our study demonstrated international differences in the discretionary use of elective colectomy after acute diverticulitis. In the USA, these differences may stem from financial remuneration, or adherence to older guidelines dependent on the absolute number of episodes. A recent study from the USA on 2724 patients from multiple hospitals undergoing elective colectomy for diverticular disease found nearly a third failed to meet guideline indications[25]. This improved over time with implementation of a benchmarking initiative.

Whilst our study suggests that elective colectomy may be over-utilized in some countries, its exact role remains controversial. The risk of recurrence after non-operative management of diverticular abscess was found to be 61% in a study from USA, suggesting a role for routine elective colectomy for these patients[26]. On the contrary, another study from New Zealand found a recurrence rate of 29% in similar patients, most of whom were managed non-operatively[27].

Furthermore, studies rarely consider quality of life in patients with persistent low acuity disease. The DIRECT trial randomly assigned patients with recurrent diverticulitis or persistent abdominal complaints after diverticulitis to elective colectomy or conservative management[28]. They found that quality of life was significantly improved in patients who underwent surgery. It is likely that many patients with chronic abdominal symptoms do not require hospitalisation despite utilising healthcare and community resources in other ways. Therefore, disease burden from acute diverticulitis cannot be solely measured by rates of recurrent hospitalisations for diverticulitis.

The key strength of our study was the use of a single platform that combined administrative data from hospitals from three countries. As far as we know, this is the first study to examine the rate of elective operations after acute

diverticulitis in multiple hospitals. No other international comparisons exist. The use of unique patient identifiers allowed the follow-up of patients to measure recurrence, which sets it apart from many other studies that used administrative data.

The main limitation of our study was the definition of recurrent diverticulitis as an episode requiring hospitalisation. There was no information regarding quality of life in patients not undergoing subsequent elective surgery. Also, it is possible that in some hospitals, patients with mild diverticulitis were managed as outpatients, which would skew the results. However, the proportions of complicated to uncomplicated diverticulitis were similar among the countries, which would suggest a similar inpatient population. Our follow-up was limited to two years, and whilst most recurrences occur within that timeframe, some recurrences would have occurred outside of this period. Lastly, administrative data does not record the specific indications for the elective colectomies, other than the primary diagnosis of diverticular disease. This meant that episodes of complicated diverticulitis after initial uncomplicated episodes, (which are rare at 3 to 5%[14, 20]), fistulae and low acuity disease were not recorded. We assumed that the spectrum of natural history of diverticular disease, following an initial acute admission, would remain similar among the countries. Characterising the indications for elective colectomy in each country is required to further explore the reasons for discrepancies in operative propensity. Prospective analysis of quality of life data in patients not undergoing elective colectomy after acute diverticulitis and their use of all healthcare resources would be required to make any recommendations about reducing elective surgical intervention.

Conclusion

We have demonstrated that there is a greater propensity for elective colectomy after acute diverticulitis in hospitals in USA than in England or Australia. A similar recurrence rate among the countries highlights the discretionary nature of elective colectomy and the potential for a less aggressive surgical approach to reduce resource utilization. However, prospective analysis

of outpatient data is required to make any recommendations to reduce elective colectomies after acute diverticulitis.

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List of Supplemental Files

Supplement Figure 1 Logic algorithms for acute diverticulitis for each country

Supplement Table 1 Emergency procedure codes relevant to acute diverticulitis in each country

Supplement Table 2 Elective colectomy codes for diverticular disease in each country and diagnostic codes considered to be diverticular.

Table 1

Outcomes for acute diverticulitis in health services from 3 countries with index admissions 2008-2012 and recurrent admissions and elective colectomies until 2014.

