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State by State Variation in Emergency versus Elective Colon Resections: Room for Improvement

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Abstract

Background—Compared to elective surgical procedures, emergency procedures are associated with higher cost, morbidity, and mortality. This study seeks to investigate potential state-by-state variations in the incidence of emergent versus elective colon resections.

Methods—A retrospective analysis of all adult patients (≥18years) included in the Nationwide Inpatient Sample from 2005–2009 who underwent hemicolectomy (right or left) or sigmoidectomy was conducted. Discharge-level weights were applied and generalized linear models were used to assess the odds of a patient undergoing emergent versus elective colon surgery nationally and for each state after adjusting for patient and hospital factors. Odds ratios were estimated with the national average as the reference.

Results—The final study cohort included 203,050 observations comprised of 83,090 emergent and 119,960 elective colectomies. The state with the highest unadjusted proportion of emergent procedures was Nevada (53.6%), while Texas had the lowest (2.8%). Compared to the national

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average, the adjusted odds of undergoing emergency colectomy remained highest in Nevada (OR: 1.70; 95% CI: 1.54–1.87) and lowest in Texas (OR: 0.43; 95% CI: 0.36–0.51)..

Conclusions—Substantial state variations exist in rates of emergency colon surgery within the United States. Identification of these differences suggests significant variations in practice and a potential to decrease the number of emergent colon operations.

Level of Evidence—Level III Prognostic and Epidemiological Study

Keywords

Emergency Colon Surgery; State Variation; Outcomes

INTRODUCTION

Several studies have reported worse outcomes and higher costs with emergent versus elective colon surgery. Emergency colon surgery has been shown to be an independent negative prognostic factor with respect to both mortality and morbidity.[1–6] A mortality incidence of 34% has been reported following emergent colon surgery, as compared to 7% for elective colon surgery.[1]

A number of hypotheses exist to explain the relatively higher morbidity and mortality following emergency compared to elective colon surgery. Factors that led to the surgery being performed as an emergent, rather than elective, procedure in the first place likely play a large role. In addition, worse outcomes may be a reflection of the potentially unstable condition in which some of these patients present.[1,8]

While the performance of colon surgery as an emergent procedure has been shown to have increased morbidity and mortality, there has been no study to look at state variation in the rates of emergent colon surgeries across the U.S. In a recent report of the Dartmouth Atlas project, researchers examined rates of several elective procedures across communities in Minnesota and showed that significant variations exist across the state in the performance of these surgeries as elective cases.[7] This finding highlights the role location plays in the likelihood of receiving an elective versus emergent surgical procedure for surgically amenable conditions. Identifying such potential inter-state variations within colon surgery procedures would suggest that there may be opportunities to decrease the rates of emergent colon operations across states. Similar strategies have been used in other aspects of medical care, following the simple notion that if one state or region can do a procedure more safely, more cost-effectively, or with better outcomes, then others could learn from it and emulate the same.

The objective of this study was to use a nationally representative database to examine state variations in the performance of colon operations as an emergent versus elective procedure, adjusting for patient factors, comorbidities, and hospital factors. By improving our understanding of the factors that lead to variances in colon surgery outcomes, we may identify potential ways to safely reduce emergent procedures.

MATERIALS AND METHODS

We conducted a retrospective analysis using discharge data from the 2005–2009 Nationwide Inpatient Sample (NIS). The NIS is part of the Healthcare Cost and Utilization Project (HCUP) sponsored by the Agency for Healthcare Research and Quality (AHRQ). It is the largest all-payer inpatient care database available in the United States and includes a 20 percent stratified sample of discharges from community hospitals in participating states, comprising 95 per cent of the U.S. population.[9]

Adult patients (aged 18 years or older) were identified. The International Classification of Diseases 9th Edition (ICD-9-CM) codes were used to identify patients who had undergone right hemicolectomy (45.73 or 17.33), left hemicolectomy (45.75 or 17.35), or sigmoidectomy (45.76 or 17.36) as the primary procedure. Patients with a primarydiagnosis of trauma (ICD-9-CM codes 800–959) were excluded because trauma is known to result in a high rate of emergent surgery (94% in the present study), and we did not want to skew the results to simply reflect state-by-state variations in trauma volumes. Patients with missing data on the type of admission were also excluded, as well as patients with missing data on demographics or hospital characteristics. The final study cohort included 203,050 discharge records (Figure 1).

