Elective Surgery for Diverticulitis and the Risk of Recurrence and Ostomy

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Objective: To assess the comparative risk of recurrence and ostomy after elective resection or medical therapy for uncomplicated diverticulitis, incorporating outpatient episodes of recurrence.

Background: While surgeons historically recommended colon resection for uncomplicated diverticulitis to reduce the risk of recurrence or colostomy, no prior studies have quantified this risk when considering outpatient episodes of disease. It remains to be determined whether surgery actually decreases those risks.

Methods: Retrospective cohort study employing an adjusted time-to-event analysis to assess the relationship of medical or surgical treatment with diverticulitis recurrence and/or receipt of an ostomy. Subjects were adults with ≥1 year continuous enrollment treated for ≥2 episodes of uncomplicated diverticulitis from a nationwide commercial claims dataset (2008–2014).

Results: Of 12,073 patients (mean age 56 ± 14 yr, 59% women), 19% underwent elective surgery and 81% were treated by medical therapy on their second treatment encounter for uncomplicated diverticulitis. At 1 year, patients treated by elective surgery had lower rates of recurrence (6%) versus those treated by medical therapy (32%) [15% vs 61% at 5 years, adjusted hazard ratio 0.17 (95% confidence interval: 0.15–0.20)]. At 1 year, the rate of ostomy after both treatments was low [surgery (inclusive of stoma related to the elective colectomy), 4.0%; medical therapy, 1.6%].

Conclusions: Elective resection for uncomplicated diverticulitis decreases the risk of recurrence, still 6% to 15% will recur within 5 years of surgery. The risk of ostomy is not lower after elective resection, and considering colostomies related to resection, ostomy prevention should not be considered an appropriate indication for elective surgery.

Keywords: colorectal surgery, colostomy, commercial claims, diverticulitis, diverticulitis recurrence, ostomy risk

(*Ann Surg* 2021;273:1157–1164)

Acute diverticulitis is a common illness, accounting for $2.4 billion in costs annually,[1–3] including 300,000 admissions and perhaps 3 times as many episodes in the outpatient setting.[4] Although most cases of uncomplicated diverticulitis are treated with antibiotics alone, diverticulitis remains one of the most common reasons for colon resection.[5–7] Historically, the threshold for recommending elective resection was after 2 episodes, but over the last 2 decades professional organizations have encouraged a more restrained approach, moving away from counting episodes to determine indications for surgery.[2] Despite these recommendations, the incidence of elective operation for diverticulitis has continued to increase,[8,9] and it is unclear if patient and surgeon decision-making aligns with these recommendations. A recent trial comparing elective surgery and conservative management for patients with recurrent diverticulitis revealed that surgery was associated with significantly higher gastroenteric-specific quality of life (DIRECT trial),[10] emphasizing the importance of patient-specific outcomes in this disease.

Conventionally, surgeons have recommended elective surgery with the goal of preventing recurrence, progression, or most importantly to patients, to prevent an emergency surgery resulting in a colostomy.[11,12] Colostomies are associated with diminished quality of life and both patients and surgeons have cited avoidance of colostomy as motivation for elective surgical intervention.[13–16] Assessing the actual risk of recurrence and colostomy after operative or nonoperative treatment has been challenging because of limitations in available data. Prior large population-based studies assessing diverticulitis recurrence have used healthcare claims which include only hospitalized patients. These studies miss the dramatic shift to outpatient care for diverticulitis over the last decade including patients treated for recurrence as outpatients.[17–19] These limitations have prevented an accurate assessment of risk and preclude a data-driven approach to decision making. Studies of inpatient-based care have shown that approximately one-third of patients with diverticulitis will develop a recurrence requiring hospitalization after their index episode.[20,21] Patients treated surgically have a risk of recurrence as well,[20] although the exact rate of recurrence in this group has not been well defined. Rates of colostomy are estimated as 5% to 7% following a first episode of diverticulitis,[6] but elective surgery itself has a small risk of colostomy and the rate of "rescue colostomy" (unplanned ostomy for complications including leak) with elective resection is 1% to 3%.[22–24] What is not known is whether medical treatment or surgery confers a greater risk of future colostomy.

To address the evidence gap about risk of recurrence and ostomy, and to support informed decision making, we compared the risk of recurrence and ostomy among patients treated for uncomplicated diverticulitis using a national healthcare claims database that includes both inpatient and outpatient claims for millions of Americans. We hypothesized that elective resection is associated with a reduced risk of disease recurrence and ostomy.

METHODS

We performed a time-to-event analysis for recurrence-free and ostomy-free survival from a retrospective cohort of patients treated for uncomplicated diverticulitis using the Thompson Reuters MarketScan Commercial Claims and Medicare Supplement Databases between January 1, 2008 and December 31, 2014. This data source includes claims and enrollment data for patients with employer-

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Research reported in this publication was supported by the National Institute of Diabetes and Digestive and Kidney Disease of the National Institutes of Health under Award Number R01DK103915 and through a training grant that supported Dr. Thornblade's work (T32DK070555). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.
The authors declare no conflict of interests.
Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.annalsofsurgery.com).

