Original Article

Inpatient burden of gastrointestinal stromal tumors in the United States

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Abstract: The purpose of this study was to determine the inpatient burden among patients with gastrointestinal stromal tumors (GISTs). The study assessed hospitalization rates of GISTs and compared hospital characteristics among patients with and without GISTs. Further, predictors of total charges and mortality among patients with GISTs were identified.

The 2009 Healthcare Utilization Project Nationwide Inpatient Sample (HCUP-NIS) database was analyzed for this study. Inpatient burden among patients with GISTs (cases) was compared to that among patients without GISTs or any diagnosis of cancer (controls). Linear regression was used to determine the factors predicting total charges, and logistic regression was used to determine predictors of mortality. Analyses were performed using SAS version 9.2.

In 2009, there were 14,562 hospitalizations among patients with GISTs at a rate of 44/100,000 admissions. Hospitalization rates among patients with GISTs varied by patient-, hospital-, and discharge-level characteristics. Patients with GISTs had longer length of stay (LOS), total charges, and mortality rate as compared to the control group. Total charges for hospitalizations among patients with GISTs varied by household income, hospital location and region, LOS, and number of diagnoses on record, respectively. When examining the predictors of mortality, household income, hospital region, and number of diagnoses on record emerged significant.

By examining the inpatient burden among patients with GISTs, this study fills a critical gap in this area of research. Future studies could merge medical services claims data with cancer registry data to study in-depth the humanistic and economic burden associated with GISTs.

Key Words: Gastrointestinal stromal tumors; inpatient; charges; mortality

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Introduction

Gastrointestinal Stromal Tumors (GISTs) are the most common tumors of the gastrointestinal (GI) tract that arise from mesenchymal cells, and are considered to be a subset of soft tissue sarcomas (1). GISTs account for less than 1% of all GI tumors (2). The prevalence of GISTs has been found to be 129 per million adults while the incidence is reported to be 3000-4000 adults per year (3-5).

Though the incidence and prevalence numbers of GISTs are lower as compared to other more common cancers, the disease burden associated with these tumors is significant (6). The 3-year survival rate for patients with GISTs is 79%, while the 5-year survival rate is 63% (7,8). Besides leading to significant morbidity and mortality, GISTs cause considerable economic burden. In their study of costs associated with GISTs using the SEER-Medicare database, Rubin *et al.* (2011) reported the first-year total medical costs after surgical resection of GISTs to be $35,478.

A few studies have reported the survival rates and costs associated with GISTs; however, there is currently no information available regarding the inpatient burden associated with these tumors. Information concerning total charges and mortality among patients hospitalized with GIST is currently unknown. The purpose of this study was to determine the hospitalization burden associated with GISTs in the United States (US) using a nationally representative database. Specific objectives

of the study were to: (I) assess the hospitalization rates of GISTs by different patient-, hospital- and discharge-level characteristics; (II) compare the hospitalization characteristics of patients with GISTs to those without GISTs; and (III) identify the factors predicting total charges and mortality, respectively, among patients with GISTs.

Patients and methods

Data source

The study was conducted using the 2009 Healthcare Utilization Project-Nationwide Inpatient Sample (HCUP-NIS) data. The HCUP-NIS contains data from 1,050 hospitals and represents a 20% stratified sample of US community hospitals (9). Since the HCUP-NIS is a discharge-level database, each line represents a single unique hospitalization. Institutional Review Board approval is not required when using this database, since it is made available to researchers in a de-identified format.

Study design and sample

A retrospective cross-sectional design was used for this study. Discharges with LOS greater than 365 days or total charges greater than $1 million were excluded from the analysis. Patients hospitalized with any listed diagnosis of GISTs were identified using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes including 171.5, 171.8, 171.9, 215.1 or 238.1 (10). A control group consisting of patients without any diagnosis of GISTs or other cancers was identified. Cases and controls were matched based on age and gender in a 1:4 ratio using a greedy match algorithm (11).

