

Health Care Utilization and Costs Associated With Acute Pancreatitis

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Objective: Acute pancreatitis is a common inpatient diagnosis among gastrointestinal disorders. The aim of this study was to evaluate the incidence of inpatient admissions, costs, and mortality rates associated with acute pancreatitis in the United States.

Methods: We analyzed the National Inpatient Sample for all patients in which acute pancreatitis (*International Classification of Diseases, Ninth Revision* code: 577.0) was the principal discharge diagnosis during the period 1997–2012. The statistical significance of the difference in the hospital discharges, length of stay, and costs over the study period was determined by utilization of regression analysis.

Results: In 1997, there were 164,776 admissions with a principal discharge diagnosis of acute pancreatitis as compared with 275,170 in 2012 ($P < 0.001$). The mean length of stay for acute pancreatitis decreased from 6.4 days in 1997 to 4.7 days in 2012 ($P < 0.001$). However, during this period, the mean hospital charges increased by 118.6% from \$15,433 in 1997 to \$33,744 in 2012 ($P < 0.001$). The in-hospital mortality rate decreased significantly from 1.9% in 1997 to 0.78% in 2012 ($P < 0.001$).

Conclusions: Inpatient admissions for acute pancreatitis and associated costs have increased markedly over the last 16 years in the United States. However, the lengths of stay and mortality rates have decreased significantly.

Key Words: Inpatient admission rates, pancreas, epidemiology, acute pancreatitis

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Acute pancreatitis is a common inflammatory condition of the pancreas resulting in more than 220,000 hospital admissions every year in the United States.¹ Based on severity, it is commonly divided into interstitial edematous pancreatitis and necrotizing pancreatitis.² The two most common etiologies of acute pancreatitis are gallstones and excessive alcoholic consumption.³ It is the most common gastrointestinal cause of hospital admissions in the United States, with an annual incidence rate of 13 to 45/100,000 patients.⁴ Pancreatitis can either be localized and self-limited, or be complicated in about 20% of the patients, by a pan-systemic proinflammatory response causing multiorgan failure with or without associated pancreatic necrosis; the spectrum of which is called severe acute pancreatitis. Severe acute pancreatitis is associated with high mortality (10%–85%) along with prolonged median

hospital stays of about 3 months among patients undergoing pancreatic necrosectomy.^{5,6}

A recent study on the burden of acute pancreatitis in the emergency departments found that more than 75% of patients presenting with acute pancreatitis end up being admitted to the hospital.⁷ That study also found that the mortality rates were increasing among the older, sicker Medicare and Medicaid patients, who constitute a significant proportion of the American population. Because acute pancreatitis is a common condition associated with significant morbidity and mortality, it represents an important factor determining hospital costs and utilization of health care resources. There is a paucity of data in literature about the inpatient burden of acute pancreatitis in the United States. Brown et al⁸ studied costs and outcomes related to hospitalizations for acute pancreatitis during the period 1997–2003. However, there have been significant improvements in the management of acute pancreatitis since then, such as predicting the severity, early aggressive fluid resuscitation, and preference of enteral feeding, all of which might have led to improved outcomes. Hence, our study aimed at examining the recent trends, costs, and outcomes associated with inpatient admissions related to acute pancreatitis in the United States.

MATERIALS AND METHODS

The National Inpatient Sample (NIS) database was utilized to obtain a population-based estimate of national trends. The NIS is the largest publicly available all-payer inpatient care database in the United States. It is a part of the Healthcare Cost and Utilization Project, which has been sponsored by the Agency for Healthcare Research and Quality, Rockville, Md. Data were sampled from approximately 20% of the patient population of US nonfederal hospitals and were stratified according to geographic region, location, ownership, teaching status, and bed size until 2011. In 2012, NIS was redesigned to include a 20% stratified sample of discharges from US community hospitals of all the participating states, except from rehabilitation and long-term acute care hospitals. Data from approximately 8 million hospital stays have been accumulated by the NIS every year. Data from 1997 were collected from 22 States and contain 7.1 million records drawn from inpatient stays from over 1000 hospitals. The 2012 database contains discharge documentation from over 4000 hospitals in 44 states, accounting for about 8 million records. This large database is an excellent representative sample of the general US population, representing more than 95% of the US population and useful for analyzing health care utilization, access, charges, quality, and outcomes.^{9,10} The NIS database provides only administrative data for analysis. Patient-specific clinical data (ie, laboratory tests, procedures) are not available.