ISSN: 0003-4932/19/27306-1157
DOI: 10.1097/SLA.0000000000003639

provided insurance and for their dependents and Medicare claims for patients who continue to have private supplemental insurance once enrolling in Medicare. Diagnoses and procedures are coded by *International Classification of Disease, 9th revision*, Current Procedural Terminology, and Healthcare Common Procedures Coding System codes. This study was approved by the University of Washington Institutional Review Board.

Cohort Definition

Among all patients in the MarketScan database who were treated as inpatients for an index diagnosis of uncomplicated diverticulitis (*International Classification of Disease, 9th revision:* 562.11), we selected those who were subsequently treated by either medical therapy or elective surgery on a second encounter for uncomplicated diverticulitis (>6 wk since index encounter) (n = 26,471), and repeated this analysis for patients treated at a third, fourth, and fifth encounter (which include both inpatient and outpatient episodes of care). Uncomplicated diverticulitis was defined as diverticulitis absent any concurrent diagnoses of abscess, peritonitis, bowel perforation, colonic stricture, colonic fistula, colonic bleeding, emergency colon resection, or percutaneous drainage of an intra-abdominal abscess. We excluded patients older than 18 years and those with prior colon cancer or colon operations (n = 3120 excluded). In order to accurately identify index episodes of diverticulitis, patients were excluded if they did not have 1 full year of continuous enrollment before index diagnosis that was free from the diagnosis of diverticulitis (n = 9163 excluded), of if they had discontinuous enrollment between treatment and outcome (n = 2115 excluded). We calculated the Deyo-adapted Charlson Comorbidity Index(CCI),[25] and identified patients with diagnoses of immunosuppression: malignancy (except non-melanoma skin cancer), lymphoma, human immunodeficiency virus, steroid use, solid organ transplant, and other immunologic disorders.[26–28] All codes used in cohort selection and treatment definitions are listed in Appendix A, http://links.lww.com/SLA/B791. A diagram of all patient exclusions is found in Appendix B, http://links.lww.com/SLA/B791. Differences between treatment groups were assessed by Chi-squared tests for categorical data and by Student *t* tests and Kruskal-Wallis test for normally and non-normally distributed continuous variables, respectively.

Treatment Types

Medical therapy was classified as a physician encounter with a diagnosis of diverticulitis and either an associated hospitalization during the 6 weeks following diagnosis (inpatient medical therapy), or a prescription filled for oral antibiotics used to treat diverticulitis within 1 week of diagnosis (outpatient medical therapy). An episode was defined as elective surgery if surgical resection of the colon occurred during the 6 weeks following the beginning of diverticulitis-related treatment for that episode. This was meant to capture elective operations which may have been preceded by an outpatient clinic visit (eg, a preoperative visit with a surgeon which billed for diverticulitis). We did not include patients with potentially emergent operations on their second treatment episode by excluding surgeries that occurred within 1 week of an emergency room visit.[29] Figure 1 demonstrates a conceptual timeline for washout, claims, treatment encounters, and follow-up.

Outcomes

Because numerous claims may be generated around the time of a single episode of diverticulitis, we assigned 6-week windows to capture all claims for a single episode of disease.[30] We defined diverticulitis recurrence as any subsequent encounter for diverticulitis treatment (including inpatient, outpatient, complicated, uncomplicated, medical, or surgical) occurring greater than 6 weeks following the previous episode. Outpatient recurrences were defined by a diagnosis of diverticulitis and a concomitant antibiotic prescription. Patients were followed for all subsequent treatment encounters until disenrollment from their current health plan or until the end of 2014, whichever occurred first. Figure 1 demonstrates a conceptual timeline for washout, claims, treatment encounters, and follow-up. For patients who required an ostomy during primary elective surgical treatment, time-to-event was considered one day. We believe that patients would rate ileostomy (created to protect an anastomosis) and colostomy (created because of severe inflammation, perforation, or abscess) as equally poor outcomes. Therefore, we measured the rate of any ostomy as a single outcome. We report the proportion of patients with recurrence and ostomy at 1, 3, and 5 years among those patients with continuous enrollment since treatment, respectively.

Survival Analysis

We performed a survival analysis to determine the hazard of diverticulitis recurrence and subsequent ostomy. Recurrence-free survival is summarized via Kaplan-Meier plots. Controlling for patient age, sex, CCI, immunosuppression, and health plan type, we performed a Cox regression analysis to assess the hazards of recurrence and subsequent ostomy associated with either treatment. The proportional hazards assumption was tested by plotting scaled Schoenfeld residuals over survival time. Data were missing only for health plan type in 2% of subjects and analysis did not reveal any significant differences in covariates for those with and without missing data; therefore, complete-case analysis was adopted.

