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Variation of outcome and charges in operative management for diverticulitis

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Abstract

Background Outcomes after surgery for diverticulitis are of continued interest to improve quality of care. The aim of this study was to assess variations in mortality, length of stay, and patient charges between geographic regions of the United States.

Methods A retrospective analysis of the Nationwide Inpatient Sample database was performed. Adults with diverticulitis who underwent laparoscopic or open segmental colectomy were identified using ICD-9 codes. Subset analyses were performed by state and then compared. Outcomes included mortality, length of stay (LOS), and total charges. Results were adjusted for age, race, gender, findings of peritonitis, stoma placement, Charlson comorbidity index, and insurance status on multivariate analysis.

Results 148,874 patients underwent segmental colectomy for diverticulitis from 1998 to 2010. Using California as the comparison state and after adjusting for covariates, in-hospital mortality was significantly higher in the State of New York (OR 1.32; 95 % CI 1.13–1.55; $P < 0.05$) and Mississippi (OR 2.84; 95 % CI 1.24–6.51, $P < 0.02$). Wisconsin had a significant lower mortality rate (OR 0.74; 95 % CI 0.59–0.94, $P < 0.01$). LOS was 1.4 days longer in New York and 0.54 days shorter in Wisconsin than in California ($P < 0.01$). Patients with age >40 years, findings of peritonitis, and without private insurance had higher in-hospital mortality and longer length of stay. Average hospital charges differed dramatically between the states in the observation period. The highest hospital charges occurred in California, Nebraska, and Nevada while lowest occurred in Maryland, Wisconsin and Utah.

Conclusions Patients who undergo surgical treatment for diverticulitis in the United States have high geographic variation in mortality, LOS, and hospital charges despite adjusting for demographic and socioeconomic factors. Further analysis should be performed to identify the causes of outlier regions, with the goal of improving and standardizing best practices.

Keywords Diverticulitis · Colorectal surgery · Laparoscopic · Outcomes research · Quality control · Bowel

Abbreviations

AHRQ	Agency for healthcare research and quality
NIS	Nationwide Inpatient Sample
HCUP	Healthcare Cost and Utilization Project
OR	Odds ratio
SD	Standard deviation
DRG	Diagnosis-related group
U.S.	United States of America
LOS	Length of stay

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Diverticulitis of the colon accounts for more than 300,000 hospitalizations with approximately 3,400 deaths and results in $2.4 billion in direct health care costs each year in the United States (U.S.) [1–3]. From 1998 to 2005, annual age-adjusted admissions for diverticulitis increased by 26 % with a predilection for summer months after adjusting for age, sex, race, and geographic region [2, 4]. In Western countries, colon diverticula are present in 50 % of the population aged 50 and older, and symptomatic diverticulitis occurs in 10–30 % of patients; the annual admission and operation rates in the U.S. are 47 and 12 per 100,000 inhabitants [5]. Factors associated with diverticulosis include alterations in colonic wall resistance, colonic motility, and a low-fiber diet, which contributes to increased intraluminal pressure and weakness of the bowel wall [6].

Recent literature shows widespread variation in outcomes of certain surgical procedures in the United States [7–11]. In most western health care systems, geographic outcome variation in large population samples is difficult to measure due to the lack of international registries. However, even smaller national registries in single European countries show varying effects for colorectal cancer surgery or disease incidence [12–16]. For colorectal cancer, first promising attempts establishing international databases have been accomplished in Europe by the EURECCA group [17, 18].

Well-documented racial disparities and geographic variations of surgical outcomes cannot fully be explained by disease incidence or patient preferences, but are more likely the result of overuse and underuse of procedures [19]. Particularly for benign colorectal disease, outcome variability and the reasons for variation in length of stay (LOS), mortality, and charges are not well documented. In order to improve quality of care, comparing regions with different demographic and socioeconomic characteristics can help identify factors that may influence the outcomes in colorectal surgery. We used a national large administrative database to compare the in-hospital mortality, LOS, and hospital charges of partial colectomy for diverticulitis to determine the variability thereof. We hypothesize that there is significant variation in outcomes of partial colectomy for diverticulitis between different states in the U.S.

