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ORIGINAL ARTICLE

In-hospital mortality in gastroparesis population and its predictors: A United States-based population study

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Abstract

Background and Aim: To determine the United States-based in-hospital gastroparesis mortality rate and independent predictors associated with it.
Methods: A retrospective study was conducted using the deidentified National Inpatient Sample and Healthcare Cost and Utilization Project database between the years 2012 and 2014. The in-hospital gastroparesis mortality rate was calculated. Patients' demographics, including age, gender, race, comorbid conditions, and hospital characteristics, were examined as potential predictors of mortality.
Results: The gastroparesis mortality rate was 3.19 per 1000 gastroparesis patients for the years 2012–2014. Caucasians had the highest mortality rate, with odds ratio (OR) = 2.27; 95% confidence interval (CI) 1.52–3.38, and $P = 0.0001$. Rural hospitals had higher mortality, with OR = 1.51, 95% CI 1.10–2.10, and $P = 0.01$, whereas urban nonteaching and teaching hospitals showed no statistically significant mortality difference, with OR = 0.83, 95% CI 0.6–1.15, and $P = 0.27$ and OR = 0.82, 95% CI 0.59–1.15, and $P = 0.25$, respectively. In hospitals in the south region, mortality was the highest at 65.6%, with OR = 2.05, 95% CI 1.48–2.84, and $P < 0.0001$. Patients with diabetes mellitus had 39% lower probability in the mortality group.
Conclusion: Being of advanced age; being White; and being in a rural, southern U.S. hospital were predictors of in-hospital mortality in gastroparesis patients.

Introduction

Gastroparesis is a syndrome characterized by clinical symptoms of nausea, vomiting, early satiety, belching, bloating, or upper abdominal pain and delayed gastric emptying.[1] It is a debilitating disease with mild to severe symptoms, requiring hospitalization.[2] There has been a tremendous rise in gastroparesis-related hospitalizations over the last few years.[3,4]

In the reported literature, gastroparesis mortality is highly variable, ranging from 4% in a mixed cohort of inpatients and outpatients followed for 2 years to 37% in diabetic gastroparesis patients requiring nutritional support.[4–10] Bielefeld's study showed the inpatient gastroparesis mortality rate to be 0.44% in the U.S. population from 2007 to 2010.[11]

Most gastroparesis patients are only admitted to the hospital when they are decompensated, and these patients are more likely to develop complications and experience higher mortality.[6] Increasing hospitalization and variable mortality of gastroparesis create a need to understand this patient population better.

Data in the literature have demonstrated the disparities in the outcomes of hospitalization based on race[12] and socioeconomic status.[13] The data suggest that this disparity can be attributed to variations within the same hospital or differences between hospitals where patients receive a different quality of care based on their socioeconomic status.[14]

Although previous studies have reported on inpatient gastroparesis mortality, there has been no reported study in recent years. No study has reported the predictors of gastroparesis mortality in hospitals. Given the rising prevalence of gastroparesis, this study aimed to assess gastroparesis mortality in U.S. hospitals and identify predictors of in-hospital mortality using a large United States-based population database.

Methods

Data source. The National Inpatient Sample (NIS) database was used for this study. It is part of a family of databases developed for the Healthcare Cost and Utilization Project (HCUP). The NIS is an inpatient health-care database that consists of an approximately 20% stratified sample of all discharges from U.S. hospitals, excluding acute rehabilitation and long-term care facilities. When this database is weighted, it contains more than 35 million hospitalizations nationally. It contains clinical and nonclinical data elements, including patient demographics, diagnoses, and procedures, using the International Classification of Diseases, Ninth Revision, Clinical modification (ICD-9-CM). It also includes hospital characteristics, expected payment sources, total charges, length of stay, etc. In the NIS-HCUP, the principal diagnosis is the condition primarily responsible for the hospitalization of the patient.

