Published in final edited form as:

Ann Surg. 2016 January ; 263(1): 123–129. doi:10.1097/SLA.0000000000001053.

The Impact of Elective Colon Resection on Rates of Emergency Surgery for Diverticulitis

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Abstract

Objective—To determine the impact of elective colectomy on emergency diverticulitis surgery at the population level.

Summary Background Data—Current recommendations suggest avoiding elective colon resection for uncomplicated diverticulitis because of uncertain effectiveness at reducing recurrence and emergency surgery. The influence of these recommendations on use of elective colectomy or rates of emergency surgery remains undetermined.

Methods—A retrospective cohort study using a statewide hospital discharge database identified all patients admitted for diverticulitis in Washington State (1987–2012). Sex and age-adjusted rates (standardized to the 2000 state census) of admissions, elective and emergency/urgent surgical and percutaneous interventions for diverticulitis were calculated and temporal changes assessed.

Results—84,313 patients (mean age 63.3 years and 58.9% female) were hospitalized for diverticulitis (72.2% emergent/urgent). Elective colectomy increased from 7.9 to 17.2/100,000 people ($p<0.001$), rising fastest since 2000. Emergency/urgent colectomy increased from 7.1 to 10.2 per 100,000 ($p<0.001$), non-elective percutaneous interventions increased from 0.1 to 3.7 per 100,000 ($p=0.04$) and the frequency of emergency/urgent admissions (with or without a resection) increased from 34.0 to 85.0 per 100,000 ($p<0.001$). In 2012, 47.5% of elective resections were performed laparoscopically compared to 17.5% in 2008 (when the code was introduced).

Conclusions—The elective colectomy rate for diverticulitis more than doubled, without a decrease in emergency surgery, percutaneous interventions or admissions for diverticulitis. This may reflect changes in thresholds for elective surgery and/or an increase in the frequency or

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severity of the disease. These trends do not support the practice of elective colectomy to prevent emergency surgery.

INTRODUCTION

Each year in the United States 300,000 admissions and 1.5 million days of inpatient care are related to the management of acute diverticulitis.¹⁻⁴ While most episodes resolve with antibiotics alone,⁵ 10-20% of patients will have an emergency colectomy, often including a colostomy, at their initial presentation and all patients remain at lifetime risk for recurrent episodes.^{6,7} Diverticulitis is one of the most common reasons for emergency colostomy⁶ and the leading reason for elective colon resection.^{8,9}

There has been a long-held belief that elective, “prophylactic” colectomy can prevent future episodes of diverticulitis and emergency colostomy.^{5,9} More recent evidence, however, suggests that the rate of diverticulitis recurrence after resection (5-11%)⁷ is similar to the rate of recurrent hospitalized events (4-13%) for those who do not have elective resection.¹⁰ Modeled analyses have shown little value to prophylactic colectomy and observed changes in the rate of elective colectomy do not appear to correlate with decreases in emergency colectomy.² Recent studies have shown that the risk of emergency colectomy is greatest at the initial presentation with diverticulitis, with 80-90% of emergency procedures being performed in patients without a prior hospitalization.^{6,7,10} Several professional organizations have used this evidence to shift their recommendations away from early prophylactic resection (after one or two documented episodes) until after multiple (3 or more) episodes.^{5,11,12} The most recent American Society of Colon and Rectal Surgeons (ASCRS) guidelines¹³ now actually advise against routine elective resection for uncomplicated diverticulitis. Despite these cautions, a recent series of studies of the use of elective resection for diverticulitis from 1998 to 2007 found it increased more than 50%.^{1,2,14} These studies have suggested that the pace of growth is related to the wide uptake of laparoscopic approaches for colectomy, rather than changes in the disease.¹⁴

Studies evaluating trends in elective colectomy have either been limited by short study periods^{1,2,14} or have drawn conclusions based on proportions of elective procedures for diverticulitis among all colectomy procedures, rather than rates of elective colectomy in a population at risk for disease.¹⁵ A focus on proportions rather than on the rates of colectomy does not account for changes in the population at risk or changes in the use of emergency colectomy. A recent meta-analysis⁷ points to gaps in our understanding of the association between elective resection and prevention of subsequent complications. The purpose of this study was to characterize trends in the incidence of elective colectomy for diverticulitis in an entire state's “at risk” population over a 26 year time period, encompassing periods before and after laparoscopy was introduced. We sought to evaluate whether changes in the incidence of elective colectomy were associated with rates of emergency colectomy and factors that might be associated with varying rates of elective colectomy.