Statistical analysis

All analyses were performed using PROCSURVEY procedures in Statistical Analysis System (SAS) version 9.2 to account for the complex sampling design of the HCUP-NIS. Hospitalization rates for GISTs were reported by patient-, hospital-, and discharge-level characteristics. Rates were calculated by dividing the number of weighted hospitalizations associated with GISTs in each category by the total number of hospitalizations in that category. In addition, common comorbid diagnoses and procedures performed among patients with GISTs were assessed. Hospitalization characteristics among patients with GISTs were compared to the control group using χ^2 test and t-test. Linear regression (PROC SURVEYREG) was used to determine the factors predicting total charges among patients with GISTs. Factors predicting mortality among patients with GISTs were determined using logistic regression (PROC SURVEYLOGISTIC). Results reported in the study are weighted estimates.

Results

Table 1 describes the hospitalization rates for GISTs and compares the patient-, hospital-, and discharge-level characteristics among patients with and without a diagnosis of GISTs. In 2009, there were a total of 14,562 hospitalizations among patients with GISTs in the US. The overall hospitalization rate of patients with GISTs was 44/100,000 admissions. In terms of patient-level characteristics, the highest rates for GISTs were among patients aged 50-64 years, males, having household income of $63,000 or more, and with private insurance, respectively. As per hospital-level characteristics, rates were the highest for hospitalizations that took place in small hospitals, urban hospitals, hospitals located in the South, and teaching hospitals, respectively. Also, hospitalization rates were higher among patients with GISTs who died during the course of their stay as compared to patient with GISTs who had other discharge dispositions.

When comparing study characteristics among patients with and without GISTs, significant differences emerged. A significantly greater proportion of patients with GISTs were from households with income greater than $63,000 as compared to patients in the control group (24.76% *vs.* 19.97%; P<0.0001). A greater proportion of patients with GISTs than those without GISTs had private insurance (41.54% *vs.* 30.42%; P<0.0001). Hospitalizations associated with GISTs were higher in urban and teaching hospitals than hospitalizations in control group. The LOS [6.72 (0.18) *vs.* 4.74 (0.07); P<0.0001] and total charges [$49,429 ($1,985.87) *vs.* $34,522 ($1,023.11); P<0.0001] were significantly higher for patients with as compared to those without GISTs. Patients with GISTs had roughly three times higher mortality rate as compared to the control group (4.62% *vs.* 1.72%; P<0.0001). The average number of diagnoses recorded were also higher for patients with GISTs than for those in the control group [9.43 (0.15) *vs.* 8.65 (0.09); P<0.0001].

Although not tabulated, the comorbid conditions and procedures performed among patients with GISTs were also studied. Roughly 37% of patients with GISTs had a diagnosis of hypertension, which was also the most common co-morbid condition. Anemia (31.25%), disorders of fluid electrolyte and acid-base balance (26.1%), disorders of lipid metabolism (19.03%), and diabetes (16.40%) were also common. Injection or infusion of prophylactic or therapeutic substance (13.33%), puncture of vessel (11.91%),

Table 1 Hospitalization characteristics and rates among patients with gastrointestinal stromal tumors (GISTs)

