



# The influence of payor status on outcomes associated with surgical repair of upper gastrointestinal perforations due to peptic ulcer disease in the United States

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## ABSTRACT

**Background:** An association between lack of insurance and inferior outcomes has been well described for a number of surgical emergencies, yet little is known about the relationship of payor status and outcomes of patients undergoing emergent surgical repair for upper gastrointestinal (UGI) perforations. We evaluated the association of payor status and in-hospital mortality for patients undergoing emergency surgery for UGI perforations in the United States.

**Methods:** Nationwide Inpatient Sample (NIS) was queried to identify patients between 18 and 64 years of age who underwent emergent (open or laparoscopic) repair for UGI perforations secondary to peptic ulcer disease (2010–2014). Primary outcome was in-hospital mortality. Secondary outcomes were major and minor postoperative complications. The main predictor outcome was insurance status (Private, Medicaid, Uninsured). Univariate and multivariable regression analyses were performed. Data were weighted to provide national estimates.

**Results:** 21,005 patients underwent surgical repair for UGI perforations. Patients with private insurance represented the largest payor group (47%). After adjustment of other factors, payor status was not a statistically significant predictor of in-hospital mortality (Medicaid vs. Private: [OR] 1.1; 95% [CI] 0.67–1.81; Uninsured vs. Private: OR 0.9, 95% CI 0.52–1.61). However, payor status remained a statistically significant predictor of major postoperative complications (Medicaid vs. Private [OR] 1.4; 95% CI 1.1, 1.8; Uninsured vs. Private [OR] 1.2, 95% CI 0.9, 1.5) and minor postoperative complications (Medicaid vs. Private [OR] 1.4; 95% CI 1.1, 1.9; Uninsured vs. Private [OR] 1.2, 95% CI 0.9, 1.6).

**Conclusions:** Emergency surgery for UGI perforations is associated with high mortality and morbidity across all payor classes; however, Medicaid is a predictor for both major and minor postoperative complications. Preventing perforation through preventative measures will be key to reducing the burden of peptic ulcer disease across all populations.

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## Introduction

Payor status is known to be a significant contributor of health-care disparities in the US.<sup>1–6</sup> More than a decade ago, the Institute of Medicine (IOM) Care without Coverage Report declared that

being uninsured was hazardous to the American people's health. Working-age Americans without insurance were sicker, died sooner, and received inferior care when hospitalized even for acute situations.<sup>7</sup> Alarming, despite an evolving US health care system, the US Census Bureau reports that 49.9 million Americans remain uninsured as of 2010.<sup>8</sup> Uninsured adults are less likely to receive clinical preventive services that prevent premature death.<sup>9</sup> In addition, they are more likely to die from serious acute conditions compared to their insured counterparts.<sup>9</sup> Uninsured Americans are

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also at a higher risk for requiring emergency surgery for a variety of indications including biliary, hernia, and colorectal conditions that are typically addressed electively.<sup>1</sup> The association of payor status on in-hospital mortality and other risk-adjusted surgical outcomes after major surgical operations (e.g., colectomy, coronary artery bypass grafting, hip replacement) is significant.<sup>10</sup>

Upper Gastrointestinal (UGI) perforations are a devastating consequence of undiagnosed, untreated, or undertreated peptic ulcer disease (PUD) that mandate emergent repair. While the advent of medical therapy for PUD has resulted in decreased demand for elective surgery for PUD,<sup>11</sup> the rates of emergency surgery to repair UGI perforations have increased.<sup>11–13</sup> UGI perforations result in high morbidity and mortality; more than 70% of deaths associated with PUD are due to perforations.<sup>14</sup> However, the payor status among those patients who have undergone emergency surgery for UGI perforations and the effect of payor status on surgical outcomes emergent repair of UGI perforations due to PUD remain to be elucidated.

It is known that those who are uninsured and on Medicaid are more likely to smoke and present to a physician with later stage of a disease and have worse outcomes compared to their counterparts with private insurance.<sup>15,16</sup> In this study, we aimed to describe the epidemiology and outcomes of emergency surgery for UGI perforations due to PUD and to evaluate whether payor status is a predictor of case-mix and outcomes. Given that access to healthcare, as mediated by insurance, is a requisite for prevention, early diagnosis, and medical management of PUD, we hypothesized that patients who are uninsured or who have Medicaid would not only represent a higher population of those undergoing EGS for UGI perforations but would also experience worse outcomes, compared to those with private insurance.