METHODS

This study was exempted from human subjects review by agreement of the University of Washington Human Subject Review Committee and the Washington State Department of Social and Health Services Institutional Review Board.

Data Source

A retrospective cohort study was conducted using a statewide, population-based hospital discharge database. Data were obtained from the Washington State Comprehensive Hospital Abstract Reporting System (CHARS) database. This dataset was derived from all public and private hospitals in Washington State, excluding Veterans Affairs (VA) and U.S. military hospitals. Error resulting from missing VA and military hospital patients was recognized but assumed to be stable over time. The dataset contains demographic variables, admission and discharge administrative details, payer status, Ninth Revision of the International Classification of Diseases (ICD-9) procedure and diagnosis codes, and coded hospital identifiers. United States census bureau data for yearly state population estimates were used for population-based analyses. Surgeon volume per county was estimated using unique NPI numbers appearing as operating surgeon in the database.

Study population

Inclusion into the cohort was defined by identifying all CHARS reports for ICD9 diagnostic codes for diverticulitis (see **Appendix**). We excluded patients under the age of 18. We excluded hospital records that came from trauma admissions. A modified Charlson comorbidity index was calculated for each patient based on ICD-9 diagnostic codes.¹⁶

Variable Definition

The administrative designation of admission type was used to classify hospitalizations. Patients whose initial admission was characterized as not-elective (in other words, urgent or emergent per their discharge records) were included in the analysis. We identified those admissions having a concurrent colectomy code, open or laparoscopic, and those having percutaneous drainage performed based on the ICD9 codes listed in the Appendix. These codes were compiled from a non-systematic literature review of studies using administrative data to describe diverticulitis trends.^{2,10,14,17} Patients who underwent colectomy procedures during their admission for diverticulitis were defined to have surgically treated diverticulitis. ICD9 codes for laparoscopy became available in 2008 (**Appendix**). As in previously published studies, our definition of laparoscopic surgery included codes for laparoscopic exploration or lysis of adhesions when combined with a code for colectomy.¹⁷

Data Analysis

Because population-based frequencies are sensitive to changes in the underlying population at risk, yearly population-based frequencies of diverticulitis admissions and surgical procedures were also calculated. Employing the direct method, all data were standardized for sex and age using the 2000 population of Washington State as the reference. All population-based frequencies were reported as a frequency per 100,000 people adjusted for age and sex using the direct standardization method. A test for trend using regression (i.e.,

the P value for whether the coefficient for calendar year was significantly different from 0) was applied to the frequencies of diverticulitis admissions, emergency and elective colectomies, and percutaneous interventions. The cohort was also divided into 5-year periods and demographic characteristics and treatment patterns were compared in each time period. County-specific rates were calculated for 2010, the year with the most current census demographic data, to offer a current estimate of prevalence of elective colectomy in those counties. Statistical analysis was performed using STATA statistical analysis software, version 13 (STATA Corp, College Station, TX).

Statewide variation

To evaluate for variation in practice within our state, we determined age- and sex- adjusted rates for admission and colectomy per county in Washington State. CHARS records reflect county of residence of the patient, not necessarily the county where they received their care. To account for fluctuations in rates of smaller counties, we focused our analysis on the 12 counties with a population of >100,000 people per the 2010 census. The number of surgeons practicing in each county was derived from unique operating physician identifier codes recorded in the discharge record.

RESULTS

There were 84,313 hospitalizations for diverticulitis, including 26,308 admissions with colon resections. The average age was 63.3 and decreased from 67.4 to 62.5 ($p<0.001$) (**Table 1**) over the study period.