Sensitivity Analyses

Because of the potential for bias in cohort and treatment selection, we performed 3 sensitivity analyses. First, because outcomes for patients after their second treatment encounter may vary from patients treated on later encounters, we assessed the rate and hazard of recurrence and ostomy among patients treated for uncomplicated disease by medical or surgical therapy on their third through fifth treatment encounter (among those patients who had been treated medically for uncomplicated disease on prior encounters). Second, because a 1-year washout period may not have accurately defined index disease, we also assessed the rate and hazard of recurrence and ostomy among patients with 3 and 5 years of disease-free enrollment before index diagnosis. Third, because patients treated medically as outpatients may have less severe disease than those treated medically as inpatients, we assessed the rate and hazard of recurrence and ostomy among those treated medically as inpatients and outpatients separately compared with elective surgery. All analyses we performed using commercially available software (Stata v14.2 IC, StataCorp, College Station, TX).

RESULTS

A total of 12,073 patients (mean age 56 yr, 59% female, 10% immunosuppressed) were treated on a second encounter for uncomplicated diverticulitis. Patient characteristics are summarized in Table 1. Median length of hospitalization at the index hospitalization was 3 days [interquartile range (IQR) 2–4 days]. On their second treatment encounter, 81% of patients (n = 9832) were treated by medical therapy, whereas 19% (n = 2241) underwent elective surgery. Nearly all patients underwent computed tomography scanning at their index diagnosis or second episode of disease (93.9% for medical therapy, 92.7% for surgical therapy). The median time between index diagnosis and second treatment encounter was 199 days ([QR 85–475; 257 days (IQR 105–551) for the medical therapy group, and 88 days (IQR 60–143) for the elective surgery group]. Patients treated by elective surgery were younger, more often men, less commonly immunosuppressed and a greater proportion had no comorbid conditions (all $P < 0.001$). There were no differences in health plan types