To identify all cases of acute pancreatitis, we searched the NIS database to recover hospital data on patients who received, at the time of discharge, diagnoses with a primary *International Classification of Diseases, Ninth Revision, Clinical Modification* diagnosis code of 577.0 (acute pancreatitis). According to the

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HCUPnet, principal diagnosis is defined as “the condition established after study to be chiefly responsible for occasioning the admission of the patient to the hospital for care.” The principal diagnosis is always the reason for admission (definition according to the Uniform Bill [UB-92]). Therefore, we assume that we accurately captured data regarding hospitalizations due to acute pancreatitis.

The query parameters searched for data for the period ranging from 1997 to 2012. The NIS data are available from as far back as 1988 to 2012. However, in 1997, there was a change was implemented in the NIS data set, allowing details of the patient and hospital characteristics to be included, which helped to analyze trends in detail over time. Therefore, we chose this particular period for our study.

Variables Recorded

Patient demographics that were recorded included age and sex. Hospital characteristics included region (northeast, midwest, south, and west), location (metropolitan vs nonmetropolitan area), type (teaching vs nonteaching), and size (small, medium, and large). As per the HCUPnet definitions, metropolitan areas are those with population of more than 50,000 people. Areas with smaller population were classified as nonmetropolitan areas. A hospital was considered to be a teaching hospital if the American Hospital Association Annual Survey indicates it had an American Medical Association–approved residency program, was a member of the Council of Teaching Hospitals, or had a ratio of full-time equivalent interns and residents to beds of 0.25 or higher. The definition of bed size subsequently changed according to the hospital location and teaching status. Small hospitals ranged from 1 to 299 beds. Medium-sized hospitals ranged from 50 to 499 beds, whereas the bed size for large hospitals ranged from 100 to 500 or more. We also looked at the payer status for all admissions. “Hospital charges” was defined as the amount that the hospital has charged for the entire hospital stay. It did not include professional (MD) fees. “Aggregate charges” or the “national bill” was defined as the sum of all charges for all hospital stays in the United States. “Length of stay” was defined as the number of nights the patient remained in the hospital for that admission.

Statistics

The trends for the annual point estimates of the frequency of acute pancreatitis for the data sample were plotted and analyzed. The annual frequency of discharges with acute pancreatitis was computed by dividing the annual number of discharges with acute pancreatitis listed in the NIS database in a given year by the total number of all discharges listed in the NIS for the same year. The temporal trend in frequencies of discharges, length of stay, hospital charges, and frequencies of deaths in subjects with acute pancreatitis was assessed by linear and polynomial regression. The most appropriate functional form for the trend was assessed by examination of regression diagnostic plots. Linear shape was determined for costs and length of stay and a cubic shape for discharge and in-hospital death rates. All analyses were performed using SAS (version 9.4, The SAS Institute, Cary, NC), and a $P < 0.05$ was considered statistically significant.

In addition to the percentages available adjacent to the data in the tables, the frequency per 10,000 admissions for each categorical variable was also calculated. These numbers represent the density of patients diagnosed with acute pancreatitis compared with the total number of hospital discharges per category. Each frequency was calculated by dividing the number of patients with acute pancreatitis by the total discharges in a specific categorical variable for each year and multiplying the number by 10,000.

We view the counts as arising from a Poisson distribution and the total discharges as an offset, yielding Poisson rates that have been compared over time using Poisson regression, which yields relative rates (RRs) that express the ratio of rate per 10,000 in 2012 to that in 1997. These values differ from the percentages, which describe each category exclusively for either patients with acute pancreatitis or for total discharges. The percentages distinguished differences among the variables for each specific year, whereas the frequencies were vital in comparing trends from 1997 to 2012, especially for age group and region.

RESULTS

There were a total of 164,776 discharges for acute pancreatitis in 1997 compared with 275,170 in 2012. The rate of discharges per 100,000 persons increased from 60.4 in 1997 to 87.7 in 2012 with a steady increase from 1998 to around 2002 and then a period of less-pronounced increase ($P < 0.001$; Fig. 1). The mean cost of hospitalization had steadily increased by \$1389 per year and with a total increase of 118.6% from 1997 to 2012 ($P < 0.001$; Fig. 2). The mean length of stay had steadily declined with an average decrease of 0.5 day every 5 years ($P < 0.001$; Fig. 3). In-hospital deaths were seen to be on the decline up to around 2010 and appear to be stabilizing after that, but further data on subsequent years would be needed to verify if that pattern continues ($P < 0.001$; Fig. 4).

