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20-Year Trends in the Management of Diverticulitis Across New York State: an Analysis of 265,724 Patients

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Abstract

Introduction Management of acute diverticulitis (AD) has considerably changed over time. This study evaluates practice patterns for diverticulitis across demographic populations in New York State.

Methods Two hundred sixty-five thousand seven hundred twenty-four patients with acute diverticulitis were analyzed from 1995 to 2014 from the New York-Statewide Planning and Research Cooperative System database. The likelihood of having surgery over time was compared across patient demographic subgroups using logistic regression models to calculate estimated odds ratio with their 95 % confidence intervals. Using Chi-square test and Welch's *t* test, categorical and continuous variables were compared.

Results From 1995 to 2014, there was an increase in newly diagnosed diverticulitis patients while the proportion of those patients undergoing operative management steadily decreased (31 to 10 %, $p < 0.0001$). Of those receiving surgery, emergent surgeries decreased (58 to 47 %, $p < 0.0001$) while elective surgeries increased (42 to 53 %, $p < 0.0001$) with the odds of having emergency surgery decreasing by 4 % annually (OR 0.96 (0.95–0.97), $p < 0.0001$). With the exception of patients greater than 80 years old, these linear trends were substantiated across patient subgroups.

Conclusions Over the past 20 years in New York State, there has been an increase in diverticulitis diagnoses and hospital admissions, with a decrease in surgeries performed reflecting a shift towards conservative management and more effective antibiotic treatment.

Keywords Diverticular · Diverticulitis · Management

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Introduction

Diverticular disease of the colon is one of the most prevalent conditions in western society and is a leading cause of both outpatient visits and hospitalizations.[1] Diverticulitis, the acute inflammation and/or infection of the colonic diverticulum, is commonly an emergent condition.[2] Diverticulitis affects 70 % of Americans by age 80, and healthcare-related costs may exceed 4.5 billion dollars annually in the USA.[3] Acute diverticulitis is also responsible for around 314,000 annual discharges, 1.5 million days of care, and accounts for an average length of stay of 4.8 days.[4]

The two mainstays of treatment are broad-spectrum antibiotics along with bowel rest and surgical intervention[5] Antibiotic therapy is reserved for initial presentation of

uncomplicated acute diverticulitis.[6–8] Emergent surgical management is reserved for patients with life-threatening complications,[9] while elective surgical management is used in cases of recurrence, and/or when conservative management fails to resolve symptoms[10] These management decisions frequently incorporate patient preferences as well.

The management of diverticulitis is often dependent upon physician preferences, patient preference, patient's medical history, and available resources. One study showed significant national variability among physicians choosing to employ surgical management.[11] Other studies have also suggested that race and insurance status were associated with different management patterns for diverticulitis patients, as well as differences in mortality.[12] Despite all this data, no correlative trends have been characterized in the state of New York between vulnerable populations (including racial, ethnic, age, gender, and socioeconomic cohorts) and diverticulitis management.

Our study sought to explore and identify any correlative relationships in management of diverticulitis and, if present, analyze their significance, with the potential to re-focus and refine resources, funding, and/or research efforts associated with the care of diverticulitis in New York and the USA.

Materials and Methods

Following approval by our institutional review board (IRB) and the New York Department of Health (DOH), 265,724 patients with the primary diagnosis of diverticulitis from 1995 to 2014 were identified from the New York Statewide Planning and Research Cooperative System (SPARCS) administrative database. SPARCS is a longitudinal comprehensive data reporting system which collects patient level data on patient characteristics, diagnoses and treatments, services, and charges for hospital discharge, ambulatory surgery patient, and emergency department admission in New York State. Data is collected from all Article 28 Facilities in New York State as well hospital-based and free-standing ambulatory surgery facilities. Patients were identified via the SPARCS database using International Classification of Diseases, Ninth Revision (ICD-9) primary diagnosis code for diverticulitis (ICD-9 562.11, 562.13) from both inpatient and outpatient records. Among records with primary diagnosis of diverticulitis, to define if any procedure was performed during that visit, primary procedure column was further searched for ICD9 codes from both inpatient files (1995–2014) and outpatient files (1995–2007) (Table 1), and seven CPT columns were searched for CPT codes from outpatient files (2008–2014) (Table 2). Among these records, there were 2788 in-hospital deaths. Patients younger than 18 or without complete records were excluded from the study population.