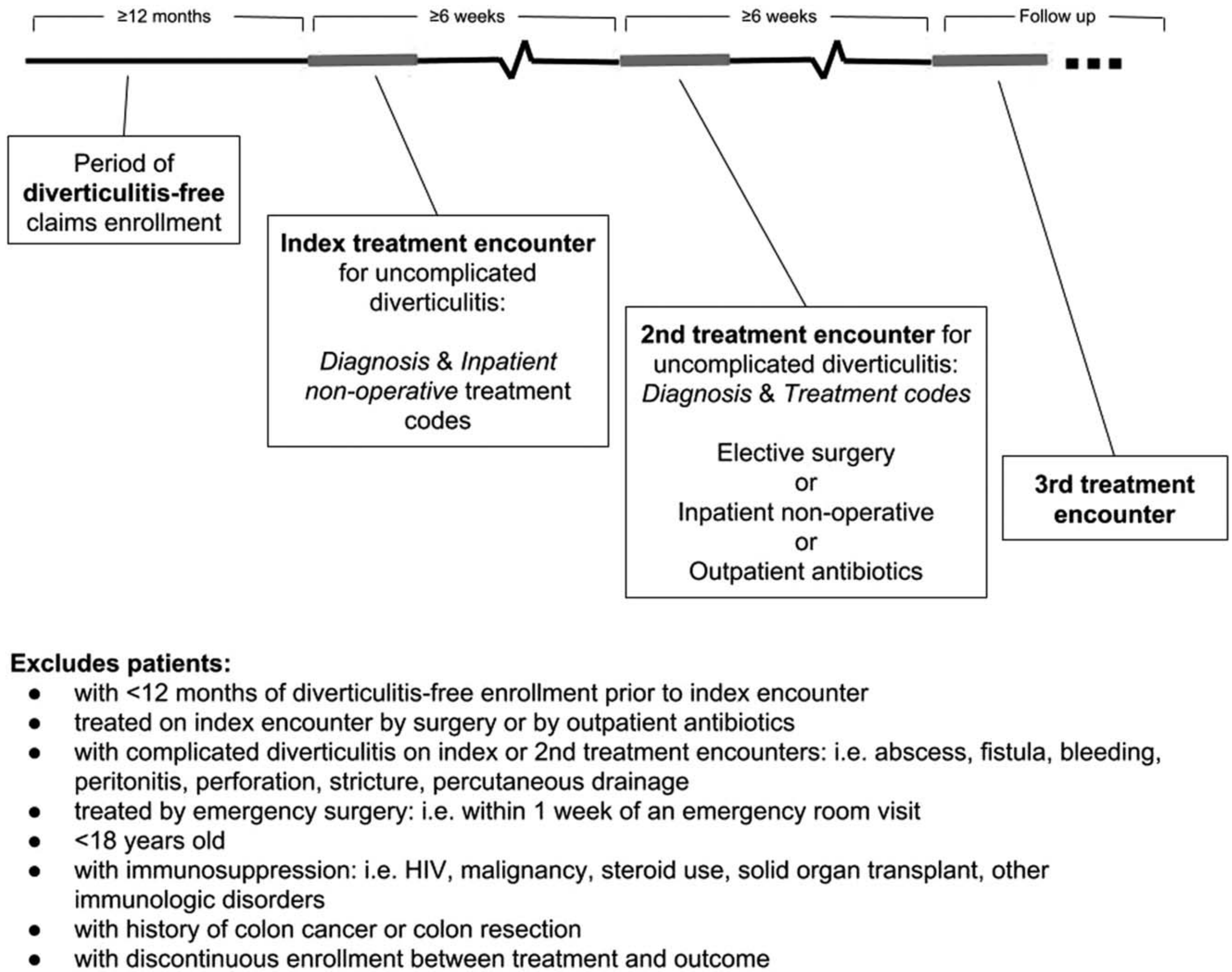

FIGURE 1. A conceptual timeline for washout, claims, treatment encounters, and follow-up.

by treatment group ($P = 0.13$). Compared with patients who did not have evidence of recurrent diverticulitis, those who recurred were slightly younger (54.6 vs 56.3 yr, $P < 0.001$) and less likely to have comorbidities (CCI ≥ 2, 17% vs 21%, $P < 0.001$). These groups, however, did not differ by other factors. Similarly, patients who ultimately received an ostomy were only slightly more likely to have comorbidities (25% vs 19%, $P = 0.04$, Tables 2 and 3).

Median follow-up time was 537 days (IQR: 229–1042 days). Of all patients, 3844 (32%) had subsequent treatment encounters for recurrent diverticulitis (50% outpatient recurrences, 4% recurrences requiring emergency operation). Among patients with 1 year of follow-up, 32% treated medically and 6% of those treated by elective surgery had recurrence of diverticulitis by 1 year. At 3 years, the rate of recurrence was 51% after medical therapy and 12% after elective surgery (61% and 15% at 5 yr, Table 4). After adjusting for differences between groups, patients treated with elective surgery had an 83% lower hazard of diverticulitis recurrence compared with those treated by medical therapy [hazard ratio (HR): 0.17, 95% confidence interval (CI): 0.15–0.20]. Median time to recurrence was shorter among patients treated medically [165 days (IQR: 76–396 days)] than those treated surgically [272 days (IQR: 82–612 days)]. Figure 2 demonstrates Kaplan-Meier curves for survival from recurrence of diverticulitis at the second treatment encounter. As after the second treatment encounter, rates of diverticulitis recurrence at 1 year were higher for medical therapy compared with elective surgery on the third [44% vs 9%, HR 0.18 (95% CI: 0.14–0.23)], fourth [53% vs 6%, HR 0.09 (95% CI: 0.05–0.14)], and fifth treatment encounter [54% vs 7%, HR 0.18 (95% CI: 0.09–0.34)] (Table 5). Kaplan-Meier curves for recurrence on later encounters are included in Appendix C, http://links.lww.com/SLA/B791.

At 1 year, 1.6% of patients treated medically and 4.0% patients treated by elective surgery had an ostomy ($P < 0.001$, Table 4). Among patients with 3 years of follow-up, rate of ostomy did not appear higher in either group (1.8% after medical therapy vs 2.9% after elective surgery, $P = 0.09$). The adjusted hazard of receiving an ostomy was more than twice as high in the elective surgery group compared with medical therapy (adjusted HR: 2.3, 95% CI: 1.8–3.0) but this model did not fulfill the proportional hazards assumption. Importantly, ostomies in the elective surgery group were related to the index elective resection with all but 2 ostomies occurring within 6 weeks of primary treatment (76% within 1 week of elective surgery). We cannot determine from claims data whether these ostomies were performed prophylactically, because of anatomical challenges, or because of postoperative anastomotic

TABLE 1. Demographics and Survival Characteristics of Patients Treated by Medical Therapy or Elective Surgery on Second Treatment Encounter

	Medical Therapy n = 9832	Elective Surgery n = 2241	All Patients n = 12,073	*P*
Demographics				
Age, mean (SD)	56.6 (14.3)	52.0 (10.6)	55.7 (13.8)	<0.001
Female, n (%)	5878 (60)	1234 (55)	7112 (59)	<0.001
Charlson Comorbidity Index, n (%)				<0.001
0	5789 (59)	1553 (69)	7342 (61)	
1	1969 (20)	412 (18)	2381 (20)	
≥2	2074 (21)	27 (12)	2350 (19)	
Immunosuppressed, n (%)	1056 (11)	177 (8)	1233 (10)	<0.001
Utilization				
Median length of index hospital stay, days (IQR)*	3 (2–4)	3 (2–4)	3 (2–4)	<0.001
Median days between index episode and second treatment episode, days (IQR)	257 (105–551)	88 (60–143)	199 (85–475)	<0.001
CT scan at index or second episode of care, n (%)	8724 (89)	2047 (91)	10,771 (89)	<0.001
Health insurance type, n (%)				0.13
HMO or Capitated POS	1448 (15)	298 (14)	1746 (15)	
Standard private insurance	7687 (80)	1770 (81)	9457 (80)	
High deductible insurance	479 (5)	123 (6)	602 (5)	
Survival characteristics				
Median follow-up time, days (IQR)	526 (220–1013)	593 (273–1173)	537 (229–1042)	–
Recurrent diverticulitis, n (%)	3638 (37)	206 (9)	3844 (32)	<0.001
Median time to recurrence, days (IQR)†	165 (76–396)	272 (82–612)	168 (76–408)	–
Subsequent colostomy, n (%)	179 (1.8)	90 (4.0)	269 (2.2)	<0.001
Median time to colostomy, days (IQR)‡	159 (72–372)	1 (1–1)	74 (1–243)	–