Study population. The study population was selected from the NIS-HCUP database using the ICD-9-CM between the years 2012 and 2014. Hospitalization with the primary diagnosis of gastroparesis (ICD 9 code 536.3) was included in the study. The patient demographics included in the study were age, gender, race, and median household income. Median household income was defined as the median income of each patient's household in the reporting year based on zip code. The expected primary payers included Medicare, Medicaid, private insurance, self-pay, no charge, and other pay. The hospitals were characterized based on their total bed numbers, the region in which they were located, their teaching status, and control/ownership. The mortality rate was calculated in the cohort with the primary diagnosis of gastroparesis. Comorbidities were assessed in the gastroparesis population using ICD-9-CM codes.

Statistical analysis. Data were analyzed using the Statistical Package for the Social Sciences 27 (SPSS) Armonk, New York, USA. The data were weighted using the discharge-level weight variable (DISCWT) to create national U.S. estimates. Age was compared using a Student *t*-test. Categorical factors were compared using Chi-square tests. *P*-values less than 0.05 indicate a statistically significant association. Univariate analysis was conducted to compare patients' demographics, morbidity, and hospital characteristics between gastroparesis with mortality and gastroparesis without mortality. Weighted multivariable regression was performed to assess the predictors of mortality in the gastroparesis population. The NIS-HCUP database does not contain specific information about any patients, physicians, or hospital identifiers; therefore, the study did not require institutional review board approval.

Study outcome. The aims of this study were to calculate the mortality in the inpatient gastroparesis population and to assess the predictors of mortality in the gastroparesis cohort.

Results

There were 50 170 hospitalizations with a primary diagnosis of gastroparesis between 2012 and 2014. Five hospital encounters had missing mortality data, so those were excluded. The mortality rate was 3.19 per 1000 gastroparesis patients. The gastroparesis patients (n = 50 165) were further divided into two groups: gastroparesis with mortality (n = 160) and gastroparesis without mortality (n = 50 005). There was no mortality in the age group below 18 years, but the mortality rate increased with increasing age as follows: 18–44 years (0.097%), 45–64 years (0.23%), 65–84 years (1.1%), and above 85 years of age (1.8%). The mean age of the mortality group was high compared to the nonmortality group (shown in Table 1).

Differences between population demographics. In a comparison of gastroparesis patients with mortality to those without mortality, males had higher mortality, with odds ratio (OR) = 1.25 and 95% confidence interval (CI) 0.89–1.75, but it was not statistically significant. Being White had the highest mortality rate, with OR = 2.27, 95% CI 1.52–3.38, and P = 0.0001. The mortality rates for being White and being Black were 0.41% (130/31 580) and 0.15% (15/10 290), respectively. The median household income quartile of 0%–25% had the highest mortality rate, 41.9%, compared to other income levels. The mortality decreased as the median household income increased, except for a 3.2% increase from median quartile 50–74% to 75–100%. Medicare patients had the highest mortality among all the payer sources, with a rate of 78.1% (125/160) (shown in Table 1).

Effect of hospital characteristics on mortality. In hospitals in the south region, mortality was highest at 65.6%, with OR = 2.05, 95% CI 1.48–2.84, and P < 0.0001. Hospital ownership made no statistically significant difference with respect to gastroparesis mortality. Rural hospitals had higher mortality, with OR = 1.51, 95% CI 1.10–2.10, and P = 0.01, whereas urban nonteaching (OR = 0.83, 95% CI 0.6–1.15, P = 0.27) and teaching hospitals (OR = 0.82, 95% CI 0.59–1.15, P = 0.25) showed no statistically significant mortality difference. Mortality was the highest in hospitals with a large number of beds, with OR = 1.42, 95% CI 1.04–1.94, and P = 0.02 (shown in Table 2).

Diabetes mellitus (DM) and nausea with vomiting had lower odds in the mortality group compared to the nonmortality group, but these were not statistically significant. Although there was no statistically significant differences for nausea with vomiting between the two groups, electrolyte abnormalities and acute kidney injury had higher odds of mortality, usually the outcome of vomiting in the gastroparesis population. Pneumonia and sepsis had higher odds in the gastroparesis mortality group. Hypovolemia and urinary tract infection (UTI) had higher odds of mortality, but they were not statistically significant (shown in Table 3). Caucasians had a lower prevalence of DM compared to other races, 14.9% and 26.9%, respectively.