The aggregate charges (ie, national bill) for acute pancreatitis increased by 365.8% from \$2,536,641,014 \pm \$119,508,921 in 1997 to \$9,279,927,328 \pm \$149,600,667 in 2012 ($P < 0.001$). The national bill percentage for acute pancreatitis discharges (national bill for acute pancreatitis/total national bill) had markedly increased over the last 16 years (0.68% in 1997, cf., 1.55% in 2012).

Patient Characteristics

The 45-to-64-years age group had the highest discharges per 10,000 patients in 1997 for acute pancreatitis (88) followed by the 18-to-44-years age group (66). The trends reversed in 2012, where the 18-to-44-years age group had the highest number of acute pancreatitis discharges per 10,000 patients (189) compared with the 45-to-64-years age group (125) (Table 1). The highest proportion of discharges in 1997 were in the 18-to-44-years age group (59,000; 36%), and in 2012, it was the 45-to-64-years age group with 113,000 patients (41%). Interestingly, the number of patients admitted for acute pancreatitis in the 1-to-17-years age group almost tripled with a 220% increase from 1997 to 2012 (RR, 3.16 [3.0–3.3]; $P < 0.001$), followed by the 18-to-44-years age group

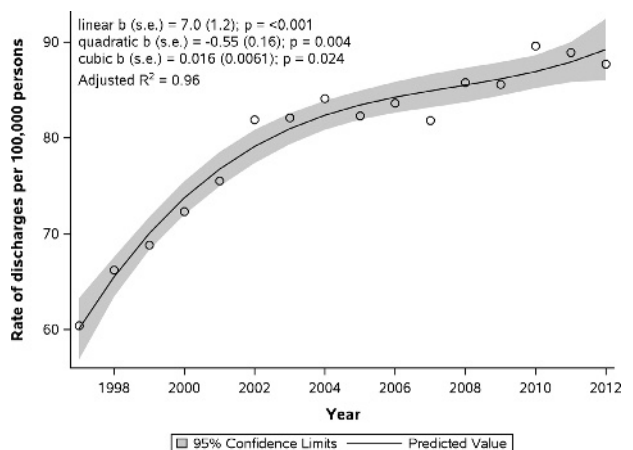


FIGURE 1. Rate of hospital discharges with acute pancreatitis.

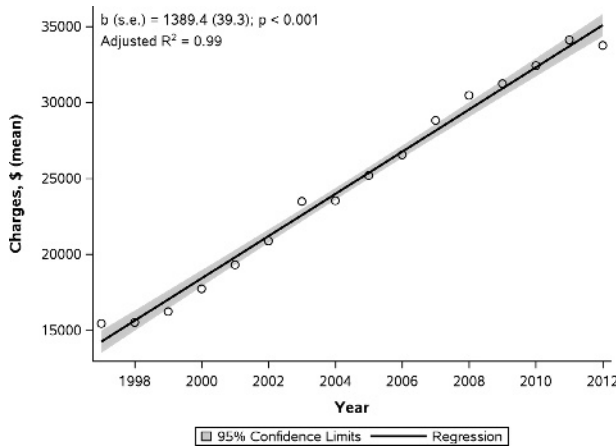


FIGURE 2. Average total hospital charges per hospitalization due to acute pancreatitis.

(RR, 2.85 [2.82–2.88]; $P < 0.001$), whereas the 45-to-64-years age group just increased by 45% (RR, 1.42 [1.40–1.44]; $P < 0.001$). Males and females were equally affected in both years, with females affected slightly more; however, compared with males, the number of females with an acute pancreatitis discharge diagnosis increased by 106% (RR, 2.05 [2.03–2.07]; $P < 0.001$) versus 80% in males (RR, 1.79 [1.77–1.80]; $P < 0.001$). The Medicare and privately insured group formed the highest proportion of patients admitted with acute pancreatitis in 1997 and 2012 (around 30% each); however, the highest increase in percentage of patients admitted with acute pancreatitis from 1997 to 2012, according to payer status, was seen in Medicaid patients (RR = 2.88 [2.84–2.93]; $P < 0.001$) followed by patients with private insurance (RR, 2.53 [2.50–2.55]; $P < 0.001$). Analyzing trends in socioeconomic status, both low- and high-income patients were equally affected in 2012 (104 vs 94/10,000, respectively) with lower-income classes being slightly more affected. These data were not available for 1997.