Materials and methods

Study population

We performed a retrospective analysis of the Nationwide Inpatient Sample (NIS), a nationwide database sponsored by the AHRQ as part of the Healthcare Cost and Utilization Project (HCUP), which provides a representative 20 % sample of hospital discharge records from 37 states [20]. Unweighted, it contains data from more than 7 million hospital stays each year. Weighted, it estimates more than 36 million hospitalizations nationally. The NIS provides information for each hospital admission including age, gender, race, income, insurance status, comorbidities (listed as secondary diagnoses), hospital location (rural or urban), and hospital type (teaching or non-teaching). The data were enriched by calculating the Charlson Comorbidity Index as per Deyo et al. adaptation for administrative data sets [21]. This study was deemed exempt by the UCSD institutional review board.

Case selection

We searched the period 1998–2010 using the International Classification of Diseases, 9th ed (ICD-9) procedure codes and identified patients recorded as having undergone partial colectomy (ICD-9 procedure codes 17.33, 17.34, 17.35, 17.36, 17.39, 45.73, 45.74, 45.75, 45.76, 45.79) for diverticulitis (ICD-9 diagnosis codes 562.11 and 562.13). For laparoscopic procedures without defined ICD-9 procedure codes and for data collected when no defined laparoscopic categories for colorectal procedures existed, we used the generic laparoscopic code (54.21) in conjunction with the specific open procedure code. Severity of the disease was measured according to Hinchey et al. by identifying patients with diagnosis codes for peritonitis [22]. Stoma placement was defined as a proximal loop ileostomy or colostomy (defined as either diverting or end colostomy). We excluded patients younger than 18 years and operations performed at charity hospitals (defined as total hospital charges <$10,000).

Outcomes of interest

The primary outcome of interest was in-hospital mortality. Adjusted length of stay and total hospital charges (adjusted for inflation to reflect 2010 US dollars) were also examined. In order to determine variation, we compared these outcomes between the different states in the U.S.

Statistical analysis

The Student t test (for continuous variables) and Chi-Square test (for nominal or categorical variables) were used for all bivariate analyses. Logistic regression analysis was performed to determine the independent predictors of mortality after partial colectomy while adjusting for age, sex, race, state, insurance status, hospital volume, elective cases, presence of peritonitis, stoma placement, laparoscopic cases, and comorbid disease as measured by the Charlson Comorbidity Index score. Subset analyses were repeated for each state. All tests were 2-sided, with statistical significance set at $P \leq 0.05$. All statistical analyses were performed with Stata MP, version 11.2 (Stata Corp, College Station, TX, USA).

Results

Study population

A total number of 148,874 patients underwent segmental colectomy for diverticulitis from 1998 to 2010. Half of the population underwent an elective procedure, one-third had a stoma placed, and less than one-tenth had very severe disease as defined by peritonitis (Hinchey 3–4). The mean age was 60.2 years (range 18–103) and the gender distribution was equal. The majority of the patients were Caucasian, with private insurance, and minimal comorbidities. A minority of patients underwent a laparoscopic procedure. Although California has the largest population, Florida contributed more patients to this study. Details are shown in Table 1 and Fig. 1.