Being White had higher odds of mortality compared to being Black. After adjusting for patient demographics, comorbid conditions, and hospital characteristics, the median household income had no statistically significant differential effect on mortality. The Medicare gastroparesis population had a 214% higher chance of mortality compared to private insurance patients. Mortality was lower in urban nonteaching (OR = 0.52) and teaching (OR = 0.55) hospitals compared to rural hospitals. Patients with DM had a 39% lower probability in the mortality group. In this

Table 1 Comparison of gastroparesis patient demographics based on mortality

	Mortality *n* = 160	No mortality *n* = 50 005	*P* value
Age	68.28 SD = 16.002	47.05 SD = 18.23	<0.0001
Gender			
Male	50 (31.2%)	13 310 (26.6%)	0.186
Female	110 (68.8%)	36 695 (73.4%)	
Race/ethnicity			0.001
White	130 (81.3%)	31 450 (65.6%)	
Black	15 (9.4%)	10 260 (21.4%)	
Hispanic	10 (6.2%)	4435 (9.3%)	
Asian or Pacific	—	410 (0.9%)	
Islander	—		
Native American	—	250 (0.5%)	
Other	Other 5 (3.1%)	1110 (2.3%)	
		Missing = 2090	
Median zip code income quartile			
0–25%	65 (41.9%)	15 750 (32.1%)	0.03
26–50%	35 (22.6%)	12 970 (26.4%)	
51–75%	25 (15.6%)	11 370 (23.2%)	
76–100%	30 (18.8%)	8995 (18.3%)	
	Missing: 5	Missing: 920	
Primary payer			
Medicare	125 (78.1%)	19 440 (38.9%)	<0.0001
Medicaid	15 (9.4%)	10 330 (20.7%)	
Private insurance	15 (9.4%)	15 690 (31.4%)	
Self-pay	—	2810 (5.6%)	
No charge	—	325 (0.6)	
Other	5 (3.1%)	1345 (2.7%)	
		Missing: 65	

Age was reported as a mean with SD.

Table 2 Difference in hospital characteristics based on mortality among the hospitalized gastroparesis population

	Mortality *n* = 130	Nonmortality *n* = 50 005	*P* value
Hospital region			
Northeast	25 (15.6%)	8330 (16.7%)	<0.0001
Midwest	15 (9.4%)	9795 (19.6%)	
South	105 (65.6%)	24 110 (48.2%)	
West	15 (9.4%)	7770 (15.5%)	
Control/ownership of Hospital			0.42
Govt, nonfederal/public	20 (12.5%)	7845 (15.7%)	
Nonprofit private	105 (65.6%)	32 680 (65.4%)	
Investor-owned private	35 (21.9%)	9480 (19%)	
Teaching status of hospital			0.04
Rural	55 (34.4%)	12 850 (25.7%)	
Urban nonteaching	55 (34.4%)	19 320 (38.6%)	
Urban teaching	50 (31.2%)	17 835 (35.7%)	
Hospital beds			
Small	35 (21.9%)	14 755 (29.5%)	0.049
Medium	40 (25%)	13 090 (26.2%)	
Large	85 (53.1%)	22 160 (44.3%)	

regression analysis, nausea with vomiting had no statistically significant effect on mortality, but epigastric abdominal pain had 5.73 times higher odds in the mortality group. Pneumonia and sepsis had higher odds of being factors in the mortality group, whereas UTI had lower odds of being factor in the mortality group. Congestive heart failure (CHF) (OR = 2.47) and pulmonary embolism (PE)\deep venous thrombosis (DVT) (OR = 8.07) had higher odds in the mortality group (shown in Table 4).