## Materials and methods

### Database

The Nationwide Inpatient Sample (NIS) was queried from 2010 to 2014 to identify patients who underwent emergency surgery (open and laparoscopic) for UGI perforations due to PUD. NIS is a product of the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ). The largest all-payor inpatient database in the United States, NIS represents a stratified sample of 20% of non-federal US community hospitals from participating states, containing data from approximately 8 million hospital stays each year. The number of participating states has grown considerably since 1988; and for 2014, there are 44 US states, plus the District of Columbia, included.<sup>17</sup> These states comprise 96% of the US population.<sup>17</sup> Sampling strata used by the NIS is based on hospital characteristics (e.g., urban or rural location, teaching status, and hospital bed size). The data can be weighted according to the NIS sampling frame to generate national estimates.<sup>17,18</sup> All of the analyses discussed and results presented in this manuscript represent weighted national estimates.

### Cohort

Patients between 18 and 64 years old undergoing emergency surgery (open and laparoscopic) for UGI perforations due to PUD were identified using International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) procedure codes (Appendix A) along with an associated diagnosis code for PUD (Appendix B). We restricted our adult patient population to those under age 65 years to exclude bias from access to Medicare health insurance plans based on age criteria only. Furthermore, Medicare

patients less than 65 years old were also excluded as these patients require debilitating comorbidities to receive such coverage. Patients were then stratified by primary payor status into 3 comparison groups: Medicaid, Private, and Uninsured. According to HCUP, Medicaid includes patients covered by fee-for-service and managed care Medicaid; Private insurance includes Blue Cross, commercial carriers, private health maintenance organizations (HMOs) and preferred provider organizations (PPOs); Uninsured includes an insurance status of self-pay or no charge.<sup>19</sup> Patient comorbidities were assessed using categories developed by Elixhauser et al.<sup>20</sup> The Elixhauser Index (EI) has been shown to provide effective adjustments for mortality risk among surgical populations and has been shown to be superior to the Charlson/Deyo method.<sup>21,22</sup> Patients were classified as having no comorbidities (EI = 0), 1 co-morbidity (EI = 1), 2 comorbidities (EI = 2), 3 or more comorbidities (EI ≥ 3).

### Outcomes

The primary outcome of interest was in-hospital mortality. Secondary outcomes were in-hospital postoperative complications, including minor postoperative complications (postoperative pulmonary embolus, postoperative wound infection, postoperative pneumonia) and major postoperative complications (postoperative myocardial infarction, postoperative acute respiratory distress syndrome). Length of stay in days was also measured.

### Statistical analysis

Continuous variables were analyzed using survey-weighted analysis of variance. Categorical variables were analyzed using either Pearson  $\chi^2$  analysis or Fisher exact test, as appropriate. Categorical data are presented as percentage frequencies, and continuous data are presented as mean  $\pm$  standard error. Three multivariable regression models were created. The primary multivariable model's outcome was in-hospital mortality with payor status being the forced variable of interest. This model was adjusted for patient demographic characteristics [age, race, gender], comorbidities [Elixhauser index] and hospital characteristics [hospital bed size, teaching status] and postoperative complications. Since complications can greatly impact mortality, presence of any one of these complications were also included as initial covariates in the multivariable model for mortality. The second multivariable model's outcome was postoperative major postoperative complications. The third multivariable model's outcome was minor postoperative complications. For the second and third multivariable model, the forced variable of interest was payor status and both models were adjusted for patient demographic characteristics [age, race, gender], comorbidities [Elixhauser index] and hospital characteristics [hospital bed size, teaching status]. Statistical significance was defined as  $p < 0.05$ . All statistical analyses were performed using SAS 9.4 statistical software (SAS Institute, Cary, NC).

## Results

A weighted estimate of 21,005 patients underwent emergency open (95.4%) and emergent laparoscopic (4.6%) surgery for UGI perforations due to PUD. Patients with private insurance represented the largest payor group (47%) compared to Medicaid (24%) and uninsured (29%). All three payor groups were predominantly male and white. However, those with private insurance were slightly older compared with Medicaid and those without insurance. (Table 1). For hospital characteristics, all three payor groups were predominantly treated at urban teaching hospitals with a large bedsize (Table 2).

**Table 1**  
Baseline Characteristics of Patients who underwent Emergent Repair for Upper Gastrointestinal Perforations due to Peptic Ulcer Disease.