Unadjusted outcomes

The overall in-hospital mortality rate was 3.01 % with the lowest rate in patients under the age of 40 (0.31 %), 6.81 % in patients with a Hinchey Score of 3 or more, and highest among patients over 75 (9.22 %). Mean LOS was 9.73 days (95 % CI 9.69–9.77) and the mean total hospital charges were $59,561 (95 % CI 59,194–59,928). Mean LOS for laparoscopic cases was 5.8 days (95 % CI 5.77–5.92) compared to 10.17 days (95 % CI 10.12–10.21) for open procedures. Open cases had higher total hospital charges than laparoscopic cases ($60,807 vs. 48,527, respectively, $P < 0.05$)

Adjusted outcomes

Using California as the comparison state, and after adjusting for age, gender, comorbidities, laparoscopic and elective procedures, Hinchey Score equal to or greater than 3, stoma placement, race and insurance status, significantly higher in-hospital mortality was found in New York (OR 1.32; 95 % CI 1.13–1.55; $P < 0.01$) and Mississippi (OR 2.84; 95 % CI 1.24–6.51, $P < 0.02$). Wisconsin had a significantly lower mortality rate (adjusted OR 0.74; 95 % CI 0.59–0.94, $P < 0.02$). Details are shown in Table 2 and Fig. 2.

Significant differences in LOS were seen in New York (+1.4 days) and Wisconsin (−0.54 days) compared to California. A detailed overview is given in Fig. 3. Patients with age >40 years, Hinchey Scores ≥3, stoma placement, and patients without private insurance had higher in-hospital mortality and longer length of stay, whereas increased hospital volume, female gender, private insurance, and laparoscopic management had a protective effect with lower mortality and shorter LOS ($P < 0.01$).

Table 1 Demographic information

	Mean	Min	Max
Age	60,2	18	103
		N	%
Female		79,095	53.39
Race			
Caucasian		96,858	84.27
Black		6,434	5.6
Hispanic		8,166	7.1
Asian		930	0.81
Native American		383	0.33
Other		2,164	1.88
Charlson index			
0		92,038	62.04
1		42,031	28.33
≥2		14,279	9.63
Laparoscopic		14,966	10.05
Elective		72,453	50.26
Hinchey score 3–4		11,787	7.92
Stoma		46,574	31.28
Insurance status			
Medicare		58,578	39.57
Medicaid		5,936	4.01
Private insurance		74,080	50.04
Self-pay		5,056	3.42
Other		4,389	2.96

Average hospital charges differed dramatically between states in the observation period (Fig. 4). The highest charging outlier states were Nebraska (+$78,066), California (+$70,800), and Nevada (+$57,318) while lowest were Maryland (-$30,009), Wisconsin (−$6,741), and Utah (−$9,514) with New York as the comparison state ($P < 0.01$). As California is an outlier for charges, we chose New York as reference for this analysis.

Subset analysis for elective cases

Elective patients were younger than non-elective patients and had a mean age of 58.4 (95 % CI 58.27–58.46) years. Unadjusted in-hospital mortality was 0.71 %. Mean unadjusted total charges were $41,237 (95 % CI 40,920–41,553) compared to $77,371 (95 % CI 76,727–78,016) for non-elective cases. In multivariate subset analyses adjusting for the same covariates as described above, California and

Fig. 1 State contribution

States with n<1000 summarized as "Other"

Table 2 Multivariate analysis of mortality (adjusting for states and shown variables)

	OR	*P*	95 % CI min	95 % CI max
Laparoscopic	0.46	0.00	0.35	0.60
Volume	0.97	0.00	0.95	0.98
Female	0.93	0.06	0.86	1.00
Elective	0.32	0.00	0.28	0.36
Stoma	2.35	0.00	2.17	2.56
Hinchey 3–4	1.63	0.00	1.46	1.82
Private insurance	0.52	0.00	0.45	0.59
African American	1.45	0.00	1.26	1.67
Hispanic	1.04	0.67	0.88	1.22
Asian	1.32	0.13	0.92	1.89
Native American	0.95	0.90	0.45	2.03
Other race	0.77	0.09	0.57	1.04
Age 45–64	2.94	0.00	2.21	3.92
Age 65–74	5.70	0.00	4.27	7.61
Age >74	12.56	0.00	9.44	16.71
Charlson 1–2	2.27	0.00	2.08	2.48
Charlson >2	3.31	0.00	2.99	3.67

Nevada were still the outliers for charges ($P < 0.01$). An analogous variation was found in the subset of non-elective cases.