Table 3 Comparison of comorbid conditions between gastroparesis population with mortality and without mortality

Factor	Mortality	Nonmortality	Odds ratio (95%CI)	*P* value
Diabetes mellitus	25 (15.6%)	9670 (19.3%)	0.77 (0.50–1.18)	0.24
Nausea with vomiting	15 (9.4%)	4745 (9.5%)	0.99 (0.58–1.68)	0.96
Epigastric abdominal pain	10 (6.3%)	1040 (2.1%)	3.14 (1.65–5.97)	<0.0001
Electrolyte abnormalities	70 (43.8%)	13 140 (26.3%)	2.18 (1.56–2.98)	<0.0001
Hypovolemia	5 (3.1%)	340 (0.7%)	4.71 (1.92–11.55)	0.005
AKI	65 (40.6%)	3890 (7.8%)	8.11 (5.91–11.14)	<0.0001
Sepsis	40 (25%)	230 (0.5%)	72.14 (49.30–105.55)	<0.0001
UTI	20 (12.5%)	4360 (8.7%)	1.50 (0.94–2.40)	0.09
Pneumonia	25 (15.65)	830 (1.7%)	10.97 (7.12–16.9)	<0.0001
CHF	35 (21.9%)	2905 (5.85)	4.54 (3.12–6.62)	<0.0001
PE/DVT	5 (3.1%)	175 (0.3%)	9.19 (3.72–22.66)	<0.0001

AKI, acute kidney injury; CHF, congestive heart failure; CI, confidence interval; DVT, deep venous thrombosis; PE, pulmonary embolism; UTI, urinary tract infection.

Discussion

In this analysis of the in-hospital gastroparesis population in the United States, the mortality rate was 3.19 per 1000 gastroparesis patients using the NIS-HCUP database for the years 2012–2014. This mortality rate was ~0.12% lower than that calculated by Bielefeldt[11] for gastroparesis patients, also using the NIS-HCUP database but using a different time interval, 2007–2010; that rate was 0.44%. The data are consistent with only the Olmsted County population-based study, which demonstrated that gastroparesis is associated with a lower life expectancy.[4]

This study showed a strong racial difference in gastroparesis mortality. White people had a mortality rate 2.27 times higher than did those of other races. Even after accounting for demographics, socioeconomics, and comorbid diseases, this rate persisted. Friedenberg et al. studied the influence of race and found that non-White patients had more severe symptoms and a poorer quality of life.[15] One would also expect to find higher mortality in non-White races, but on the contrary, White people had a higher mortality rate. Similar to this study, the prevalence of diabetic gastroparesis was far higher in non-White gastroparesis patients (55%) than in White gastroparesis patients (19%).[3] In our study, the coexistence of DM was associated with lower odds of mortality. Bielefeldt's study[11] also showed that DM was associated with lower mortality.

Medicare patients had the highest mortality among all the payer sources. Medicare is a national health program for Americans aged 65 years and older and for younger people with disabilities. According to the 2018 Medicare report, this program provided health insurance for over 59.9 million individuals, including more than 52 million aged 65 years and older and about 8 million younger people.[16] The most likely explanation for increased mortality in Medicare patients is that these patients are 65 years and older compared to private insurance, where patients are mainly younger.

In this study, those of advanced age had higher chances of gastroparesis mortality. This might be due to comorbid diseases associated with aging. Multimorbidity, which is two or more chronic conditions, increased with age, from 50% for persons under age 65 years of age to 62% for those aged 65–74 years[17]; it is associated with an elevated risk of death.[18] Pneumonia, sepsis, CHF, and PE/DVT were all associated with higher mortality, similar to the Bielefeldt study, which showed an association of a severe infectious source (sepsis) with higher mortality.[11] Advanced age and comorbidities are associated with higher rates of admission, more aggressive interventions, and poor outcomes.[4,5]

In this analysis, hospitals in the south U.S. region had twofold higher gastroparesis mortality than in other U.S. regions. This might be due to biological or disease-related factors[17] or differences in clinical practices between the regions. A U.S. population-based study[17] showed that gastroparesis admission rates were higher in states with a larger fraction of the population living below the poverty line, and poverty correlated with higher mortality. According to the U.S. census, the U.S. south region has the highest poverty rate in the United States, accounting for 44% of the poverty population of the country.[19] Poverty is likely related to lower socioeconomic status, limited access to health-care facilities, reduced medical compliance leading to a worsening of disease-related symptoms, and the need for hospitalization[20,21] and, hence, is related to a poor outcome.