Characteristic	Discharges with a diagnosis of GIST[e]	Discharges without a diagnosis of GIST[e]	P value	Rates (per 100,000 hospital admissions)[a]
Socio-demographic characteristics				
Age in years, n (%)				
Less than 35	2,081 (14.29)	8,490 (14.45)		31.90
35-49	2,481 (17.04)	10,098 (17.19)		44.93
50-64	4,312 (29.61)	17,338 (29.51)		57.49
65-79	3,991 (27.41)	15,988 (27.21)		50.53
>79	1,697 (11.65)	6,835 (11.63)		30.07
Gender, n (%)				
Male	6,844 (47.02)	27,625 (47)		51.73
Female	7,718 (52.98)	31,124 (53)		38.96
Median household income, n (%)			<0.0001*	
$0–$38,999	3,132 (22.09)	16,921 (29.75)		34.31
$39,000–$47,999	3,927 (27.70)	15,125 (26.59)		45.75
$48,000–$62,999	3,608 (25.45)	13,479 (23.70)		47.54
≥$63,000	3,511 (24.76)	11,361 (19.97)		52.01
Primary payer, n (%)			<0.0001*	
Public	7,579 (52.13)	34,472 (58.82)		38.41
Private	6,039 (41.54)	17,824 (30.42)		59.67
Other[c]	920 (6.33)	6,305 (10.76)		29.04
Hospital characteristics				
Hospital size, n (%)			0.44	
Small	1,862 (13.08)	7,116 (12.31)		47.19
Medium	2,996 (21.05)	13,948 (24.13)		38.26
Large	9,372 (65.86)	36,751 (63.57)		45.19
Location of hospital, n (%)			<0.0001*	
Rural	1,063 (7.47)	7,396 (12.79)		26.30
Urban	13,165 (92.53)	50,419 (87.21)		46.24
Region of hospital, n (%)			0.08	
Northeast	2,761 (18.96)	11,816 (20.11)		41.70
Midwest	3,589 (24.64)	13,642 (23.22)		46.55
South	5,022 (34.49)	22,972 (39.10)		395.43
West	3,190 (21.90)	10,319 (17.56)		52.66
Teaching status of hospital, n (%)			<0.0001*	
Non-teaching	5,764 (40.51)	32,048 (55.43)		32.31
Teaching	8,465 (59.49)	25,768 (44.57)		57.66
Discharge characteristics				
Discharge disposition, n (%)			<0.0001*	
Routine	9,415 (64.78)	40,317 (68.64)		41.79
Died	671 (4.62)	1,012 (1.72)		91.54
Other[d]	4,447 (30.60)	17,405 (29.63)		45.32
Length of stay (days), mean (SE)	6.72 (0.18)	4.74 (0.07)	<0.0001*	
Total charges ($), mean (SE)	49,429 (1,985.87)	34,522 (1,023.11)	<0.0001*	
Number of diagnoses on this record, mean (SE)	9.43 (0.15)	8.65 (0.09)	<0.0001*	
Total	14,562[b]	58,750[b]		44.01

GIST = Gastrointestinal stromal tumors; SE = Standard error; *Significant at alpha level of 0.05; [a]Rates were calculated based on the number of hospitalizations (weighted) of patients with GIST in each of the categories divided by the total number of hospitalizations (weighted) within those categories; [b]Hospitalizations total within each category may not add up to the final total due to missing data; [c]Other category included self-pay and other type of insurances; [d]Other category included transfer to short-term hospital, other transfers, including skilled nursing facility, intermediate care, and another type of facility, home health care, against medical advice and discharged to an unknown destination; [e]The 'n' within each category may not add to the total because of missing data. Percentages listed were calculated based on observed values

diagnostic procedures on small intestine (10.29%), and lysis of peritoneal adhesions (5.11%) were some of the procedures performed among patients with GISTs.

Table 2 displays the predictors of total charges among patients with GISTs. Average total charges were lower for patients having household income between $39,000 and $47,999 [β =–$9,089.22; 95% confidence interval (CI) (–$15,292.54, –$2,885.90); P=0.005] as compared to patients with income $63,000 or more. Charges were lower in rural hospitals [β = –$13,443.01; 95% CI (–$19,472.47, –$7,413.56); P<0.0001] than urban hospitals. Patients admitted to hospitals in the Midwest [β =–$22,305.75; 95% (–$34,704.19, –$9,907.31); P=0.0004], Northeast [β =–$22,939.50; 95% CI (–$32,958.24, –$12,920.77); P<0.0001] and West [β =–$22,577.24; 95% CI (–$32,563.63, –$12,590.85); P<0.0001] reported significantly lower average total charges compared to those admitted in the South. Longer LOS [β =$6,069.69; 95% CI ($4,488.70, $7,650.69); P<0.0001] and greater number of diagnoses on record [β =$1,008.35; 95% CI ($99.2, $1,917.50); P=0.03] were associated with higher average total charges.

Results of logistic regression analyses for predictors of mortality are reported *in Table 3*. The odds of mortality were higher among patients from low income households [Odds Ratio (OR) =2.36; 95% CI (1.33, 4.18); P=0.015] as compared to patients from households with income greater than or equal to $63,000. Mortality rates for patients admitted to hospitals located in the Midwest [OR =2.17; 95% CI (1.20, 3.95); P<0.0001] were higher than those admitted to hospitals in the South. Mortality rates increased with the number of diagnoses on record [OR =1.14; 95% CI (1.10, 1.19); P<0.0001].