Variable	Private N = 9868	Medicaid N = 4999	Uninsured N = 6138	P value
<b>Age</b>				<.0001
18–34 years	1348 (13.7)	860 (17.2)	1468 (23.9)	
35–44 years	1490 (15.1)	1015 (20.3)	1368 (22.3)	
45–54 years	3319 (33.6)	1621 (32.4)	2123 (34.6)	
55–64 years	3712 (37.6)	1503 (30.1)	1179 (19.2)	
Male	5105 (51.7)	3068 (61.4)	4343 (70.8)	<.0001
White	6764 (68.5)	2629 (52.6)	3261 (53.1)	<.0001
<b>Elixhauser Index</b>				<.0001
Elixhauser Index = 0	2643 (26.8)	1218 (24.4)	2059 (33.5)	
Elixhauser Index = 1	2291 (23.2)	1034 (20.7)	1659 (27)	
Elixhauser Index = 2	1903 (19.3)	844 (16.9)	1070 (17.4)	
Elixhauser Index, ≥ 3	3031 (30.7)	1903 (38.1)	1349 (22)	

According to HCUP, Medicaid (Government) includes patients covered by fee-for-service and managed care Medicaid; Private insurance includes Blue Cross, commercial carriers, private health maintenance organizations (HMOs) and preferred provider organizations (PPOs); Uninsured includes an insurance status of self-pay or no charge.

**Table 2**  
Location Characteristics for Patients who underwent Emergent Repair for Upper Gastrointestinal Perforations due to Peptic Ulcer Disease.

Variable	Private	Medicaid	Uninsured	P Value
Urban Location	8611 (87.3)	4328 (86.6)	5257 (85.6)	0.40
<b>Bed Size</b>				0.02
Small	1509 (15.3)	614 (12.3)	908 (14.8)	
Medium	2873 (29.1)	1271 (25.4)	1737 (28.3)	
Large	5419 (54.9)	3090 (61.8)	3453 (56.3)	
<b>Teaching status</b>				0.005
Rural	1190 (12.1)	646 (12.9)	841 (13.7)	
Urban nonteaching	4107 (41.6)	1722 (34.4)	2419 (39.4)	
Urban teaching	4505 (45.7)	2606 (52.1)	2838 (46.2)	

For unadjusted outcomes, in-hospital mortality was highest among those with Medicaid compared to private or uninsured (Medicaid 3.1%, Private 2.6%, Uninsured 1.6%,  $p < 0.03$ ) (Table 3). The most common postoperative complications (pneumonia and wound infection) were highest among patients with Medicaid. Length of stay (days) was longest for those with Medicaid ((Mean  $\pm$  Standard Error,  $9 \pm 0.3$ ) vs. Private ( $8 \pm 0.1$ ) vs. Uninsured ( $7 \pm 0.3$ ),  $p < 0.0001$ ).

In the multivariable logistic regression analysis, after adjustment for other factors, payor status did not remain a statistically significant predictor of in-hospital mortality after emergency surgery for UGI perforations due to PUD (Table 4). After adjustment for other factors, each decade of increasing age was associated with 1.6 times higher odds of mortality; white race was associated with a 1.6 times higher odds of mortality; developing pneumonia was associated with a 1.8 times higher odds of mortality, and developing wound infection was associated with a 2.6 time higher odds of mortality. Payor status was a significant predictor of major postoperative complications after adjusting for age, sex, race, comorbidities using EI, hospital bedsize, and hospital location (Medicaid

vs. Private: ([OR]1.4, 95% CI 1.1, 1.8); Uninsured vs. Private: [OR] 1.2, 95% CI 0.9, 1.5) (Fig. 1). In a similar model payor status was, however, a significant predictor of minor postoperative complications after adjusting for age, sex, race, comorbidities using EI, hospital bedsize, and hospital location. (Medicaid vs. Private: Odds ratio [OR] 1.4; 95% Confidence Interval [CI] 1.1, 1.9; Uninsured vs. Private [OR]1.2, 95% CI 0.9, 1.6). Fig. 1 shows the adjusted odds of morbidity and mortality for patients undergoing emergency repair for UGI perforations due to PUD.