Demographic data including age, race, gender, median household income quartile for patient's residential zip code, and primary insurance payer was abstracted from the records. Age was categorized into five groups: 18–24, 25–44, 45–64, 65–84, and 85 years or older. Patients with missing race data (about 20% in the NIS) were included in the 'missing' race category, as has been done in previous studies,[10,11] since race is known to significantly impact outcomes after trauma. Race was then classified into White, Black, Hispanic, other, or missing. Median household income quartile for patients' residential zip code was classified as lowest, second, third, or highest quartile as defined in the NIS. Primary insurance payer was categorized as private insurance, public insurance, self-pay, no charge or other. A measure of comorbidity was derived using the Charlson Comorbidity Index (CCI), which is a measure of comorbidity and risk of mortalitythat is derived using a weighted formula based on the presence/absence of certain diagnoses in a patient.[12–14] The total scores derived from CCI calculations were then categorized as 0 (0 score), 1 (score of 1), or 2 (score of ≥2).

Hospital characteristics data were also retrieved from the NIS hospital subfile. Hospital bed size was categorized as small, medium, or large, as defined in NIS. Hospital location was binary (i.e. rural or urban). Hospital ownership/control was classified as government, non-federal; private; or government/private collapsed category, which is an unstratified category defined by the NIS that includes all hospitals in regions that are too small to stratify into individual categories. Classification of teaching status (non-teaching or teaching) was binary. The state where the hospital is located was the primary independent variable. Currently, six states including Delaware, North Dakota, Idaho, Mississippi, Alabama, Alaska, and the District of Columbia are not participating in the NIS and could not be included in the analysis.

For the analysis, the primary outcome variable was the type of admission (emergent versus elective). Discharge-level weights were applied to the analyses in order to obtain national estimates. Generalized linear models were used to assess the odds of undergoing an emergent versus elective colon resection nationally and for each state. Using the national average as the reference, odds ratios were then derived comparing states to the national average. The multivariable models controlled for patient age, gender, race, median income in residential zip code, primary insurance payer, comorbidity as measured by CCI, primary diagnosis, procedure type (open or laparoscopic), hospital bed size, teaching status, location, ownership/control, and discharge year. State differences were also controlled for in the model used to estimate adjusted national odds. Discharge year was included to account for the fact that the number of states participating in the NIS changed over the period studied, with some states only contributing one year of data. Reference categories for the respective variables used in the model include age group 18–25 years, White race, lowest income quartile, private insurance, small bed size, rural location, private hospital ownership, non-teaching status, CCI category 0, and the discharge year 2005. All statistical analyses were performed using STATA/MP Version 11.0 (StataCorp, College Station, Texas USA). Statistical significance was defined as p<0.05.

RESULTS

A total of 203,050 patients older than 18 years of age who underwent an elective or emergent hemicolectomy or sigmoidectomy between the years 2005–2009 as recorded in the NIS met criteria for inclusion in the analysis (Figure 1), representing 1,010,363 patients undergoing these procedures nationally within the study period. The overall proportion of patients undergoing elective surgery was higher than emergent surgery (59.1% versus 40.9%). Right hemicolectomy was the predominant procedure within the study sample, performed on 45.3% of the patients (n=91,896), followed by sigmoidectomy (41.5% ; n=84,342) andleft hemicolectomy (13.2n=26,812). The majority of patients were in the age group 65–84 years (44.8%), female (54.2%), White (62.3%) and had public insurance (54.4%) (Table 1). In terms of hospital characteristics, most patients were admitted to large bed size (65.1%), non-teaching (60.0%), and urban hospitals (88.2%) (Table 2).

The proportion of emergency surgery was highest among those patients who underwent left hemicolectomy (48.1%), while the proportion was 39.8% with both right hemicolectomy and sigmoidectomy. Most patients underwent open surgery (91.3% overall). Of patients with emergent admissions, 96.9% had an open procedure. A similarly high proportion of open surgery was also seen among patients with elective admissions (87.5%).