Subset analysis for patients with advanced disease

Patients with a Hinchey Score of 3 or more had a mean age of 61.5 (95 % CI 61.19–61.75) years, and patients with stoma placement had a mean age of 63.1 (95 % CI 63.0–63.3). Unadjusted in-hospital mortality was 6.81 and 6.76 %, respectively. Mean unadjusted total charges were $92,677 (95 % CI 90,771–94,584) and $86,362 (95 % CI 85,477–87,246). In multivariate subset analyses in patients with advanced Hinchey Scores of 3 or more, adjusting for the same covariates as described above, California and Nevada were still the outliers for high charges ($P < 0.01$). There was a similar variation of mortality, with California having the lowest. In our collective, Hinchey Scores of 3 or more occurred in 7.9 % of cases with a 95 % CI of 7.8–8.0 % depending on analyzed state, demonstrating that that variation of severity of disease was low.

Discussion

This study examined national clinical outcomes and charges for segmental colectomy in patients with diverticulitis. In contrast to existing national studies, this survey included urgent and emergent procedures. To determine outcomes and variations between states, we deemed it valuable to include non-elective procedures because they represent half of the performed operations (Table 1). We demonstrate substantial geographic differences in clinical outcomes and hospital charges. Variation in mortality and LOS from half to nearly triple the reference state, and variation greater than $100,000 charges for the same procedure within one country is striking.

The overall mortality of partial colectomy in our collective is higher, as expected, than published reports that exclude urgent and emergent cases; van Arendonk et al. [1] recently reported an overall mortality in the U.S. of 0.44 % for elective cases only, and we found a 3.01 % mortality rate including non-elective cases, and 0.71 % for elective