The age- and sex- standardized incidence of non-elective hospitalization for diverticulitis was 53.5 per 100,000 people for the entire period but increased dramatically from 34.0 to 85.0 ($p<0.001$). The incidence of elective colectomy was 13.2 per 100,000 people for the entire period but increased from 7.9 to 17.2 ($p<0.001$), rising fastest since 1995 (**Figure 1**). The incidence of non-elective colectomy was 9.9 per 100,000 people for the entire period and increased slightly over the period, from 7.2 to 10.3 ($p<0.001$).

The use of percutaneous drainage during non-elective admission increased from 0.1% to 3.7% ($p=0.04$) and the proportion of non-elective hospitalization in which an emergency colectomy was performed decreased from 21.1% to 12.1% ($p<0.001$).

Laparoscopic codes became available in 2008. Since that time, the proportion of elective cases described as laparoscopic increased from 17.5% in 2008 to 47.5% in 2012 ($p<0.001$).

Among the 12 counties with larger populations (>100,000 people), the mean rate for elective colectomy was 13.4 per 100,000 people in 2010. There was significant variability in the age- and sex-adjusted rates of elective colectomy, with the rate of elective colectomy varying 8.9 to 17.1. Notably, even the rates in adjacent counties such as counties D and F had two-fold differences (**Figure 2**). Counties with increased numbers of surgeons did not have an increased rate of age- and sex-standardized elective colectomy ($p=0.9$).

DISCUSSION

In Washington State, over the last 26 years the age- and sex-adjusted incidence of elective colectomy for diverticulitis more than doubled. This increase was not accompanied by a decrease in emergency colon resection, percutaneous interventions or admissions for diverticulitis. These trends occurred in parallel to evolving professional recommendations suggesting delaying elective colectomy for diverticulitis surgery and may highlight an important gap between recommendations and current practice. It is possible that these observations may be related to the availability of laparoscopic techniques and a lowering of the threshold for recommending resection, greater patient acceptance of the less invasive approach, a rise in more symptomatic disease that is prompting the broader use of elective colectomy or several other factors that cannot be evaluated using administrative claims data. What appears to be clear is that the growing use of elective colectomy has not decreased the use of emergency surgery on a population level.

The changes in professional guidelines over the last decade have resulted in a “moving target” related to recommendations for elective surgery for diverticulitis (**Table 2**). Long-standing recommendations from ASCRS based on data from the 1960s were that elective resection be considered after the second episode of diverticulitis¹⁸⁻²⁰ and in patients under 50 years of age, after the first episode.^{18,20,21} Studies in the last decade challenged this thinking citing a 5-11% risk of recurrence after resection^{7,12} and demonstrating a similar, small rate of recurrent hospitalized events (4-13%) for those who do not have elective resection.¹⁰ Elective resection also carries the risk (1-3%) of “rescue colostomy”^{11, 22} for anastomotic failure. A decision analysis by our group⁶ that considered all these parameters demonstrated that waiting until at least 4 recurrent hospitalized episodes—something that occurs in less than 5% of the population¹⁰—decreases the risk of colostomy, complications, and cost.⁶ The ASCRS 2006 guidelines⁵ incorporated these modeled data and recommend delaying surgery well beyond 1-2 episodes. The just released 2014 ASCRS guidelines “strongly advise” against early resection for uncomplicated disease.¹³ Similar advisory groups in Europe^{11,12} suggest that elective surgery should not be tied to a specific number of events and have called for trials to assess the value of ever performing elective resection.^{23,24} However, as a recently published systematic review in *JAMA* pointed out, the evidence behind all these existing guidelines is woefully inadequate and “there is a need for better population-level studies that address the fundamental epidemiology of the disease”.⁷