An evaluation of the primary diagnosis ICD-9-CM codes in this study cohort revealed that malignant colon neoplasm, diverticulitis, volvulus, and intestinal peforation made up more than 60% of emergent admissions (28.4%, 25.7%, 4.4%, and 4.1%, respectively), while malignant colon neoplasm, diverticulitis, benign colon neoplasm and diverticulosis made up more than 80% of elective admissions (36.8%, 27.1%, 16.5%, and 2.5%, respectively).

The weighted unadjusted proportion of elective procedures was higher than that of emergent procedures in nearly all states (Figure 2). The state with the highest unadjusted proportion of emergent procedures was Nevada (53.6%), while the state with the lowest unadjusted proportion of emergent procedures was Texas (22.8%). After adjusting for potential confounding factors in the generalized linear model, the odds of undergoing an emergent colectomy remained highest in Nevada (OR: 1.70; 95% CI: 1.54–1.87) and lowest in Texas (OR: 0.43; 95% CI: 0.36–0.51). (Figures 3–4). On the overall multivariable model, the odds of undergoing an emergent versus elective colon surgery was 67% (OR: 1.67; 95% CI: 1.55–1.80) and 49% (OR: 1.49; 95% CI: 1.23–1.81) higher for blacks and Hispanics, respectively, compared to whites (Table 3). Patients who underwent emergency surgery had 6.85% incidence of mortality, whereas the mortality incidence among patients who received elective surgery, was 0.98% (p<0.001).

DISCUSSION

The present study aimed to compare the incidence of emergency colon surgery for states across the U.S. using a nationally representative database. We found that significant variations in the likelihood of performance of emergent colon surgery exist among states across the country even after controlling for potential confounding variables. Our findings demonstrate as much as a 70% higher odds of emergent colon surgery in Nevada when compared to the national average, and odds as low as 53% below national average in Texas. The existence of wide state variations may be an illustration of differential practice patterns across the country. Whether these differences occur on a practitioner level, institutional level, regional level, or otherwise, it is essential that we identify and address them. As increasing efforts are made to reduce rising health care costs while still providing adequate and quality care, standardization of care is becoming increasingly important. Thus the acknowledgement of wide practice variations provides an opportunity for improvement.

The substantial state variations in performance of colon surgery as an emergent versus elective procedure found in the present study is similar to findings noted in a recent report by the Dartmouth Atlas team.[7] The Dartmouth team investigated the likelihood of Medicare fee-for-service patients undergoing ten different elective surgical procedures (coronary artery bypass grafting, back surgery, total hip replacement, total knee replacement, transurethral resection of the prostate, carotid endarterectomy, mastectomy, cholecystectomy, percutaneous coronary intervention, and radical prostatectomy) in various communities within the state of Minnesota. After adjusting for age, sex, and race, the authors noted wide variations in the incidence of procedures across the state. Likewise, the Dartmouth Atlas group has also shown large nationwide variations among Medicare beneficiaries in rates of these same procedures (www.dartmouthatlas.org). In the present study, we examine variations in rates of emergent colectomy across states only. Of note, however, is that there is no apparent geographical or regional trend in the differences that we report (Figure 4). Montana and Wyoming, for instance, share a state border but have among the highest and lowest risk-adjusted rates of emergent colectomy, respectively. Similarly Texas and Nevada, both of which are located in the Southwest and may theoretically contain a similar population, have disparately difference rates. Additional analysis comparing regions also did not find any regional differences (data not shown). Based on these observations and those of the Dartmouth Atlas data, it is likely that there are some significant within-state variations in emergent colectomy that are not represented by our analysis. This is an important consideration as we work to define the factors that contribute to the procedural variations observed and begin developing appropriate interventions.

In the present study, we found the proportion of mortality to be higher in patients who had emergent admission compared to those admitted as elective patients (6.85% versus 0.98%, $p<0.0001$). This finding is consistent with data from prior studies that have shown higher rates of morbidity and mortality for emergent colon surgery compared to colon surgery performed as an elective procedure [1,3,5]. In a case-control (age- and stage-matched) study comparing emergent and elective colon surgery for colon cancer, Smothers et al[1] showed a seven-fold higher odds of perioperative mortality (34% vs. 7%) in patients who underwent emergent surgery compared to those who had an elective procedure. A case-control study by Coco et al[3] also noted higher overall surgical morbidity (44% versus 12%) and postoperative mortality (4% versus 0%) among patients undergoing emergent surgery compared to those that underwent elective surgery. A larger case-mix-adjusted study by McArdle and Hole[5] reported similar data, including an 8.2% versus 2.8% difference in immediate post-operative mortality and an overall 5-year survival difference of 57.5% versus 39.1% in colon cancer patients who underwent curative resection as an emergent procedure compared to those who had the same procedure in an elective setting.