*All patients in this cohort were hospitalized with medical therapy on their index episode of diverticulitis.
†Among those with recurrence.
‡Among those with subsequent colostomy.
CT indicates computed tomography.

TABLE 2. Factors Associated With Diverticulitis Recurrence

	Recurrence n = 3844	No Recurrence n = 8229	All patients n = 12,073	*P*
Demographics				
Age, mean (SD)	54.6 (12.8)	56.3 (14.2)	55.7 (13.8)	<0.001
Female, n (%)	2285 (59)	4827 (59)	7112 (59)	0.41
Charlson Comorbidity Index, n (%)				<0.001
0	2401 (62)	4941 (60)	7342 (61)	
1	780 (20)	1601 (19)	2381 (20)	
≥2	663 (17)	1687 (21)	2350 (19)	
Immunosuppressed, n (%)	398 (10)	835 (10)	1233 (10)	0.73
Health insurance type, n (%)				0.18
HMO or capitated POS	589 (16)	1157 (14)	1746 (15)	
Standard private insurance	2993 (79)	6464 (80)	9457 (80)	
High deductible insurance	184 (5)	418 (5)	602 (5)	

TABLE 3. Factors Associated With Receipt of Ostomy

	Ostomy n = 269	No Ostomy n = 11,804	All Patients n = 12,073	*P*
Demographics				
Age, mean (SD)	55.9 (12.4)	55.7 (13.8)	55.7 (13.8)	0.88
Female, n (%)	150 (56)	6962 (59)	7112 (59)	0.29
Charlson Comorbidity Index, n (%)				0.04
0	159 (59)	7183 (61)	7342 (61)	
1	43 (16)	2338 (20)	2381 (20)	
≥2	67 (25)	2283 (19)	2350 (19)	
Immunosuppressed, n (%)	30 (11)	1203 (10)	1233 (10)	0.61
Health insurance type, n (%)				0.76
HMO or capitated POS	38 (14)	1708 (15)	1746 (15)	
Standard private insurance	215 (81)	9242 (80)	9457 (80)	
High deductible insurance	11 (4)	591 (5)	602 (5)	

TABLE 4. Rate of Recurrence and Ostomy by Treatment Type on Second Treatment Encounter* at 1, 3, and 5 Years of Follow-up

	Recurrence Rate			Ostomy Rate		
	Medical Therapy	Elective Surgery	HR† (95% CI)	Medical Therapy	Elective Surgery	HR† (95% CI)
Rate at 1 yr (% w/ 1 yr f/u)	32% (62)	6% (68)	0.17 (0.15–0.20)	1.6% (62)	4.0% (68)	2.3‡ (1.8–3.0)
Rate at 3 yr (% w/ 3 yr f/u)	51% (22)	12% (28)		1.8% (22)	2.9% (28)	
Rate at 5 yr (% w/ 5 yr f/u)	61% (4)	15% (8)		2.3% (4)	1.8% (8)	

*Each prior encounter was for uncomplicated diverticulitis managed medically.
†Controlling for patient age, sex, Charlson Comorbidity Index, immunosuppression, and health plan type. Reference group is medical therapy.
‡Model failed to satisfy the proportional hazards assumption.

leaks. Conversely, there was a continuous distribution of ostomies after medical therapy. A logistic regression model controlling for covariates listed above revealed a 2.7 greater odds of ostomy after elective surgery at 1 year (95% CI: 1.9–3.8, proportional hazards not achieved). Cumulative risk of ostomy at 1 year remained low after treatment on the third (0.4% vs 3.9%, $P < 0.001$), fourth (0.5% vs 7.1%, $P < 0.001$), and fifth treatment encounter (0.8% vs 2.3%, $P = 0.43$) for medical therapy and elective surgery, respectively (Table 5).

On sensitivity analysis, we did not identify any influence of the length of continuous enrollment before the index episode of diverticulitis (washout period) on the risk of recurrence or the risk of ostomy by treatment group (Table 6). We also did not identify differences in outcomes due to the type of medical therapy (inpatient vs outpatient, Table 7) or in patients with immunosuppression.