Primary procedures were defined as either emergent or elective. If the type of inpatient admission was classified as emergent or urgent in SPARCS database and that patient went on to have a procedure performed during that admission, the surgery type was defined as emergent for the purposes of this study. If the type of inpatient admission was classified as anything else and the patient went on to have a procedure performed during that admission, the surgery type was defined as elective. For all outpatient procedures performed, the surgery type was defined as elective.

Chi-square test and Welch's t test were used to compare categorical variable and continuous variables, respectively. Logistic regression was performed to compare linear trends of emergent surgery percentage within each subgroups of age group, gender, payment type, and race/ethnicity. Trends for the percentage of each subgroup were illustrated by the estimated odds ratio along with their 95 % confidence intervals. All analysis was performed using SAS 9.3 (SAS Institute Inc., Cary, NC), and significance level was set at 0.05. All statistical analyses were performed and reviewed by a statistician (J.Y.).

Results

Table 3 and Fig. 1 show the number of newly diagnosed patients in each year from 1995 to 2014, which increased by 206 % from 8505 patients in 1995 to 17,578 patients in 2014. Table 3 also shows the number of patients who went on to have surgery that year, as well as whether or not their surgery was emergent or elective.

Figure 2 shows the trend of the total surgery, emergent, and elective surgery percentages from Table 3. Overall, there is a decreasing trend in the percentage of emergent surgery over time: the odds of having emergent surgery decreased by 3.79 % yearly (OR: 0.9621, 95 % CI: 0.9592–0.9651, p value < 0.0001). In addition, the percentage of newly diagnosed patients who went on to have surgery decreased from around 31 % in 1995 to 10 % in 2014.

Figure 3 shows the percentage of emergent surgery over years by patients' characteristics such as age (Fig. 3a), gender (Fig. 3b), race/ethnicity (Fig. 3c), and payer (Fig. 3d). Table 4 shows the odds ratio of yearly trends of emergent surgery percentage given by patient's demographics. The linear trends were significantly different across gender, race/ethnicity, and most payment methods (p values < 0.001). For patients older than 80 years old, the yearly trend is not significant (p value = 0.0738). However, the linear trends were significantly different across all other age groups (p value < 0.001).

Discussion

This studied showed an incremental increase in nonoperative management over the past 20 years. Our data showed the percentage of patients receiving surgery in 1995 was 31 %

Table 1 Defined procedures and ICD-9 procedure codes for inpatient (1995–2014) and outpatient (1995–2007)

Procedure	ICD-9 code
Laparoscopic right hemicolectomy	17.33
Laparoscopic left hemicolectomy	17.35
Laparoscopic sigmoidectomy	17.36
Open robotic assisted procedure	17.41
Laparoscopic robotic assisted procedure	17.42
Percutaneous robotic assisted procedure	17.43
Other and unspecified robotic assisted procedure	17.49
Open and other right hemicolectomy	45.73
Open and other left hemicolectomy	45.75
Open and other sigmoidectomy	45.76
Laparoscopic total intra-abdominal colectomy	45.81
Open total intra-abdominal colectomy	45.82
Other and unspecified total intra-abdominal colectomy	45.83
Intestinal anastomosis, not otherwise specified	45.9
Small-to-small intestinal anastomosis	45.91
Anastomosis of the small intestine to rectal stump	45.92
Other small-to-large intestinal anastomosis	45.93
Large-to-large intestinal anastomosis	45.94
Anastomosis to the anus	45.95
Exteriorization of the small intestine	46.1
Temporary colostomy	46.11
Permanent colostomy	46.13
Delayed opening of colostomy	46.14
Closure of fistula of the duodenum	46.72
Closure of fistula of the small intestine, except the duodenum	46.74
Closure of fistula of the large intestine	46.76
Revision of anastomosis of the small intestine	46.93
Revision of anastomosis of large intestine	46.94
Transsacral rectosigmoidectomy	48.61
Closure of other rectal fistula	48.73
Repair of perirectal fistula	48.93
Closure of anal fistula	49.73
Exploratory laparotomy	54.11
Reopening of recent laparotomy site	54.12
Other laparotomy	54.19
Laparoscopy	54.21
Repair of fistula involving the bladder and intestine	57.83
Repair of other fistula of the bladder	57.84
Repair of colovaginal fistula	70.72
Repair of rectovaginal fistula	70.73
Repair of other vaginoenteric fistula	70.74
Repair of other fistula of the vagina	70.75

as compared to 10 % in 2014 in the setting of increasing cases of diverticulitis. Currently, guidelines suggest bowel rest or intake of oral fluids, and a 7–10-day regimen of broad-spectrum antibiotics is recommended in patients with uncomplicated acute diverticulitis (AD).[13] This treatment strategy has been reported to be successful in 85–100 % of patients.[14,15] In addition, one study corroborates that nonoperative management is safe in patients with AD because fewer than 5 % of patients will need an emergent procedure should they have a subsequent attack.[16] This information is corroborated by the trends we observed. Interestingly, more recently, the AVOD and Cochrane trials have found that antibiotic