Discussion

This study assesses the inpatient burden of GISTs using a nationally representative dataset. To the best of our knowledge, this is the first study to report the hospitalization rates and burden of GISTs in the US. Given the dearth of prior research in this regard, it is difficult to make substantial conclusions. However, the results of this study are noteworthy and add to the literature concerning GISTs.

Hospitalization rates among patients with GISTs varied by study characteristics. In terms of patient-level variables, rates were highest for patients aged 50-64 years, males, with household income greater than or equal to $63,000, and those with private insurance, respectively. As is true for most cancers, the rate of GISTs was found to increase with age. We found a linear relationship between household income and hospitalization rate, with the rate increasing with income level. Differences in cancer incidence and healthcare access by socioeconomic status could explain this result. When studying the occurrence of cancers of GI tract by socioeconomic status and education, Pukkala and Teppo [1986] found a higher incidence of cancers of colon and rectum among individuals of higher socio-economic status (12). Other studies have also found a positive association between colon cancer and socioeconomic status (13,14). Dietary habits and lifestyle could account for such occurrences (12,14). Besides the variation in cancer incidence by socioeconomic status, access-related factors could attribute for the positive relationship seen between hospitalization rates and income and insurance (15,16). Differences in hospitalization rates for GISTs also existed by hospital characteristics. Hospitalization rates were higher in hospitals located in urban areas. Cancer incidence rates are generally higher in urban areas as compared to rural areas (17). The higher rates in urban areas may be explained by the differences in lifestyle factors and exposure to environmental pollutants (17). Teaching hospitals had higher hospitalization rates than non-teaching hospitals. The specialized nature of care provided in teaching hospitals may explain this result.

The average total charge among patients with GISTs was found to be ~$49,000. In the only previous study of cost among patients with GISTs, Rubin *et al*. [2011] reported the first-year total medical costs after surgery to be $35,478, with hospital costs accounting for $22,042 (6). The higher amounts observed in this study as compared to Rubin *et al*. [2011] could be attributed to a couple of reasons. First, we used total charges while Rubin *et al*. calculated total costs. Charges are generally higher than costs for healthcare visits (18). Second, our charges were based on hospitalizations among patients with GISTs, which does not imply that patients were specifically admitted for GISTs. The charges among these patients in our study might be a reflection of other conditions or procedures performed in these patients. Results from linear regression analyses highlighted significant predictors of total charges. As expected, total charges were higher for patients with longer LOS and higher number of diagnoses on the record. Further, total charges were higher for patients admitted to urban as compared to rural hospitals. This could be a reflection of the resource intensive nature or the use of more expensive treatment options in healthcare facilities (hospitals) located in urban areas as compared to those located in rural areas (19).

Mortality rates among patients with GISTs were three times higher than those of the control group, indicating the significant humanistic burden associated with GISTs. Due to data limitations, we were unable to compare mortality

Table 2 Predictors of total charges for hospitalizations among patients with gastrointestinal stromal tumors (GISTs)

Characteristic	β	95% confidence interval	P value
Age in years			
Less than 35	6,255.02	[–3,265.32, 15,775.36]	0.19
35-49	4,691.75	[–4,124.17, 13,507.66]	0.29
50-64	4,019.12	[–4,936.38, 12,974.63]	0.38
65-79	–1,300.08	[–9,062.44, 6,462.28]	0.74
>79	Ref		
Gender			
Male	–1,678	[–2,667.78, 6,023.81]	0.45
Female	Ref		
Median household income			
$0–$38,999	–7,300.45	[–15,329.86, 728.97]	0.078
$39,000–$47,999	–9,089.22	[–15,292.54, –2,885.90]	0.005*
$48,000–$62,999	–5,554.50	[–12,440.79, 1,331.80]	0.12
≥$63,000	Ref		
Primary payer			
Public	6,959.59	[–3,923.94, 17,843.11]	0.21
Private	7,098.23	[–3,663.66, 17,860.12]	0.19
Other[a]	Ref		
Hospital size			
Small	–1,852.23	[–13,693.36, 9,988.89]	0.76
Medium	–5,754.61	[–12,820.31, 1,311.10]	0.11
Large	Ref		
Location of hospital			
Rural	–13,443.01	[–19,472.47, –7,413.56]	<0.0001*
Urban	Ref		
Region of hospital			
Midwest	–22,305.75	[–34,704.19, –9,907.31]	0.0004*
Northeast	–22,939.50	[–32,958.24, –12,920.77]	<0.0001*
West	–22,577.24	[–32,563.63, –12,590]	<0.0001*
South	Ref		
Teaching status of hospital			
Non-teaching	–5,204.65	[–11,657.30, 1,248.00]	0.11
Teaching	Ref		
Discharge disposition			
Routine	–1,967.60	[–8,583.06, 4,647.85]	0.56
Died	6,929.45	[–11,723.39, 25,582.30]	0.47
Other[b]	Ref		
Length of stay	6,069.69	[4,488.70, 7,650.69]	<0.0001**
Number of diagnoses on this record	1,008.35	[99.2, 1,917.50]	0.03*