	USA	England	Australia	p-value
Index Admissions				

Patients	2636	3522	1684	
Mean Age (years, sd)	58±16	65±16	60±16	
Gender (male)	43%	41%	49%	
Emergency Operative Intervention Rate	14%	13%	12%	0.045
Median Length of Stay (days, IQR)	4 [2-7]	4 [2-7]	4 [3-6]	
Complicated Diverticulitis	28%	24%	26%	
Recurrent Diverticulitis				
Patients	283 (11%)	347 (9.9%)	171 (10%)	0.52
Mean Emergency Admissions	2.3	2.3	2.2	
Patients with emergency operation in index admission	6 (2.1%)	19 (5.5%)	5 (2.9%)	
Emergency Operative Rate in Admission for Recurrence	81 (29%)	53 (15%)	23 (13%)	<0.001
Subsequent Elective Colectomies				
Operative Intervention Rate	333 (13%)	189 (5.4%)	57 (3.4%)	<0.001
Initially Complicated	130 (18%)	54 (6%)	31 (7%)	
Initially Uncomplicated	203 (11%)	135 (5%)	26 (2%)	
Median Emergency Admission Prior	2	2	2	
Mean Age	55±13	58±13	57±13	
Stoma Rate	14%	25%	19%	
Minimally Invasive	58%	21%	N/A	