Table 2 Defined procedures and procedure codes for outpatient (2008–2014)

Procedure	CPT codes
Image-guided fluid collection drainage by catheter	10030
Incision and drainage, complex, postoperative wound infection	10180
Mobilization of splenic flexure performed in conjunction with partial colectomy	44139
Colectomy, partial	44140, 44141, 44143, 44144, 44145, 44146, 44147
Colectomy, total	44150, 44151
Laparoscopy, surgical; colectomy, partial	44205, 44206, 44208
Revision of colostomy	44340, 44345, 44346
Closure of enterostomy	44626
Closure of rectovesical fistula; with colostomy	45805
Closure of rectourethral fistula; with colostomy	45825

therapy did not prevent complications, accelerate recovery, or prevent recurrences[17], and there were no significant differences in treatment or complications between antibiotics and no antibiotics for the treatment of uncomplicated diverticulitis.[18] These findings suggest the use of an even more conservative approach consisting of intravenous hydration and bowel rest. With such debate, it was important to explore if clinical management trends mirrored the findings of recent studies.

In addition, our study found that management is trending towards elective surgery, with a decreasing percentage of emergent surgeries being performed. These shifts could reflect

Table 3 Frequency table for diagnosis and surgery records of diverticular disease (1995–2014)

Year	Patients diagnosed with diverticulitis	Patients who had surgery (%)	Surgery type	
			Emergent *N* (%)	Elective *N* (%)
1995	8505	2607 (30.65)	1508 (57.84)	1099 (42.16)
1996	8184	2441 (29.83)	1419 (58.13)	1022 (41.87)
1997	8902	2538 (28.51)	1443 (56.86)	1095 (43.14)
1998	9336	2628 (28.15)	1429 (54.38)	1199 (45.62)
1999	9435	2594 (27.49)	1351 (52.08)	1243 (47.92)
2000	10,162	2764 (27.2)	1416 (51.23)	1348 (48.77)
2001	10,913	2935 (26.89)	1557 (53.05)	1378 (46.95)
2002	11,107	3021 (27.2)	1525 (50.48)	1496 (49.52)
2003	12,135	2989 (24.63)	1493 (49.95)	1496 (50.05)
2004	13,908	3260 (23.44)	1554 (47.67)	1706 (52.33)
2005	14,773	3129 (21.18)	1420 (45.38)	1709 (54.62)
2006	15,572	3199 (20.54)	1407 (43.98)	1792 (56.02)
2007	15,687	3072 (19.58)	1326 (43.16)	1746 (56.84)
2008	15,602	3062 (19.63)	1267 (41.38)	1795 (58.62)
2009	15,774	2872 (18.21)	1207 (42.03)	1665 (57.97)
2010	16,291	2844 (17.46)	1175 (41.32)	1669 (58.68)
2011	16,998	2715 (15.97)	1097 (40.41)	1618 (59.59)
2012	17,620	2478 (14.06)	1034 (41.73)	1444 (58.27)
2013	17,242	2123 (12.31)	929 (43.76)	1194 (56.24)
2014	17,578	1778 (10.11)	835 (46.96)	943 (53.04)
Total	265,724	55,049 (20.72)	26,392 (47.94)	28,657 (52.06)