Of note, most studies that have compared outcomes in emergent versus elective colon surgery have done so among colon cancer patients. In the present study, however, we found that although the primary diagnosis for the majority of patients regardless of surgical urgency was malignant colon neoplasm, the other predominant primary diagnoses varied among emergent compared to elective admissions.

In addition to emergency colon surgery itself being a risk factor for worse outcome, it has also been thought that factors leading to a procedure being performed as an emergent, rather than an elective, procedure may also significantly contribute to the higher morbidity and mortality observed among this group of patients. One such factor is inadequate screening,[16] which is more likely to occur among those of low socioeconomic status.[17,18]. In the risk-adjusted model of our study, we found statistically significant higher odds of undergoing an emergent versus elective colon surgery in patients without insurance and those with residential zip code median income in the lowest quartile (Table 4). Thus, lower rates of screening among a particular population or in a particular state may be a mechanism that leads to higher rates of emergent surgery. It is also possible that proximity and access to healthcare facilities, healthcare attitudes, practitioner variation, and other regional variables that we have not accounted for in our model may play a role in determining whether patients undergo emergent versus elective colectomies. Targeted interventions to improve screening protocols among patients with high risk of emergent surgery may provide one means by which post-colectomy surgical outcomes can be improved. Focused analysis of other locoregional factors may also provide opportunity for additional interventions in the future.

The limitations of the present study deserve some discussion. The sampling frame of the NIS is national, rather than a regional or state-based, which may be contributing to our findings. Even though the NIS is a weighted sample, not all states are currently participating and there may be some residual difference as it does not represent every patient discharged from each state. Finally, because the NIS is an administrative dataset, all NIS analyses are subject to possible coding errors and a lack of information on severity of disease. In addition, the cross-sectional nature of the dataset makes it difficult to infer causality. Despite these limitations, the NIS has been used in studies of regional variation in other fields and is currently our best estimate of national trends[19,20] Importantly, it includes information on all payers and is not age-restricted, thus making our study more broad-based than previous studies that used data only on Medicare beneficiaries.

In conclusion, substantial state variations exist in rates of emergency colon surgery within the United States. Identification of these differences suggests significant variations in practice, and highlights an opportunity to decrease the need and number of emergent colon operations. Further in-depth study is required to elucidate the factors that lead to increased emergent procedures in some communities so that effective interventions can be formulated. By reducing rates of emergent colon surgery, we will not only improve post-operative outcomes, but we will also likely save huge costs.[6,15]

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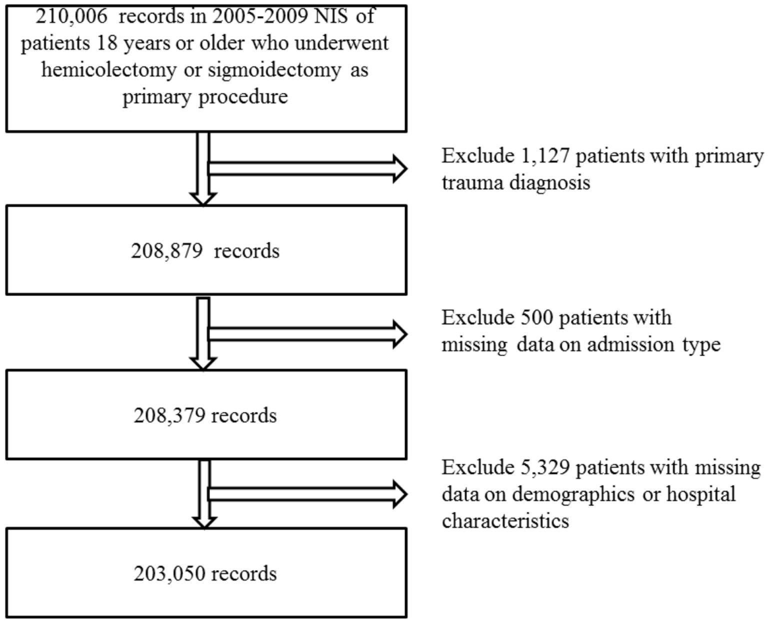

Figure 1.
Selection of study population.