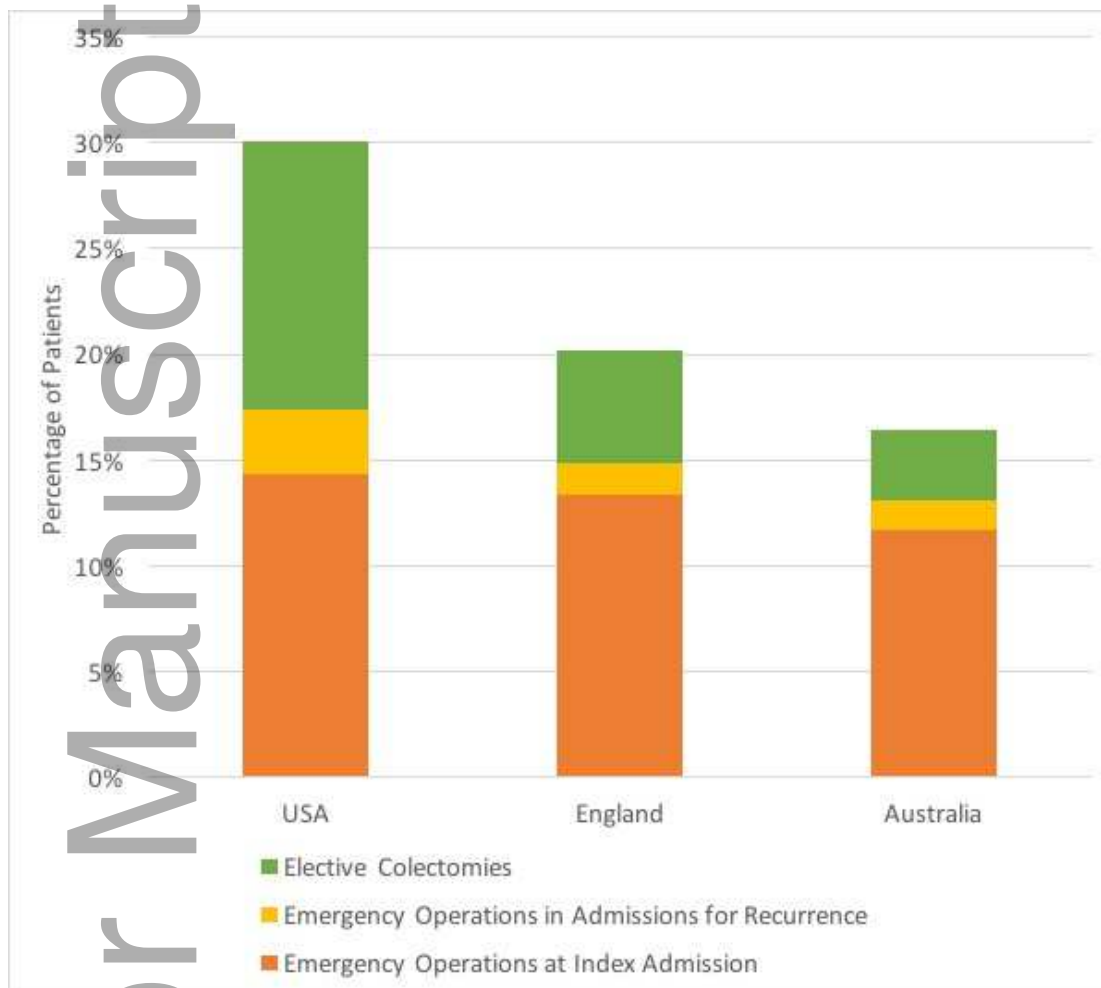
Table 2

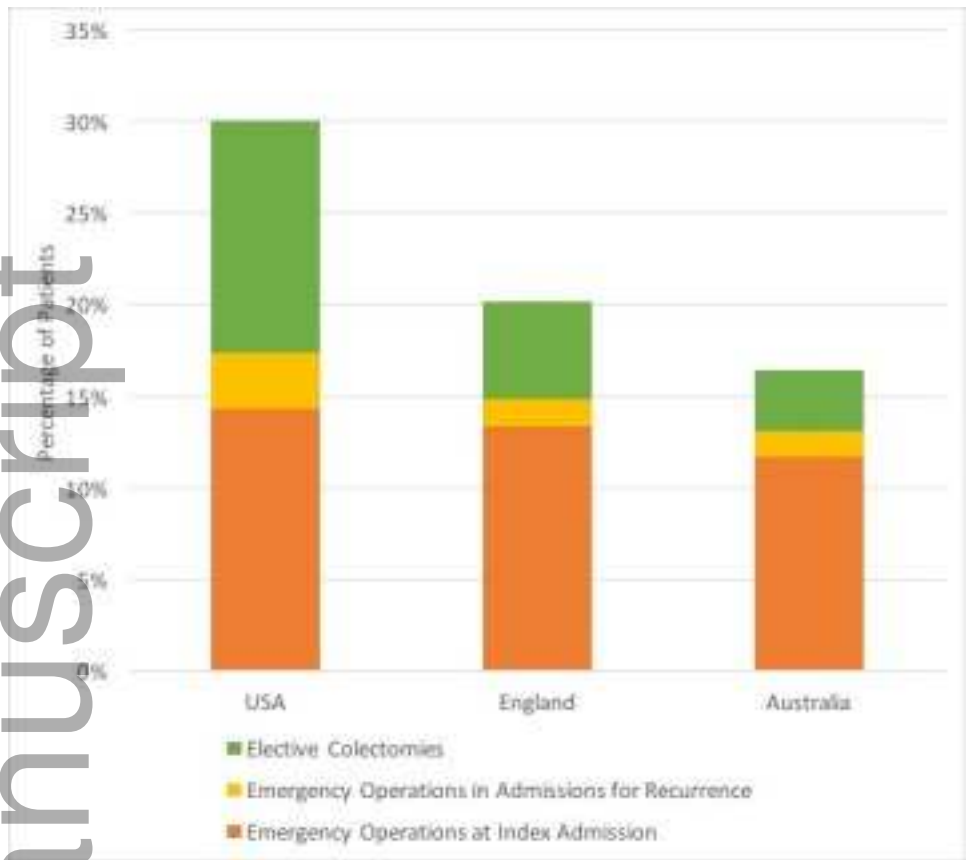
Multivariable analysis for propensity for elective colectomy after acute diverticulitis.

Propensity for Elective Colectomy			
Variable	OR	95% CI	P value
<i>Country</i>			
Australia	Ref		
England	1.8	1.3-2.4	<0.001
USA	4.2	3.1 -5.6	<0.001
<i>Age</i>			
60 or younger	Ref		
60-80	0.80	0.66-0.96	0.017
Older than 80	0.12	0.07-0.23	<0.001
<i>Other Variables</i>			
Increasing Year	0.90	0.84-0.97	0.004
Increasing Comorbidity Score	0.97	0.96-0.98	<0.001
Male	1.07	0.89-1.3	0.48
Complicated Diverticulitis (Index admission)	2.0	1.7-2.4	<0.001

Figure 1

Proportion of patients undergoing any operative intervention during the study period by country.





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