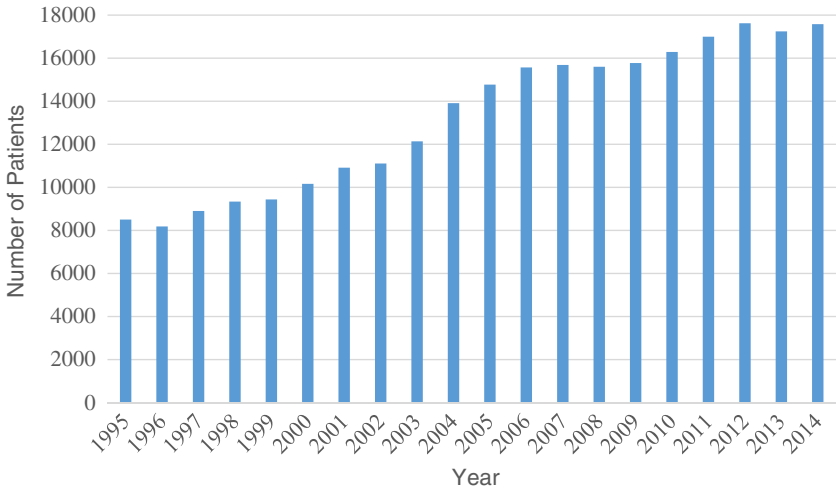

Fig. 1 Total number of patients who received primary diagnosis of acute diverticulitis from 1995 to 2014

the superior antibiotic therapy as well as recent management parameters suggesting elective procedures following two AD attacks. When to employ operative management on a patient suffering from AD has been a point of controversy for many years. Some studies concluded that the risk of emergency surgery increases with increasing number of recurrent attacks,[19] while others found that the risk of free perforation decreased with increasing number of previous episodes.[20] The decision to perform elective surgery to prevent recurrence has been controversial as well. Some studies suggest a patient's medical condition (i.e., age, comorbidities, symptoms, etc.) should influence the decision to perform elective procedures more so than the number of AD attacks,[21] while others find that performing elective surgery after two attacks significantly decreases morbidity and mortality.[22] Another line of argument is that elective surgery should be performed on patients under the age of 50 whom experience AD due to their longer life span and, thus, increased risk of reoccurrence,[23] but subsequent studies have found no significant differences in reoccurrence rates within this younger patient subgroup.[24,25]

Finally, our study explored whether or not these management trends were reflected across gender, race/ethnicity, payment type, and age subgroups. In all the subgroups besides payment subgroups "other" and "unknown" and age subgroup ">80," there was a significant decrease in the odds a patient received emergent surgery. This argues that management paradigms have changed equally regardless of patient demographics and socioeconomic status which is important when monitoring healthcare equality. Within the older ">80" age group, the trend was still towards nonoperative management, albeit not statistically significant, which could reflect the decreased likelihood of performing surgery on patients in that age group.

The strengths of the study include the sample size, dataset used, and years of analysis. SPARCS is an ideal database to capture admissions as it tracks data across all participating New York hospitals. By capturing all procedures and grouping them into emergent or elective categories, trends of nonoperative management in the past 20 years were able to be fully classified in the state of New York. Limitations of this study include all those that accompany use of an administrative database, namely coding errors as well as inability to access clinically rich data. Severity of disease, imaging, antibiotic choice, and duration of treatment were unable to be accounted for.

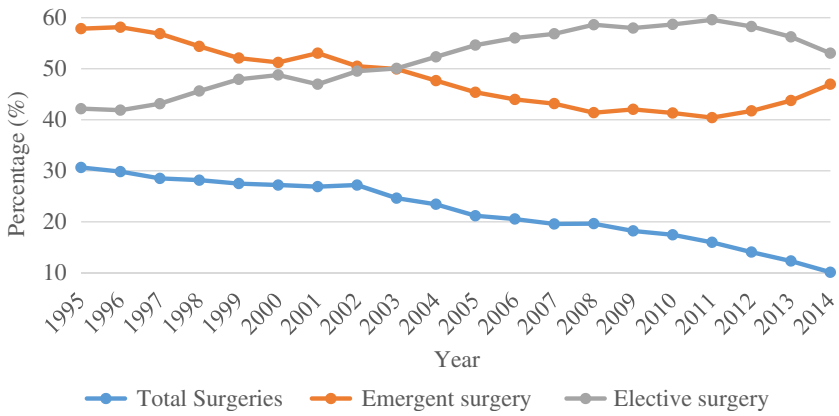

Fig. 2 Trend for percentage of patients who ever had surgery later on, emergent, and elective surgery