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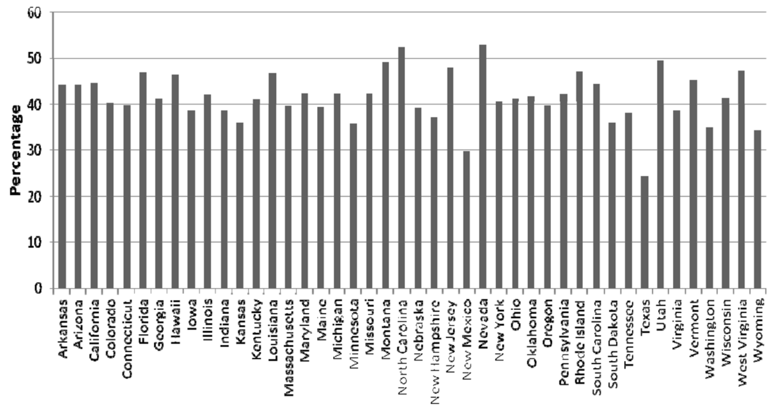

Figure 2. Unadjusted rates of emergent versus elective colon surgery by state

The weighted unadjusted proportion of elective procedures was higher than that of emergent procedures in nearly all states. The state with the highest unadjusted proportion of emergent procedures was Nevada (53.6%), while the state with the lowest unadjusted proportion of emergent procedures was Texas (22.8%).

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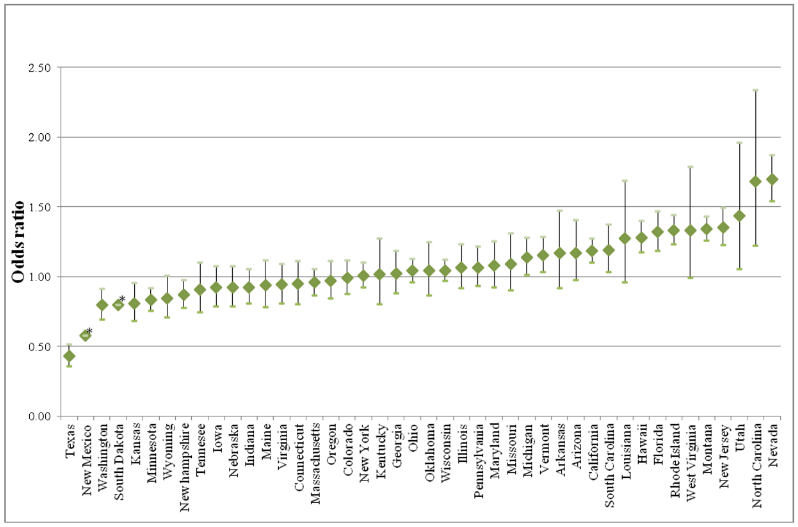

Figure 3. Adjusted odds ratios and 95% confidence interval of emergent versus elective hemicolectomy and sigmoidectomy by state

After adjusting for potential confounding factors (patient age, gender, race, median income in residential zip code, primary insurance payer, comorbidity as measured by CCI, primary diagnosis, open vs. laparoscopic procedure, hospital bed size, teaching status, location, ownership/control, and discharge year), the odds of undergoing an emergent colectomy was highest in Nevada and lowest in Texas. Odds ratios are in comparison to the calculated national average. Asterisks (*) denote that confidence intervals could not be obtained due to small sample size.