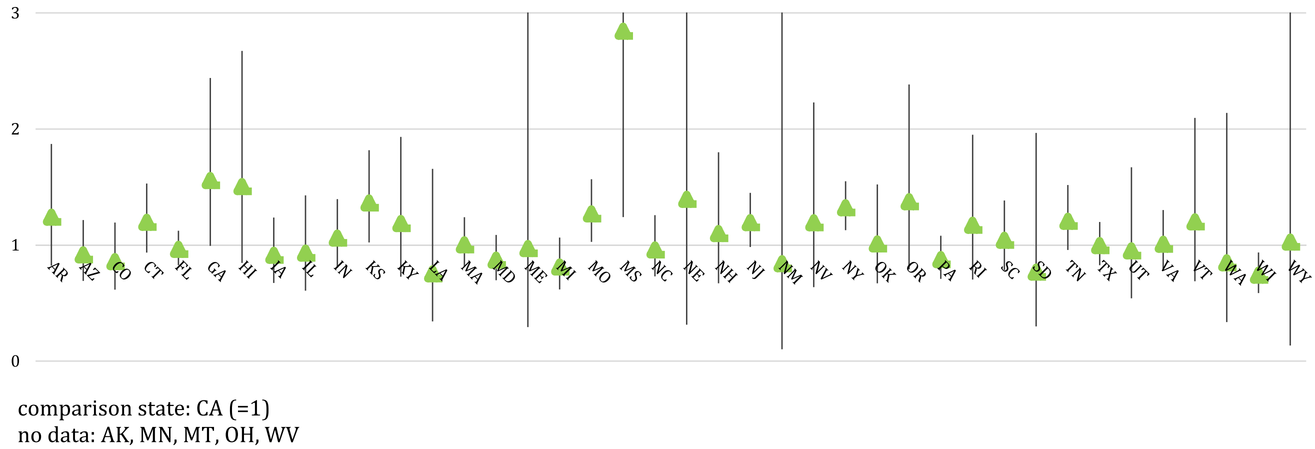

Fig. 2 Adjusted OR of mortality, state comparison

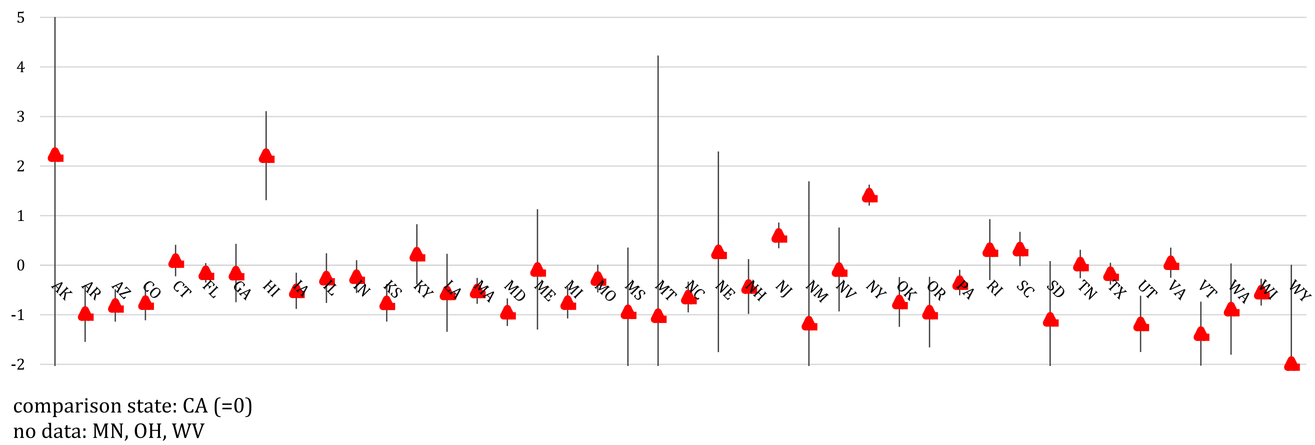

Fig. 3 Adjusted differences in length of stay (in days), state comparison

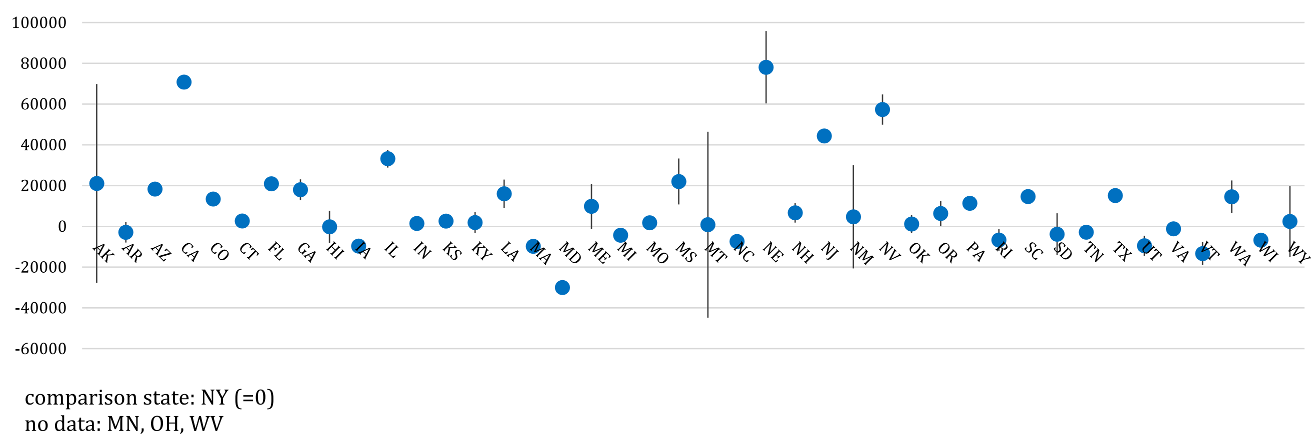

Fig. 4 Adjusted difference of hospital charges (in USD), state comparison

cases in our subset analysis. Our mean LOS (9.73 days) exceeds comparable U.S. studies that only include elective cases by 3 days [2]. Understandably, our mean total hospital charges ($59,561) are higher than in Van Arendonk's study of elective operations for diverticulitis ($40,935), but are less than mean charges for any colorectal resection regardless of diagnosis, published by Lawson et al. ($70,994) out of the NIS of 2008 [1, 23].