DISCUSSION

Diverticulitis is one of the leading reasons for colostomy, a treatment outcome ranked among the worst nonlethal complications by patients and clinicians alike.[31,32] After an episode of diverticulitis there is a lifetime risk of disease recurrence[6]; therefore, when counseling patients, surgeons have historically recommended elective colon resection to prevent recurrent disease and/or a future more severe episode requiring emergent colostomy. Although the rates of emergency surgery for diverticulitis are highest on initial presentation,[5,6,33] the risk of ostomy following subsequent episodes has not been well described. Most administrative datasets are restricted to inpatient care which has made it difficult to describe rates of recurrence occurring in the outpatient setting. In this study, we address that limitation and demonstrate that, while patients treated with elective resection have a considerably lower hazard of disease recurrence compared with those treated medically, as many as 6% of patients will have recurrent disease within a year after elective surgery, and that rate is as high as 15% by 5 years. Counter to our hypothesis, the rate of a subsequent ostomy is low for both treatments but is greater among patients treated surgically. Furthermore, in our study nearly all ostomies occur either at the time of elective resection or shortly thereafter rather than during subsequent surgical emergencies. To our knowledge this is the first time that

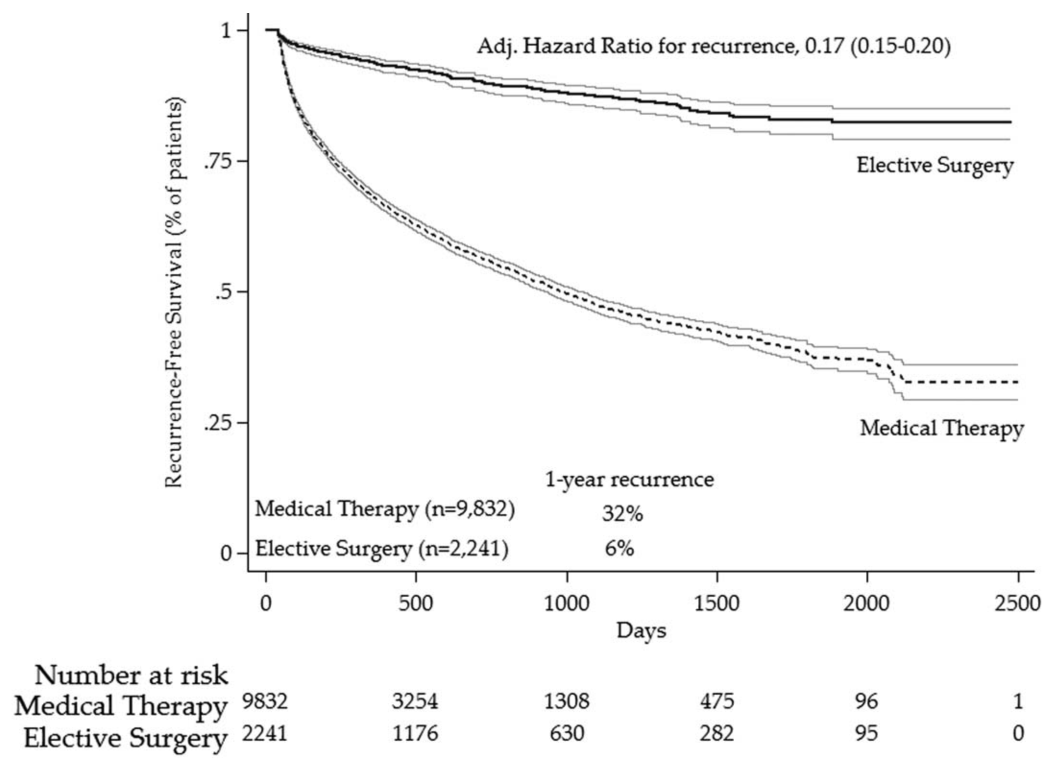

FIGURE 2. Kaplan-Meier curves for survival from recurrence of diverticulitis after medical therapy or elective surgery.

TABLE 5. Risk of Recurrence and Ostomy by Treatment type on Second, Third, Fourth, and Fifth Treatment Encounter*

	1-yr Recurrence Rate (% Patients w/1-yr Follow-up)			1-yr Ostomy Rate (% Patients w/1-yr Follow-up)		
	Medical Therapy	Elective Surgery	HR† (95% CI)	Medical Therapy	Elective Surgery	HR† (95% CI)
Medical therapy (n = 9832) vs elective surgery (n = 2241) on second treatment encounter*	32% (62)	6% (68)	0.17 (0.15–0.20)	1.6% (62)	4.0% (68)	2.3‡ (1.8–3.0)
Medical therapy (n = 2412) vs elective surgery (n = 617) on third treatment encounter*	44% (59)	9% (66)	0.18 (0.14–0.23)	0.4% (59)	3.9% (66)	7.8‡ (3.9–15.7)
Medical therapy (n = 709) vs elective surgery (n = 221) on fourth treatment encounter*	53% (56)	6% (64)	0.09 (0.05–0.14)	0.5% (56)	7.1% (64)	6.7‡ (2.3–19.1)
Medical therapy (n = 232) vs elective surgery (n = 72) on fifth treatment encounter*	54% (55)	7% (61)	0.18 (0.09–0.34)	0.8% (55)	2.3% (61)	1.1‡ (0.10–11.8)