There are several hypotheses to explain the apparent gap between the dramatic rise in elective colectomy found in our study and professional guidelines which call for delay and even avoiding surgical resection of diverticulitis. First, it is possible that during the last several decades, despite evolving guidelines, the threshold for offering elective colectomy has not changed, and instead the population of patients who have the disease is increasing. To our knowledge, there has been no other evidence of such rapid growth of the condition (e.g. colonoscopic detection of diverticulosis) over so short a period, particularly since 2000. It may be that some of the apparent increased incidence of hospitalization for diverticulitis shown by our study and others^{1,2,14,25} is attributable to the greater use of computed tomography, identifying diverticulitis in patients who formerly would have been diagnosed with abdominal pain “not otherwise specified” or some other condition.^{26, 27} While this

might explain some of the increase in non-elective admissions for diverticulitis, it is unlikely that there was such a large group of previously misdiagnosed patients admitted to hospitals in the 1990s, when CT scans were also widely available.

Another possibility is that the severity of diverticulitis has been increasing, and surgeons may be performing more elective procedures on patients with more complicated disease. This theory was popularized by advocates for early resection in younger patients (described as age < 50 years)^{9,21,28} due to the belief that younger people were more likely to have severe recurrences requiring emergency surgery.^{10, 18, 29, 30} However, recent studies offer conflicting evidence about whether diverticulitis in the young is a more virulent entity,³⁰⁻³³ and the newest ASCRS guidelines do not recommend resection in younger patients either. Severity of disease is difficult to measure with claims data, because codes for abscess, peritonitis and perforation are often secondary and inconsistently recorded. Thus, our study and others¹⁵ have tried to understand patterns of severity by evaluating the proportion of non-elective admissions having emergency surgery, which has actually decreased considerably (from 20 to 10% in our study). Plausible explanations for the decreased proportion requiring emergency operation include better management with percutaneous interventions,^{15, 25} better classification of disease severity with improved imaging,³⁴ a higher threshold for offering emergency operation⁷ or perhaps a shift from offering emergency surgery to a delayed elective surgery.⁷ The approach of delaying surgery beyond the first hospitalization may be unsupported however given that a prior report on a subset of this WA State population,^{6,35} the most recent ASCRS guidelines,¹³ and a recent systemic review,⁷ have highlighted that 80-90% of patients who have complications requiring emergency surgery do so during their initial hospitalization for diverticulitis. Based on these constellations of findings, offering elective surgery to prevent future emergency surgery is no longer supported.

An alternate explanation for the findings in this study may be that surgeons' threshold for offering elective colectomy for diverticulitis is lower now than in the past and/or that a patients' willingness to undergo elective resection has changed. It has been speculated that the growth in elective resection has more to do with the availability of laparoscopy than any changes in the disease itself.¹⁴ Laparoscopic techniques for colorectal surgery have grown in popularity since they were introduced in 1991.³⁶ Widespread uptake did not come until the early 2000s when training programs began incorporating it and several randomized trials of laparoscopy for colon cancer were published.^{37,38} Recent studies suggest that laparoscopic colectomy improves outcomes through lower morbidity, including lower rates of wound infection and quicker discharge from the hospital.^{38,39} Nationally, there is growing use of laparoscopic colon surgery (LCS), and when measured in 2012 at most hospitals in Washington State, 60% of all colectomies for diverticulitis were performed laparoscopically.³⁵ Hospitals that adopted laparoscopy at a faster pace in Washington State had much faster growth in the use of elective resection for diverticulitis and a surge in right-sided resections, previously an uncommon procedure.⁴⁰ This growth in the use of elective resection has been shown to be even greater among younger patients^{1,2} the majority of which had LCS. Another suggestion of the association between the availability of LCS and the rise of elective resection is that countries where there is greater use of laparoscopic resection have higher rates of elective surgery for diverticulitis.^{17,41} Since these countries

are assumed to have similar incidence of disease, this has reinforced speculation that the threshold to recommend and undergo surgery has been lowered by the availability of LCS, similar to what occurred with the introduction of laparoscopic gall bladder surgery in the late 1980s.^{42, 43}

The variation between counties in our study may reflect a combination of these hypotheses. We focused on the most populated counties to minimize fluctuation that would be seen with low-population counties. Still, we found no association between age- and sex-adjusted rates of procedures, number of surgeons, and county of residence, suggesting that the lower incidence in some counties is not explained by an ‘access to care’ barrier. Rather, it implies that variation in surgeon practice for recommending resection may be the driver of surgery in higher incidence counties.