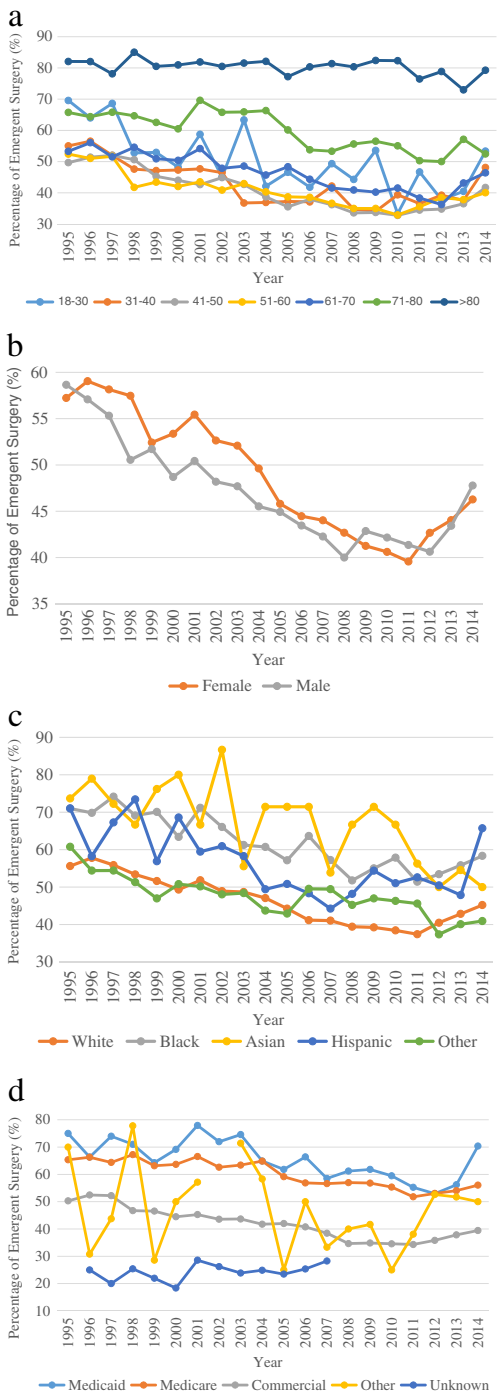

Fig. 3 Percentage of emergent surgery over years by patients' characteristics such as age (**a**), gender (**b**), race/ethnicity (**c**), and payer (**d**)

Conclusion

Over the past 20 years in New York State, there has been an increase in the prevalence of diverticulitis diagnoses and hospital admissions. Interestingly, there has been a significant shift toward nonoperative management, in particular at initial presentation as is represented by the decrease in percentage of patients receiving operative management. In addition, the percentage of patients within the operative management arm receiving emergent surgeries has decreased while elective surgeries has increased during this time. These trends were displayed across most gender, race/ethnic, payment type, and age subgroups with the notable exception of patients over 80 years old. The shift in management likely reflect more effective antibiotic treatment as well as changes in management paradigms favoring a more conservative approach. In order to more fully assess the benefits of operative vs. nonoperative management, longitudinal outcome analysis of the past 20 years can help shed light on whether or not this shift has resulted in superior patient care, as well provide information to help define more concrete management protocols to ensure safe and effective treatment of acute diverticulitis.

Table 4 Odds ratio of yearly trend of emergent surgery percentage given by patient's demographics

Patient demographics	OR	95 % CI	*P* value
Gender			
Female	0.9585	0.9544–0.9625	<0.0001
Male	0.9666	0.9621–0.971	<0.0001
Race/ethnicity			
White	0.9486	0.9084–0.9906	<0.0001
Black	0.9531	0.9395–0.967	<0.0001
Asian	0.966	0.9539–0.9782	<0.0001
Hispanic	0.9702	0.9616–0.9789	<0.0001
Other	0.9593	0.9559–0.9628	0.017
Payment			
Medicaid	0.9618	0.9579–0.9656	<0.0001
Medicare	0.9608	0.9467–0.9751	<0.0001
Commercial	0.9681	0.9628–0.9735	<0.0001
Other	0.9874	0.9475–1.0289	0.5446
Unknown	1.0227	0.9783–1.0692	0.3214
Age			
18–30	0.9504	0.9289–0.9723	<0.0001
31–40	0.9596	0.9496–0.9696	<0.0001
41–50	0.9589	0.952–0.9658	<0.0001
51–60	0.9685	0.9623–0.9747	<0.0001
61–70	0.9649	0.9586–0.9713	<0.0001
71–80	0.9654	0.9577–0.9731	<0.0001
>80	0.987	0.973–1.0013	0.0738

P value based on Wald test from multivariable logistic regression

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