## Discussion

We investigated the association between payor status on postoperative complications and in-hospital mortality after emergency surgery for UGI perforations due to PUD in a cohort of patients not eligible for Medicare due to age or severe chronic disease. In these patients, who were dependent on access to private insurance or government subsidized insurance based on personal financial situation, we found that patients with Medicaid had worse outcomes. Furthermore, our results also demonstrated that when accounting for other important factors, Medicaid insurance was a predictor for major and minor postoperative complications.

It is well known that those with Medicaid and the uninsured have worse outcomes compared to those with private insurance.<sup>1,5,10,23</sup> Interestingly, our results show that those with Medicaid fared worse than those without insurance in terms of postoperative complications. Previous studies also found that Medicaid patients had worse outcomes than patients without insurance.<sup>1,10,26</sup> Our findings of increased complications, greater risk of post-injury infection among those with insurance Medicaid compared to those who have no insurance likely reflect larger societal issues. This is similar to a previous study by LaPar at el. (2010)<sup>10</sup> that demonstrated that among patients undergoing 1 of 8 major surgical operations (lung resection, esophagectomy, colectomy,

**Table 3**  
Outcomes associated with Emergent Repair of Upper Gastrointestinal Perforations due to Peptic Ulcer Disease.

Variable	Private	Medicaid	Uninsured	P value
In-hospital Mortality	256 (2.6)	156 (3.1)	98 (1.6)	0.03
<sup>a</sup> Length of Stay (Days) (Mean $\pm$ Standard Error)	$7.9 \pm 0.14$	$9.2 \pm 0.26$	$7.3 \pm 0.25$	<.0001
<b>Major complications</b>				
Postoperative myocardial infarction	133 (1.3)	91 (1.8)	88 (1.4)	0.62
Postoperative Acute respiratory distress syndrome	121 (1.2)	88 (1.8)	30 (0.5)	0.005
<b>Minor Complications</b>				
Postoperative pulmonary embolus	49 (0.5)	30 (0.6)	35 (0.6)	0.93
Postoperative wound infection	247 (2.5)	152 (3)	103 (1.7)	0.08
Postoperative pneumonia	613 (6.2)	452 (9)	387 (6.3)	0.02

<sup>a</sup> Length of stay only included those who survived to discharge.

**Table 4**  
Multivariable Regression Model (In-hospital mortality = Outcome).

Variable	Odds Ratio	95% Confidence Interval
<b>Insurance: Private (reference)</b>		
Medicaid	1.1	(0.67, 1.81)
Uninsured	0.9	(0.52, 1.61)
Older Age	1.6	(1.18, 2.04)
Male	1	(0.6, 1.55)
White	1.6	(1.18, 2.04)
<b>Elixhauser Index: 0 (reference)</b>		
1	2	(0.49, 7.92)
2	2.9	(0.74, 10.94)
≥3	14.3	(4.38, 46.94)
Postoperative pneumonia	1.8	(1.06, 3.22)
Postoperative myocardial infarction	2.3	(0.99, 5.47)
Postoperative wound infection	2.7	(1.32, 5.47)
Postoperative pulmonary embolus	0.6	(0.08, 4.92)
Postoperative Acute respiratory distress syndrome	1.5	(0.48, 4.65)
<b>Bed Size: Large (reference)</b>		
Medium	0.8	(0.48, 1.29)
Small	0.7	(0.35, 1.29)
<b>Teaching status: Rural (reference)</b>		
Urban teaching	6.4	(1.54, 27.01)
Urban nonteaching	5.8	(1.38, 24.35)