In this study, the in-hospital mortality for patients admitted for gastroparesis was lower in urban hospitals compared to rural hospitals. The reason for the increased risk of death in rural hospitals is not apparent. However, one possible explanation may be differences in clinical practice. The utilization of gastroparesis-specific procedures, such as gastrostomy, jejunostomy, total parenteral nutrition, pyloroplasty, pyloric dilation, and gastric electrical stimulation, varies between rural and urban hospitals.[22] The study by Gray et al. showed that all these procedures are more commonly performed in urban hospitals compared to rural hospitals.[22] Patients in rural hospitals are less likely to receive care from a specialist,[23] which could explain the lower proportion of patients who undergo these procedures in rural hospitals. Thus, specialist referrals and surgical procedures for gastroparesis might help lower the gastroparesis mortality. We need further randomized controlled trials to prove the efficacy of specialist referrals and surgical interventions.

Several limitations should be considered while interpreting the results of this study. Although NIS-HCUP is the largest publicly available database, it is an administrative database. Diagnoses are coded using ICD-9 codes; the validity of these codes is

Table 4 Weighted multivariable logistic regression of subgroup status on mortality of gastroparesis

Factor	Odds ratio	95% CI	*P* value
Age	1.05	1.04–1.06	<0.0001
Gender	1.12	0.77–1.63	0.54
Male			
Race			
White	3.00	1.68–5.35	<0.0001
Black	Black ref		
Hispanic	2.14	0.92–4.98	0.07
Asian or Pacific Islander			0.99
Native American			0.99
Other	2.03	0.64–6.41	0.23
Median zip code income quartile			
0–25%	1.52	0.95–2.40	0.07
26–50%	0.73	0.43–1.23	0.244
51–75%	0.58	0.32–1.01	0.054
76–100%	Ref 76–100		
Primary payer			
Private insurance	Ref		
Medicare	2.14	1.19–3.86	0.01
Medicaid	1.67	0.78–3.58	0.184
Self-pay			0.984
No charge			0.995
Other	6.49	2.28–18.51	<0.0001
Teaching status of hospital			
Rural hoaspital	Ref		
Urban nonteaching	0.52	0.34–0.78	0.002
Urban teaching	0.55	0.36–0.85	0.007
Diabetes mellitus	0.61	0.39–0.96	0.03
Nausea with vomiting	1.29	0.73–2.32	0.38
Epigastric abdominal pain	5.73	2.80–11.77	<0.0001
Electrolyte abnormalities	1.56	1.09–2.22	0.01
Hypovolemia	0.52	0.16–1.7	0.28
AKI	4.33	2.10–6.26	<0.0001
Sepsis	42.10	25.75–71.74	<0.0001
UTI	0.57	0.33–0.97	0.03
Pneumonia	4.16	2.51–6.89	<0.0001
CHF	2.47	1.62–3.76	<0.0001
PE\DVT	8.07	2.97–21.94	<0.0001

AKI, acute kidney injury; CHF, congestive heart failure; CI, confidence interval; DVT, deep venous thrombosis; PE, pulmonary embolism; Ref, reference; UTI, urinary tract infection.

unclear. They can be subject to bias due to poor documentation by physicians or the poor reporting systems of hospitals. This database is based on hospital encounters rather than on individual patients, hence confounding the results due to repeated admissions. This could have affected the mortality rate as any gastroparesis patient could have had more than one hospital encounter during the study period.

We could not study the effect of gastrostomies, enterostomies, or other surgical interventions, such as gastric electrical stimulation or pyloric intervention, as there are only procedure codes for these when they are performed in a hospital. There are no ICD-9 codes if patients have already undergone such procedures in the past. As INS-HCUP is an in-hospital database, this study does not include outpatient gastroparesis patients.

Conclusion

This study highlights several important points. First, advanced age is associated with high in-hospital gastroparesis mortality risk. The second key finding is that being White is associated with a higher mortality risk. Third, rural hospitals and hospitals located in the south region of the United States are associated with higher gastroparesis mortality. This study provides clinicians with some risk factors for in-hospital gastroparesis mortality that might benefit from more aggressive monitoring. There is a need for further randomized controlled studies to stratify the mortality risk for patients hospitalized for gastroparesis.

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