*Significant at α level of 0.05; [a]Other category included self-pay and other type of insurances; [b]Other category included transfer to short-term hospital, other transfers, including skilled nursing facility, intermediate care, and another type of facility, home health care, against medical advice and discharged to an unknown destination; β = Standardized regression coefficient

Table 3 Predictors of mortality for hospitalizations among patients with gastrointestinal stromal tumors (GISTs)

Characteristic	Odds Ratio	95% confidence interval	P value
Age in years			
Less than 35	0.56	[0.22, 1.41]	0.681
35-49	0.56	[0.24, 1.27]	0.600
50-64	0.56	[0.29, 1.07]	0.471
65-79	0.60	[0.36, 1.02]	0.781
>79	Ref		
Gender			
Male	0.91	[0.64, 1.29]	0.589
Female	Ref		
Median household income			
$0–$38,999	2.36	[1.33, 4.18]	0.015*
$39,000–$47,999	1.55	[0.87, 2.79]	0.790
$48,000–$62,999	1.90	[0.9, 3.30]	0.561
≥$63,000	Ref		
Primary payer			
Public	1.69	[0.64, 4.49]	0.808
Private	2.43	[0.95, 6.26]	0.06
Other[a]	Ref		
Hospital size			
Small	0.79	[0.43, 1.43]	0.586
Medium	0.86	[0.53, 1.41]	0.924
Large	Ref		
Location of hospital			
Rural	1.02	[0.49, 2.15]	0.950
Urban	Ref		
Region of hospital			
Midwest	2.17	[1.20, 3.95]	<0.0001*
Northeast	0.96	[0.53, 1.74]	0.158
West	1.05	[0.49, 1.81]	0.324
South	Ref		
Teaching status of hospital			
Non-teaching	1.19	[0.81, 1.76]	0.375
Teaching	Ref		
Length of stay	1.01	[0.99, 1.04]	0.430
Number of diagnoses on this record	1.14	[1.10, 1.19]	<0.0001*

*Significant at α level of 0.05; [a]Other category included self-pay and other type of insurances

rates among patients with GISTs by stages of tumor. It will be interesting to see how inpatient burden among these patients varies by stage. Future researchers could undertake such research by merging cancer registry data with health claims data. When observing the predictors of mortality among patients with GISTs, few variables were found to be significant. Patients with GISTs from lower income households had twice the mortality rate as compared to those from high income households. This may indicate a lack of access to healthcare resources in a timely manner for patients with lower income. Mortality was higher for those with high number of comorbid diagnoses indicating the expected relationship between comorbid conditions and mortality.

This study has a few limitations. Coding errors may have occurred during processing of hospital claims that could lead to inaccurate results. Since the HCUP-NIS is

a discharge-level data, some patients may be represented more than once in the analysis. This study reports total charges, which may be higher than the actual costs of hospitalizations. Lastly, since we studied hospitalizations among patients with any listed diagnosis of GISTs, the true burden of the disease may not be known from this study.

This is one of the first studies to provide a comprehensive account of hospitalizations among patients with GISTs. Hospitalization rates for GISTs were found to vary by study characteristics. Patients with GISTs had higher inpatient burden in terms of higher length of stay, total charges, and mortality as compared to patients without GISTs. Total charges and mortality among patients with GISTs were found to vary by different patient, hospital and discharge characteristics. Policy makers could use results of this study to address the healthcare needs associated with GISTs. Though not as prevalent as some of the other common cancers, there is an urgent need to further study health outcomes among patients with GISTs given the significant burden associated with this disorder.

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