Interestingly, we found a high variation of outcomes within the U.S.: mortality, LOS, and total hospital charges differed dramatically between different states. Thus far, no studies have reported similar findings after segmental colectomy for diverticulitis. A considerable amount of research has been done in order to identify patients preoperatively who are most likely to benefit from surgery in order to optimize resource allocation, to avoid exposing those patients unlikely to benefit from surgery to its inherent risks, and to manage patients' expectations [24, 25]. Some authors do not support the hypothesis that inappropriate use of surgical procedures is the reason for geographic variation [26]. However, we agree with other published manuscripts which cite the major reason for the variation in colorectal surgery is most likely an overuse/underuse surgical management problem [19, 23, 27]. We believe that our findings cannot be fully explained by geographic and racial disparities, disease incidence, or patient preferences. Disease severity did not vary geographically in our collective as analyzed using diagnosis codes for peritonitis and procedure codes for stoma placement. Other findings of interest in this study include the protective nature of hospital volume, female patients, private insurance, and laparoscopic management. Indeed, the top quartile in volume for operations on diverticulitis represents a significant decrease in mortality risk compared to hospitals with less volume. According to these results, large centers with high patient volume have better outcomes in the operative management of diverticulitis. The protective nature of the laparoscopic approach is very likely biased due to patient selection.

Several attempts to assess variation in the U.S. healthcare system have been undertaken with the goal of quality improvement [19, 28–30]. This is the first series that documents variation of outcomes and cost of elective and non-elective partial colectomy for diverticulitis on a national level. The strengths of our study include the number of patients in our analysis. The large patient population allows for accurate estimation of mortality and charges for each State of the U.S. Even when adjusting for severe diverticulitis stages and complicated cases requiring stoma placement in multivariate analysis, a wide variation of outcomes was found. A limitation of our study is that large administrative claims-based databases are dependent on accurately entered codes and that charges do not necessarily accurately reflect cost of care or reimbursements [31]. Detailed clinical data such as Hinchey Scores or exact extent of a resection might be inaccurately coded. Therefore, Hinchey Scores 3 and 4 (peritonitis) were combined for our analysis, reflecting very severe disease. Furthermore, the NIS database does not allow us to determine the number of episodes of diverticulitis medically managed prior to an operation. Thus, we decided to include both elective and non-elective cases to avoid a possible bias in the decision-making process before surgery. Including all cases, possible coding errors (elective/non-elective) do not influence our study outcomes. Finally, due to the nature of the database used, our data reflect the U.S. While Canada and other western countries in Europe may have different outcome or outcome variation, it is likely that significant variability also exists outside of the U.S. as colorectal cancer registries and databases in both the U.S. and Europe show remarkable geographic variation in incidence and outcome. Data on benign colorectal disease are still scarce, and therefore, we feel our initial results are important to be aware of even outside the U.S. and will possibly emphasize the need for large administrative databases throughout other countries [14].

Conclusion

Patients who undergo surgical treatment for diverticulitis in the U.S. have high variation in mortality, LOS, and hospital charges, even after controlling for demographic and socioeconomic factors, and severity of disease. Differences in timing of operative management for diverticulitis may contribute for the outcome variation observed. Further analysis should be performed to identify the causes of outlier states in each category and to analyze outcome variation in other countries or geographic regions. Thus, best practices could be determined with the goal of improving and standardizing quality of care.

Disclosure Drs. Fuchs, Broderick, Harnsberger, Chang, McLemore, Ramamoorthy, and Horgan have no conflicts of interest or financial ties to disclose.

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