Our study has several limitations. Laparoscopy as a billing code first appeared in 1992 but it was not until 2008 that a code for laparoscopic colon resection was developed. Before 2008, there was variable coding for “unlisted laparoscopy” or “diagnostic laparoscopy” (**Appendix**) associated with colectomy procedures. Using this method for identifying potentially laparoscopic procedures prior to 2008, we found rates varying between 0 and 5%. For this reason we could not assess the impact of laparoscopic surgery on the trends in elective colectomy. Since the introduction of laparoscopic colectomy codes in 2008, we saw more consistent coding with the proportion of cases using laparoscopy increasing from 17.5% to 47.5% ($p<0.001$) and no difference in change in rates of elective procedures between counties that were above or below the median proportion of cases performed laparoscopically. Another limitation is that a database based on discharge records may miss important trends in the population of patients with diverticulitis who are not hospitalized, and it has been estimated that as much as 60% of all diverticulitis care takes place in the outpatient setting.⁴⁴ This limitation is not likely to effect the observation of surgery because none of that outpatient care is expected to include colectomy. Additionally, we could not evaluate the indications for surgical therapy. Granularity about episode number, complicated disease, or burden on quality of life is not available through hospital discharge records, making it impossible to determine, for instance, whether increasing rates of operations in younger patients reflects more severe disease in this group, whether the impact of diverticulitis on their lives and quality of life is greater, and/or if clinicians are making decisions about invasive treatments based on their younger patients’ comparatively good health or longer life expectancy. Another limitation is reliance on discharge record diagnostic coding. Inconsistencies in coding practices or new code adoption, such as laparoscopic procedures, might explain differences in rates reported in our study as compared to those from sources such as operative reports³⁵ or chart review.^{17, 41}

These population-level trends appear to highlight an important gap between guidelines and practice, and indicate the need for better data to describe the motivation behind the use of surgical therapy for diverticulitis. In Washington State, the Surgical Care and Outcomes Assessment Program (SCOAP), a state-wide collaborative of hospitals focused on quality improvement in surgical care, started a benchmarking and educational campaign focused on indications for colectomy for diverticulitis. Each quarter, hospital use of elective surgery and appropriateness of indications is reported, compared to others in the network. Since 2010,

elective colectomies at SCOAP hospitals, which perform over 80% of the colectomy volume in the state, have leveled without an increase in emergency surgery,³⁵ further substantiating this study's findings of a disconnect between elective colectomy at preventing subsequent emergency.

Our study shows that over the past 26 years in Washington State, rates of elective colectomy for diverticulitis have more than doubled, and this dramatic increase in elective surgery was not accompanied by a decrease in the rate of emergency surgery, percutaneous interventions or admissions for diverticulitis. Given that 80-90% of emergency surgery happens at the first episode of diverticulitis, the findings in this study suggest that the practice of routine elective colectomy does not prevent future emergency surgery. Accountable care organizations, healthcare payers, and those making strategic decisions about population health should consider this evidence when developing policies related to diverticulitis.

ACKNOWLEDGMENT

Research reported in this publication was supported by the National Institute of Diabetes And Digestive And Kidney Diseases of the National Institutes of Health under Award Number T32DK070555. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

FUNDING DISCLOSURES:

Research reported in this publication was supported by the National Institute Of Diabetes And Digestive And Kidney Diseases of the National Institutes of Health under Award Number T32DK070555. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Appendix

ICD-9 Diagnostic codes used for this study.

Abbreviations and acronyms

CHARS	Comprehensive Hospital Abstract Reporting System
ICD-9	Ninth Revision of the International Classification of Diseases
ASCRS	the American Society of Colon and Rectal Surgeons
LCS	Laparoscopic Colon Surgery

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Figure 1. Rates of Elective and Non-elective colectomy 1987-2012

Age- and sex-adjusted rates (to the 2000 state census population) of elective colectomy (solid line) and non-elective colectomy (dashed line) over 26 years in Washington State.