*Each prior encounter was for uncomplicated diverticulitis managed medically.
†Controlling for patient age, sex, Charlson Comorbidity Index, immunosuppression, and health plan type. Reference group is medical therapy.
‡Model failed to satisfy the proportional hazards assumption.

recurrence of diverticulitis and the long-term risk of ostomy have been assessed from the perspective of both the inpatient and outpatient burden of disease. Our findings have important implications when counseling patients about the choice of elective surgery to prevent the impact of future episodes of diverticulitis or risk of ostomy.

Observational studies on inpatient diverticulitis suggest that up to one-third of patients with acute diverticulitis will go on to have a recurrence.[20,21,34] In this study, estimates of recurrence after medical therapy alone (32% at 1 yr, 61% at 5 yr) are likely somewhat higher than previously reported by capturing episodes managed in the outpatient setting.[35] It was previously thought that recurrent diverticulitis represented a more virulent form of disease and was therefore more likely to fail medical treatment.[36] As a result, elective surgery was recommended to prevent such recurrences after the second episode. But this belief has been challenged[35] and guidelines now discourage the ‘‘2-strikes, you're out'' approach, favoring individualization based on patient concerns.[2] For many patients those concerns relate to fear of an ostomy, and elective colon resection is often presented as a long-term cure from recurrence and avoidance of colostomy. Despite this perspective, as many as 25% of patients have persistent symptoms after resection.[20] A small number of studies have described a risk of recurrent diverticulitis which persists after colon resection ranging from 5.8%-8.7%.[30,35,37,38] Lingering symptoms are often ascribed to inadequate resection and these recurrences are thought to be driven by inflammation of either newly formed or previously unresected diverticulae after a colosigmoid anastomosis.[30] Our study confirmed this rate of recurrence across a national sample, reporting a 1-year recurrence rate of 6% following elective surgery at the second encounter (and 7%–9% after surgery at later encounters). For patients with 3 to 5 years of follow-up (the minority of patients in this cohort), recurrence after surgery reached 12% to 15%.

The risk of colostomy is a serious concern of many patients,[31] and a motivating factor for choosing between medical therapy and surgery is the fear of a future emergent surgery resulting in a colostomy. Although this fear was a driver of older recommendations for early surgical intervention,[11,12] previous analyses reported that only a small number of patients ever go on to require emergent colostomy after an index episode (5.5%),[6] and approximately 18 patients would need to undergo elective resection for diverticulitis to prevent a single emergent surgery.[2,6]

To date, the risk of ostomy has been attributed to subsequent emergency operations, but when a patient undergoes elective

TABLE 6. Risk of Recurrence and Ostomy by Treatment Type on Second Treatment Encounter* After 1, 3, and 5-Years Diverticulitis-free Enrollment

	1-yr Recurrence Rate (% Patients w/1-yr Follow-up)			1-yr Ostomy Rate (% Patients w/ 1-yr Follow-up)		
	Medical Therapy	Elective Surgery	HR† (95% CI)	Medical Therapy	Elective Surgery	HR† (95% CI)
Medical therapy (n = 9832) vs elective surgery (n = 2241) after 1 yr disease-free enrollment	32% (62)	6% (68)	0.17 (0.15–0.20)	1.6% (62)	4.0% (68)	2.3 (1.8–3.0)
Medical therapy (n = 3755) vs elective surgery (n = 734) after 3 yr disease-free enrollment	32% (58)	8% (67)	0.19 (0.15–0.25)	1.7% (58)	4.0% (67)	2.4‡ (1.5–3.7)
Medical therapy (n = 1134) vs elective surgery (n = 227) after 5 yr disease-free enrollment	35% (41)	9% (53)	0.17 (0.10–0.29)	1.3% (41)	5.7% (53)	7.0‡ (2.9–17.0)

*Each prior encounter was for uncomplicated diverticulitis managed medically.
†Controlling for patient age, sex, Charlson Comorbidity Index, immunosuppression, and health plan type. Reference group is medical therapy.
‡Model failed to satisfy the proportional hazards assumption.