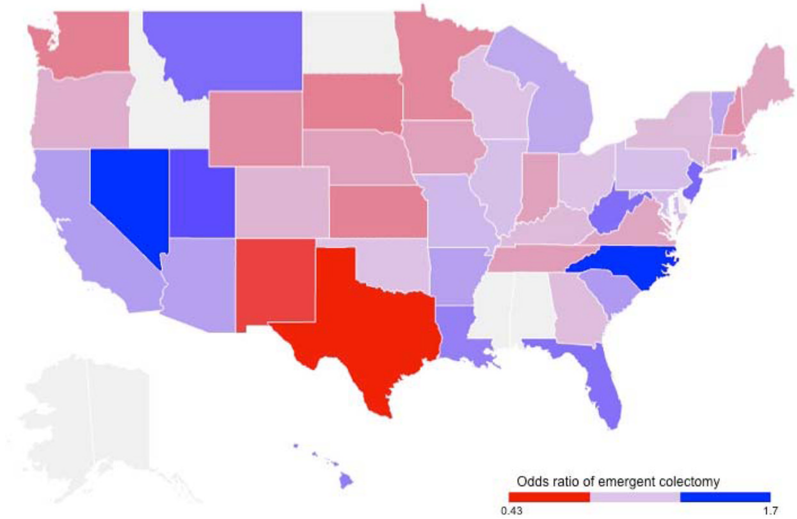

Figure 4. Heat map of adjusted odds ratios of emergent versus elective colon surgery by state
There were no apparent geographical or regional trends in the differences of emergent versus elective colon surgery. Odds ratios (OR) are in comparison to the calculated national average. States that are colored in red have an odds ratio of emergent colectomy that is less than the national average (i.e. OR < 1). States that are colored in purple have an odds ratio of emergent colectomy that is statistically similar to the national average (i.e. OR = 1). States that are colored in blue have an odds ratio of emergent colectomy that is greater than the national average (i.e. OR > 1). States that are colored in white have no available data.
States in Red are lower than National Average
States in Purple are statistically similar to the National Average
States in Blue are higher than National Average

Table 1

Demographics of study population (n=203,050)

	n	%
Age		
18–24	1,403	0.69
25–44	18,225	8.98
45–64	77,4076,603	38.12
65–84	91,067	44.85
≥85	14,948	7.36
Gender		
Male	92,943	45.77
Female	110,107	54.23
Race		
White	126,407	62.25
Black	16,095	7.93
Hispanic	9,860	4.86
Other	6,620	3.26
Missing	44,068	21.70
Charlson category		
0	80,386	39.59
1	27,622	13.60
2	95,042	46.81

Table 2

Hospital characteristics of study population

Primary payer		
Private insurance	82,302	40.53
Public insurance	110,503	54.42
Self-pay, no charge, or other	10,245	5.05
Median income in residential zip code		
Lowest	47,110	23.20
Second	58,021	28.57
Third	49,171	24.22
Highest	48,748	24.01
Hospital bed size		
Small	23,198	11.42
Medium	47,708	23.50
Large	132,144	65.08
Hospital teaching status		
Non-teaching	121,780	59.98
Teaching	81,270	40.02
Hospital location		
Rural	24,067	11.85
Urban	178,783	88.15
Hospital ownership/control		
Government, non-federal	16,453	8.10
Private	117,920	58.07
Government/Private collapsed	68,677	33.82

Table 3

Patient covariates used in multivariable logistic regression

Variable	OR	95% CI	p value
Age			
18–24	1.00	Reference	Reference
25–44	0.69	0.61–0.79	<0.001
45–64	0.55	0.48–0.63	<0.001
65–84	0.54	0.47–0.63	<0.001
≥85	1.15	1.0162–1.33	0.041
Gender			
Male	1.00	Reference	Reference
Female	0.86	0.81–0.92	<0.001
Race			
White	1.00	Reference	Reference
Black	1.67	1.55–1.80	<0.001
Hispanic	1.49	1.23–1.81	<0.001
Other	1.32	1.15–1.5	<0.001
Unknown	0.80	0.64–0.99	0.044
CCI category			
0	1.00	Reference	Reference
1	1.47	1.28–1.68	<0.001
2	1.72	1.52–1.94	<0.001
Primary payer			
Private insurance	1.00	Reference	Reference
Public insurance	1.52	1.45–1.59	<0.001
Self-pay, no charge, or other	2.64	2.33–2.98	<0.001
ZIP code income quartile			
Lowest	1.00	Reference	Reference
Second	0.76	0.65–0.88	<0.001
Third	0.87	0.81–0.92	<0.001
Highest	0.84	0.79–0.91	<0.001

OR, odds ratio, CI, confidence interval; CCI, Charlson comorbidity index