Figure 2. Adjusted rate of elective colectomy in counties with more than 100,000 people
The most contemporary age- and sex-adjusted rates (to the 2010 state census population) of elective colectomy vary nearly two-fold in the 12 largest counties (all with more than 100,000 people) in Washington State, even in counties which are geographically adjacent.

Table 1
Incidence of admissions and surgery for diverticulitis in Washington State between 1987 and 2012

	Overall	1987-1991	1992-1996	1997-2001	2002-2006	2007-2012	p-value *
Age	63.3	66.4	65.2	63.8	61.6	62.1	p<0.001
Female (%)	58.9	62.5	60.7	58.1	57.8	57.9	p<0.001
Charlson Comorbidity Index (%)							p<0.001
0	64.8	71.2	66.3	63.6	64.4	62.5	
1	22.5	19.4	21.7	22.9	23.7	23.2	
2	8.2	6.3	7.9	8.9	7.8	9.1	
3+	4.5	3.1	4.2	4.6	4.2	5.2	
Rate of non-elective admission (per 100,000 people)	53.5	35.2	41.9	50.1	59.6	76	p<0.001
Rate of non-elective colectomy (per 100,000 people)	9.9	7.9	9.6	10.3	11.2	10.4	p<0.001
Colectomy during non-elective admission (%)	18.5	22.5	22.8	20.5	18.9	13.6	p<0.001
Rate of percutaneous drain during non-elective admission (per 100,000 people)	0.7	0.1	0.3	1	1	1.2	p=0.04
Rate of elective colectomy (per 100,000 people)	13.2	8	9.5	13	17	17.6	p<0.001
Proportion of elective cases performed laparoscopically	7.65	0	0.9	2.5	2.2	21.5	p<0.001

* p-values calculated as test of trend using yearly data from 1987-2012

** rates per 100,000 people are age- and sex- adjusted to Washington State's population in 2000

Table 2
ASCRS Recommendations for surgery following recovery from acute diverticulitis

Year	1995	2000	2006	2014
Elective surgery after...	Roberts et al ⁽⁴⁵⁾	Wong et al ⁽⁹⁾	Rafferty et al ⁽⁵⁾	Feingold et al ⁽¹³⁾
Uncomplicated diverticulitis	After two attacks of uncomplicated diverticulitis, resection is recommended.	After two attacks of uncomplicated diverticulitis, resection is commonly recommended.	The decision to recommend elective sigmoid colectomy after recovery from acute diverticulitis should be made on a case-by-case basis(III B).	The decision to recommend elective sigmoid colectomy after recovery from uncomplicated acute diverticulitis should be individualized. (1B).
	Although it has been the practice to recommend elective resection in the young patient after one well-documented episode of uncomplicated diverticulitis, the natural history of diverticular disease in the young patient has not been clearly defined.	Although some surgeons recommend elective resection in the young patient after one well-documented episode of uncomplicated diverticulitis, this tenet remains controversial, because the natural history of diverticular disease in the young patient has not been clearly defined.	The number of attacks of uncomplicated diverticulitis is not necessarily an overriding factor in defining the appropriateness of surgery. There is no clear consensus regarding whether younger patients (younger than aged 50 years) treated for diverticulitis are at increased risk of complications or recurrent attacks.	The literature demonstrates that patients with more than 2 episodes are not at an increased risk for morbidity and mortality in comparison with patients who have had fewer episodes. The practice of recommending elective colectomy to prevent a future recurrence is not supported by this literature and should be discouraged. Routine elective resection based on young age (<50 years) is no longer recommended. Strong recommendation based on low-quality evidence (1C).
Complicated diverticulitis	Resection is recommended for patients with diverticulitis after one event.	Resection may be recommended for patients with complicated diverticulitis after a single attack.	Elective colon resection should typically be advised if an episode of complicated diverticulitis is treated nonoperatively(IIIB).	Elective colectomy should typically be considered after the patient recovers from an episode of complicated diverticulitis. Strong recommendation based on moderate-quality evidence(1B).