TABLE 7. Risk of Recurrence and Ostomy by Treatment Type Comparing Inpatient and Outpatient Medical Therapy on Second Treatment Encounter*

	1-yr Recurrence Rate (% Patients w/1-yr Follow-up)			1-yr Ostomy Rate (% Patients w/1-yr Follow-up)		
	Medical Therapy	Elective Surgery	HR† (95% CI)	Medical Therapy	Elective Surgery	HR† (95% CI)
All medical therapy (n = 9832) vs elective surgery (n = 2241)	32% (62)	6% (68)	0.17 (0.15–0.20)	1.6% (62)	4.0% (68)	2.3‡ (1.8–3.0)
Outpatient medical therapy (n = 6505) vs elective surgery (n = 2241)	30% (64)	6% (68)	0.19 (0.16–0.21)	1.1% (64)	4.0% (68)	3.4‡ (2.3–4.2)
Inpatient medical therapy (n = 3327) vs elective surgery (n = 2241)	37% (60)	6% (68)	0.14 (0.12–0.16)	2.4% (60)	4.0% (68)	1.6‡ (1.2–2.2)

*Each prior encounter was for uncomplicated diverticulitis managed medically.
†Controlling for patient age, sex, Charlson Comorbidity Index, immunosuppression, and health plan type. Reference group is medical therapy.
‡Model failed to satisfy the proportional hazards assumption.

resection for diverticulitis, they also incur a risk of ostomy during the preventative operation. Approximately 2%to 5% of colonic anastomoses sustain disruption requiring reintervention,[39] some of which require a rescue colostomy. Surgeons sometimes employ temporary protective ostomies at the time of elective resection as well. The identified ostomy rate of 4.0% at 1-year following elective surgery is consistent with finding from others,[22–24] but considering the very low rate of ostomy in the medical group (1.6%) may influence the decision making of those aiming to avoid this outcome. The difference in risk of ostomy between groups may not be clinically significant, but patients should be counseled that while the risk of ostomy is low ($\leq$5%) it is unlikely to be improved by an elective resection, and is actually higher when considering the risk of stoma with the elective procedure.

In this study, both treatment groups have been restricted by excluding patients with potential indications for colon resection according to current guidelines (ie, abscess, fistula, stricture, bleeding, perforation, peritonitis, or emergent presentation). Nonetheless, being an observational study of uncomplicated diverticulitis, these treatment groups likely do differ in both the timing and frequency of symptoms. In fact, the time between first (index) and second episodes differed between patients treated with elective surgery [median 88 days IQR (60–143 days)] and those treated by medical therapy [median 257 (IQR 105–551]. This suggests that patients treated by elective surgery may be more likely to experience ‘‘smoldering diverticulitis’’ or some form of more virulent or burdensome disease that is manifest as earlier surgery than the medically treated cohort. This hypothesis warrants further study as current guidelines do not address this subgroup of patients and when intervention for their disease is most appropriate.[2]

Studies using administrative data have important limitations. Diagnoses applied to claims may be carried forward from encounter to encounter within a patient's chart. To handle this uncertainty about true episodes of disease and the severity of any recurrence (such as presence or absence of complicated factors like abscess or fistula), we specified that all encounters for diverticulitis should be concurrent with at least 1 form of treatment (inpatient admission, operation, or outpatient antibiotic prescription). Another challenge to comparing outcomes between treatments in observational cohorts is the potential for differences in disease severity between treatment groups (ie, unmeasured confounding by indication) and a lack of certainty about the elective or emergent nature of a colon resection. A clinician may recommend either surgery or antibiotics based on symptom burden, disease severity, or their own specialty, but these factors are not captured by administrative databases. This study was carefully restricted to patients with uncomplicated diverticulitis (excluding abscess, peritonitis etc) to diminish the heterogeneity of disease severity. Furthermore, we do not know whether some episodes of recurrence represent, instead, persistent smoldering disease. It may be that there are unmeasured drivers of surgery in the surgical cohort such as persistent inflammation on computed tomography scan, persistent leukocytosis on repeat labs, or persistent symptoms leading to more visits or longer stays that warrant characterization in a cohort with detailed clinical data. A dataset spanning a greater number of years would allow for longer periods of washout and follow-up. For example, future inquiry should include measuring the proportion of patients who go on to have their stomas closed.

Lastly, the MarketScan database provides claims from Americans with private insurance and does not include the Medicaid or uninsured populations and therefore is not fully generalizable. Furthermore, by restricting to patients with continuous enrollment, we are selecting a cohort with stable, full-time employment who therefore may be healthier than other groups. Also, because patients appear to be frequently disenrolled from private insurance, estimates of outcomes at 3 and 5 years after an event may be imprecise due to low rates of follow-up (24%–28% and 4%–8%, respectively). Despite this limitation, to our knowledge, this study is the largest published to date from both inpatient and outpatient claims for diverticulitis and provides valuable insights not available through other data sources.

CONCLUSIONS

For patients with a history of uncomplicated diverticulitis, surgeons have previously recommended surgery to avoid recurrence and to decrease the chances of a future ostomy. This study shows that, while elective surgery clearly diminishes a patient's risk of disease recurrence, 6% to 15% of those treated with elective surgery will have a recurrence in the 5 years after surgery. Our findings also suggest that the risk of a future ostomy is low regardless of treatment choice but actually may be higher in patients having elective surgery when considering the risk of stoma related to elective resection. These findings challenge the appropriateness of elective surgery for the prevention of ostomy and should be useful in informing decision making.

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