Hospital Characteristics

The highest proportion of patients with discharge diagnosis of acute pancreatitis was in private (not-for-profit) hospitals (around 70%); and from 1997 to 2012, cases of acute pancreatitis increased the most in these hospitals (102%) compared with government or private (for-profit) institutions. In 1997, both teaching and nonteaching

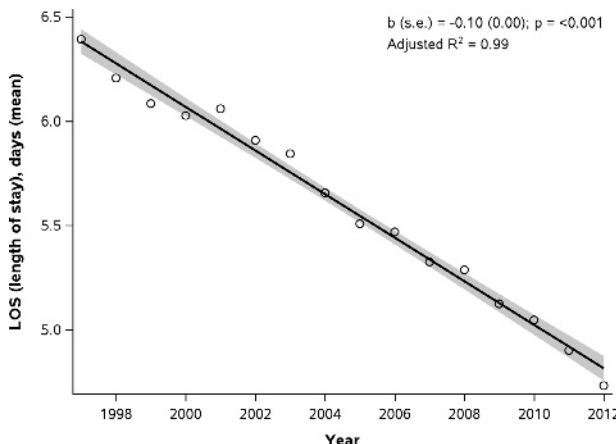


FIGURE 3. Average total length of stay per hospitalization due to acute pancreatitis.

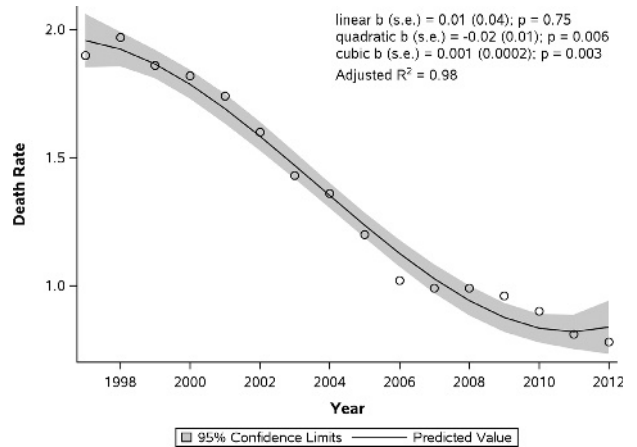


FIGURE 4. Frequency of in-hospital deaths for hospitalizations with acute pancreatitis.

hospitals were similar in the number of patients discharged with acute pancreatitis. Large hospitals in metropolitan cities admitted the most number of patients with acute pancreatitis. However, the highest increase in the number of cases from 1997 to 2012 was the highest in small hospitals (around 111%). Hospitals in the south have proportionately admitted more patients with acute pancreatitis than other regions (around 40%); however, the west saw the highest increase from 1997 to 2012, amounting to a 140% increase in patients being admitted and discharged for acute pancreatitis. This was closely followed by the midwest with a 111% increase.

DISCUSSION

The results of our study showed that acute pancreatitis is a growing problem in United States health care system. The rates of hospital discharges with acute pancreatitis have markedly increased from 1997 to 2012. The possible reasons for this increase include increasing alcohol use contributing to increasing incidence of alcoholic pancreatitis,^{11–13} though there is still some debate on this point.¹⁴ Other reasons include increasing incidence of obesity, which may increase the risk of gallstone pancreatitis.¹⁵ In addition, alcohol consumption and smoking not only play an important role in exacerbating episodes of recurrent acute pancreatitis in up to one-third of patients but also contribute in progression to chronic pancreatitis.^{16,17} Other important findings of our study were decreased length of hospital stay by almost 2 days from 6.4 to 4.7 days and a reduction in mortality rates by over 50% from 1.9% to 0.8%. These are likely due to advances in the management of acute pancreatitis such as adoption of conservative management, early and aggressive fluid resuscitation, early enteric instead of total parenteral nutrition, delaying surgical interventions unless absolutely needed, early diagnosis of complications, using invasive techniques when indicated such as in infected pancreatic necrosis or endoscopic retrograde cholangiopancreatography in biliary pancreatitis, and other goal-directed therapies.^{18–21} The mean cost of hospitalization, however, has more than doubled from \$15,433 to \$33,744 per hospitalization. This may be due to increasing reliance on investigations, such as laboratory and imaging studies, early/aggressive interventions, and increased overall hospital costs due to inflation.