pancreatectomy, gastrectomy, abdominal aortic aneurysm repair, hip replacement, and coronary artery bypass), Medicaid payor status was associated with the longest length of stay and highest total costs, compared to those with who lacked insurance, had private insurance, or had Medicare insurance. Those eligible for Medicaid must prove their socioeconomic vulnerability to gain health insurance. In the era of proton pump inhibitors, although the incidence of refractory PUD has drastically improved,<sup>11</sup> the mortality associated with emergent surgical repair once the perforation has occurred remains high.<sup>24</sup> However, although socioeconomically vulnerable populations may also be unable to navigate the system through which Medicaid is granted, it is possible that the population of uninsured people reflects those who do not otherwise qualify based on socio-economic need and have chosen not to seek insurance through other avenues. Thus, these counterintuitive findings between the publicly insured and the uninsured likely reflect baseline food security, housing security, employment rather than ability to pay for healthcare. Nevertheless, as we hypothesized, those without insurance and those with Medicaid comprised a higher proportion of UGI perforation patients overall compared to those with private insurance (53% vs. 47%). Furthermore, nationally 18% Americans age 18–64 years are uninsured.<sup>8</sup> This is in contrast to our study's findings of 29% of adult patients age 18–64 years presenting with UGI perforations requiring emergency surgery were uninsured. In the era of proton pump inhibitors, this incidence of refractory PUD has drastically improved and reduced the need for elective acid-reduction surgical procedures.<sup>11</sup> Our findings suggest that Medicaid insurance and lack of insurance, whether due to unwillingness to purchase private insurance or inability to pay for private insurance due to costs even while not qualifying for Medicaid, may result in fewer preventative visits for early symptoms of PUD. Furthermore, Medicaid insurance and lack of insurance may result in less utilization of medicines that would presumably prevent progression of disease to UGI perforations. Therefore, less preventative visits to the primary care physician and less utilization of proton pump inhibitors due to either inability to sustain the costs or willful lack of seeking care may be one explanation for a larger proportion of patients in this study having either Medicaid insurance or being uninsured compared to patients with private insurance.

Unlike other studies that have shown the independent effect of payor status on surgical outcomes among various surgical

emergencies<sup>1,10</sup>; our study did not find any independent effect of payor status on mortality of patients requiring emergency surgery for UGI perforations due to PUD. This discrepancy between our findings and those of others might be due to the kinds of surgical emergencies under consideration and the relative nuances of surgical decision-making. In the case of UGI perforations due to PUD, the objective imaging finding of “free air” and absence of any viable non-surgical options for UGI perforations due to PUD expedites the decision to operate. Thus, payor status, consciously or unconsciously, is less likely to play a role in time to surgery and therefore possibly mitigates any differences in mortality. In contrast to other emergency surgical diseases, such as perforated appendicitis with periappendiceal abscess without generalized peritonitis, with no clear guidelines in the treatment of immediate or interval appendectomy,<sup>25</sup> the management of UGI perforations is subject less to debate.

The study findings must be interpreted within the context of the limitations of administrative data. In this retrospective analysis using NIS, our results may be biased by unrecognized miscoding of diagnosis and procedure codes as well as codes for payor status. However, given that NIS is both internally and externally validated every year, miscoding has been limited by the data distributors. Unfortunately, the distribution of open to laparoscopic repairs for UGI perforations due to PUD, which is in contrast to our current clinical experience, suggests that the coding of this intervention lags behind actual penetrance of the laparoscopic approach in clinical practice; therefore, we were unable to evaluate the effect of surgical approach on postoperative outcomes in our study. We strongly believe that it is important to include both open and laparoscopic approaches in this study given the trend toward minimally invasive surgeries even among emergency general surgery in clinical practices. Due to the nature of this inpatient database, we do not have outcome data beyond the initial hospitalization. Post-discharge mortality, complications, and readmissions are important outcomes that we cannot address in the present study. In addition, although we performed a multivariable regression analysis in an attempt to adjust for baseline differences in patient factors including age and comorbidities, that age and comorbidity differences in and of themselves are associated with the allocation of health insurance in our nation may also be confounding factor. Finally, the US Patient Protection and Affordable Care Act was signed in 2010; this may have impacted

demographic characteristics of patients in various insurance groups in our study period; however, the bulk of the regulatory changes, as well as the first open enrollment, did not occur until 2014, which likely minimized the impact on our findings. Although these limitations exist, this study is the only study, to our knowledge, to investigate the effect of payor status on outcomes of patients who have undergone emergent surgical repair for UGI perforations due to PUD in a nationally representative sample of patients who are dependent on access to health insurance that is not based on age or severe debilitating disease alone.

## Conclusions

Among this group of patients who will be most impacted by changes in our nation's health insurance policies, we found that surgery for UGI perforations due to PUD is associated with high mortality and morbidity across all payor classes. Specifically, those lacking private insurance more often find themselves in need of emergency surgery due to PUD-related UGI perforations. While in-hospital mortality is similar across payor groups when accounting for other important factors, complications are more likely in Medicaid patients, likely due to higher baseline health issues and psychosocial stressors. Strategizing means to prevent perforation through preventative measures will be key to reducing the burden of PUD across all populations, even among those lacking private insurance.

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## Conflicts of interests

The authors do not have conflicts of interest to disclose.

## Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.amjsurg.2018.06.025>.

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