According to our study findings, acute pancreatitis was more likely the disease of the young, with 70% of affected patients being less than 65 years of age, and there was about 200% increase in the number of admissions among younger patients (<45 years of age) from 1997 to 2012. This was also shown in

TABLE 1. Number and Frequency of Discharges With Acute Pancreatitis by Patient and Hospital Characteristics in 1997 and 2012

Category	Category Variable	1997 Pancreatitis n (%)	2012 Pancreatitis n (%)	1997 Total n (%)	2012 Total n (%)	Acute Pancreatitis Per 10,000 Admissions in 1997	Acute Pancreatitis Per 10,000 Admissions in 2012
All discharges		164,776 (100)	275,170 (100)	33,230,554 (100)	28,391,049 (100)	49.59	96.92
Age group	<1	*	*	4,263,624 (13)	347,145 (1)	*	*
	1-17	2173 (1)	5355 (2)	1,766,699 (5)	1,376,026 (5)	12.3	38.92
	18-44	59,441 (36)	93,480 (34)	9,074,102 (27)	4,943,137 (17)	65.51	189.11
	45-64	54,817 (33)	113,050 (41)	6,226,540 (19)	9,003,812 (32)	88.04	125.56
	65-84	40,444 (25)	52,385 (19)	9,644,446 (29)	9,724,120 (34)	41.94	53.87
	85+	7898 (5)	10,855 (4)	2,245,807 (7)	2,980,584 (11)	35.17	36.42
	Missing	*	*	9336 (0)	*	*	*
Sex	Male	81,448 (49)	143,895 (52)	13,632,763 (41)	13,418,972 (47)	59.74	107.23
	Female	83,323 (51)	131,255 (48)	19,593,669 (59)	14,969,687 (53)	42.53	87.68
	Missing	*	*	4122 (0)	2390	*	*
Payer	Medicare	55,551 (34)	85,520 (31)	12,070,265 (36)	14,227,410 (50)	46.02	60.11
	Medicaid	22,682 (14)	47,465 (17)	5,448,491 (16)	3,926,823 (14)	41.63	120.87
	Private insurance	59,562 (36)	87,000 (32)	12,814,864 (39)	7,360,684 (26)	46.48	118.2
	Uninsured	19,379 (12)	41,795 (15)	1,615,542 (5)	1,779,681 (6)	119.95	234.85
	Other	7180 (4)	12,565 (5)	1,201,195 (4)	1,026,506 (4)	59.77	122.41
	Missing	423 (0)	825 (0)	80,196 (0)	69,945	52.75	117.95
Median income for zip code	Low (\$0-\$35,999)	*	89,710 (33)	*	8,646,773 (30.5)	*	103.75
	Not low (\$36,000+)	*	178,845 (65)	*	19,070,345 (67)	*	93.78
	Missing	*	6615 (2)	*	673,931 (2.5)	*	98.16
Owner	Government	27,603 (17)	34,755 (13)	4,707,979 (14)	3,390,284 (12)	58.63	102.51
	Private (not-for-profit)	112,013 (68)	198,495 (72)	23,924,271 (72)	20,916,148 (74)	46.82	94.9
	Private (for-profit)	24,610 (15)	41,920 (15)	4,464,111 (14)	4,084,618 (14)	55.13	102.63
Teaching status	Nonteaching	94,402 (57)	155,235 (56)	17,344,162 (52)	13,915,950 (49)	54.43	111.55
	Teaching	70,374 (43)	119,935 (44)	15,886,392 (48)	14,475,099 (51)	44.3	82.86
Location	Nonmetropolitan	29,706 (18)	41,830 (15)	5,165,442 (16)	3,273,738 (12)	57.51	127.77
	Metropolitan	134,520 (82)	233,340 (85)	27,930,919 (84)	25,117,311 (88)	48.16	53.56
Bed size	Small	28,259 (17)	46,520 (17)	5,284,288 (16)	4,118,586 (15)	53.48	112.95
	Medium	58,132 (35)	76,940 (28)	11,047,425 (33)	7,416,819 (26)	52.62	103.74
	Large	77,835 (47)	151,710 (55)	16,764,648 (51)	16,855,643 (59)	46.43	90.01
Region	Northeast	29,304 (18)	46,975 (17)	6,784,405 (20)	5,652,002 (20)	43.19	83.11
	Midwest	34,553 (21)	61,640 (22.5)	7,740,346 (23)	6,525,448 (23)	44.64	94.46
	South	72,734 (44)	111,005 (40.5)	12,373,424 (37)	11,019,844 (39)	58.78	100.73
	West	28,185 (17)	55,550 (20)	6,332,379 (19)	5,193,755 (18)	44.48	106.96

*No data available.

another study in the pediatric population, with 67% of cases of acute pancreatitis affecting age group 15 to 19 years.²² This may be secondary to the fact that alcohol use disorder (as defined by the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*) is predominant among younger populations, with about 26% of individuals less than 45 years of age meeting the criteria for alcohol use disorder, which peaks around 20 years of age.²³ Obesity is also sharply on the rise in the younger population, potentially leading to increased incidence of gallstone pancreatitis.²⁴ Our study showed that although the proportions of males and females admitted for acute pancreatitis were similar, the proportionate increase in the number of females affected from 1997 to 2012 was 30% more than males (107% against 80%). This could be due to the fact that females are more prone to get acute pancreatitis from alcohol use at younger ages and with smaller amounts of alcohol compared with males.²⁵ However, a more plausible reason may be that females are prone to higher incidence of gallstone pancreatitis, postprocedure pancreatitis from endoscopic retrograde cholangiopancreatography, and pancreatitis from autoimmune or idiopathic causes.⁴ Because acute pancreatitis is usually more lethal in the elderly population,²⁶ and because the age group affected by it is shifting toward the younger population, these factors likely are contributing to lower mortality rates, as reflected in our study. Some studies reported increasing incidence of alcohol consumption in the Medicare and Medicaid population.^{27,28} The higher prevalence of acute pancreatitis in privately insured and Medicare patients may be due to higher incidence of obesity-induced gallstone pancreatitis and alcoholic pancreatitis, respectively. McNabb-Baltar et al⁷ reported that Medicaid patients were less likely to be admitted but were also likely to have poorer outcomes. However, we found the sharpest rise in hospital admissions among this group with acute pancreatitis. We hypothesize that worsening risk factors including increased alcohol consumption, increasing adoption of investigative modalities, and awareness among health care providers about poorer outcomes may have led to this increased rates of hospital admissions among Medicaid patients.

Hospital distribution of patients with acute pancreatitis favored large-sized, private (not-for-profit) hospitals in metropolitan regions. Except for a study in the pediatric population pointing toward an increased number of children with acute pancreatitis presenting in tertiary care centers,²⁹ there are limited data regarding referral trends and subsequent hospital admissions for adult patients with acute pancreatitis. Our study points to a trend of these patients being referred to large centers, presumably because large metropolitan centers are more likely to have adequate resources and expertise available to manage these complex patients. The predominance of acute pancreatitis cases in the south could be secondary to the higher prevalence of obesity seen in the southern states, thus increasing the risk of gallstone disease and gallstone pancreatitis.⁸

There are several limitations in our study. The sample of patients obtained from the NIS database is based on the coding practices of each institution, which allow the diagnoses to be recorded at the time of discharge. The total number of patients with acute pancreatitis could be lower than the true number, as some of them could have been coded with an alternative diagnosis such as abdominal pain and/or nausea/vomiting. Patient-specific information such as race, social history, specific diagnostic, or therapeutic modalities used were not available in the database, thus limiting the demographics of the study population and the ability to follow the hospital course, which could influence hospital costs, length of stay, and resource utilization. Hospital readmission rates were also not available, which could also have a bearing on resource allocation and finances. This is an important factor because almost one third of the patients with acute pancreatitis get readmitted.¹⁷ In

addition, because this was an ecological study of admitted patient population affected by acute pancreatitis as a snapshot at the time of discharge and not an analytical study (like case-control cohort studies or randomized control trials), hence association or causality could not be established. This study also only assessed patients admitted to the hospital with acute pancreatitis and did not look at the workup and management of these patients done as an outpatient, which would influence their hospital course. However, because acute pancreatitis is usually an acute medical condition requiring inpatient or intensive care unit level of care, outpatient management may not play a significant factor here. Because NIS database records only inpatient mortality and does not account for deaths at home after discharge or in a nursing facility after discharge from the hospital, mortality rates could be underestimated in this study.

In conclusion, acute pancreatitis is a significant burden on the U.S. health care system with significant increase in the number of inpatient admissions and associated costs over the past 16 years. There was decrease in mean length of stay and mortality rates, likely due to early prognostication of severity, aggressive fluid resuscitation, early initiation of enteral feeding, and improvement in the interventions needed for management of these patients. However, there was a significant increase in the health care costs related to acute pancreatitis, likely due to increase in investigations/interventions needed to manage these complex patients and health care inflation.

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