Weekend Effect in Acute Pancreatitis–Related Hospital Admissions in the United States

An Analysis of the Nationwide Inpatient Sample

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Objective: This study aimed to assess the difference in overall outcomes between weekend admissions for acute pancreatitis (AP) and weekday admissions.

Methods: Between 2005 and 2012, data were extracted from the Nationwide Inpatient Sample on adult patients with AP. Exclusion criteria were applied for chronic pancreatitis and other pancreatic and biliary malignancies. In-hospital mortality, length of stay, hospitalization costs, comorbidities, complications, and intervention rates were compared between the weekend and weekday admissions.

Results: During the study period, there were a total of 432,303 weekday admissions and 147,435 weekend admissions for AP in the United States hospitals. Weekend AP admissions were more likely to develop alcohol withdrawal (5.9% vs 5.7%, $P = 0.001$) and ileus (4.1% vs 3.1%, $P = 0.04$). They were also more likely to develop acute respiratory distress syndrome (4.7% vs 4.4%, $P < 0.001$) and required more endotracheal intubation (3.9% vs 3.6%, $P < 0.001$). There was no significant in-hospital mortality difference between the weekend and weekday admissions on both univariate and multivariate analysis.

Conclusions: Weekend AP admissions develop more severe complications requiring intensive care. Despite this, there was no weekend effect for in-hospital mortality for AP-related admissions.

Key Words: acute pancreatitis, weekend effect, mortality, length of stay, hospitalization costs

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Prior studies have demonstrated higher mortality rates and overall worse outcomes among patients admitted during weekends compared with those admitted in weekdays for a diverse array of acute medical and surgical conditions, a phenomenon popularly known as the "weekend effect."[1–7] However, there is conflicting information on what causes this effect. It is suggested that 2 major factors may influence the weekend effect: (a) deficit of medical staff and specialists and (b) admission of sicker patients during the weekends.[8]

Acute pancreatitis (AP) is an inflammatory process of the pancreas with increasing incidence in the United States (US).[9] In the United States, AP accounts for 275,000 admissions each year accompanied with health care expenditure of 2.5 billion US dollars, making it the most common gastrointestinal condition requiring hospitalization.[9,10] The presentation due to AP varies from mild interstitial edematous pancreatitis to necrotizing severe fulminant form leading to multiorgan failure and death.[11] Mortality in patients with interstitial edematous pancreatitis is 3%,[12] whereas the rates are higher ranging from 17% to 25% in cases of necrotizing pancreatitis.[13,14] Mortality rates and clinical outcomes are even worse with a delay in receiving appropriate treatment whereas timely interventions have shown to improve survival.[9,11,15]

We hypothesized that weekend admissions for AP are associated with worse outcomes compared with weekday admissions. In this study, we aimed to assess the difference in outcomes in patients admitted with a diagnosis of AP during weekends in comparison with those admitted during weekdays.

MATERIALS AND METHODS

Data Source

We obtained data for the period between January 1, 2005, and December 31, 2012, from the Nationwide Inpatient Sample (NIS) hospital discharge database. The NIS is the largest all-payer inpatient care database in the United States containing approximately 8 million hospital stays from about 1000 hospitals sampled to approximate a 20% stratified sample of the United States population. It is a component of the Healthcare Cost and Utilization Project, sponsored by the Agency for Healthcare Research and Quality, Rockville, Maryland. The NIS represents a sample of nonfederal acute care hospitals in the United States and is stratified on hospital ownership/control, bed size, teaching status, location, and region. Each record represents a single patient discharge and contains demographic information, up to 25 diagnoses and 15 procedures, admission type, patient disposition, length of stay (LOS), hospital charges, and hospital characteristics.[16]

Study Sample, Definitions, Inclusion, and Exclusion Criteria

We extracted data based on *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) codes, creating an initial cohort identifying all patients with primary and secondary discharge diagnosis of AP. We excluded other causes of pancreatic and biliary disorders such as chronic pancreatitis, as well as pancreatic and biliary malignancies. They were

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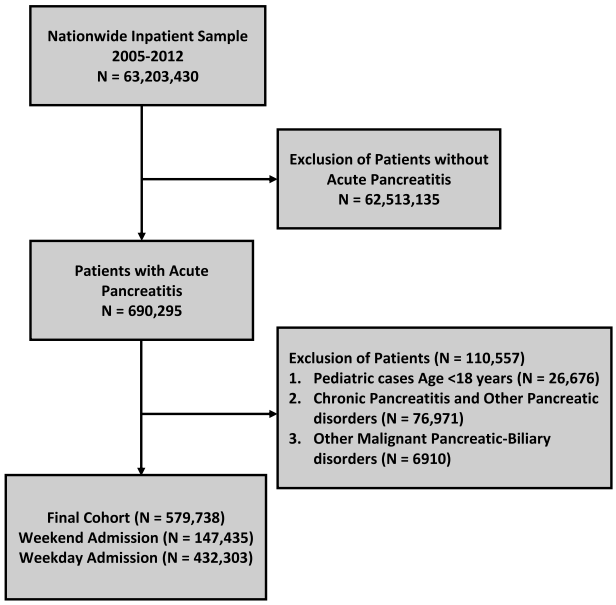

FIGURE 1. Flow diagram showing data extraction.

excluded because they can be miscoded in NIS as AP even in cases where there is elevation of amylase or lipase from malignancy-related obstruction of biliary-pancreatic tract (Fig. 1). The *ICD-9-CM* codes used for inclusion and exclusion criteria are listed in Table 1. We divided them into weekend and weekday admissions and compared AP patients admitted during weekends to weekday admissions using multiple covariates. Because of the absence of *ICD-9-CM* code specific for intensive care unit admission, a patient was presumed to have received intensive care if the patient had a procedure code for intubation.

Covariates

The covariates used in comparison included baseline demographics such as age, sex, race, insurance status, drug abuse, alcohol abuse, and comorbidities including human immunodeficiency virus (HIV), hepatitis C, anemia of chronic disease, obesity, gout, cholelithiasis, primary biliary cirrhosis, chronic liver disease, ulcerative colitis, Crohn disease, hypercalcemia, hypertriglyceridemia, celiac disease, abdominal trauma, appendicitis, biliary tract disorders, acute kidney injury, chronic kidney disease, and end-stage renal disease (ESRD). We also compared the rates of complications between the 2 groups in terms of sepsis, severe sepsis, pseudocyst, ascites, pleural effusion, acute respiratory distress syndrome (ARDS), respiratory failure, mesenteric ischemia, toxic megacolon, bowel perforation, intestinal obstruction, ileus, portal vein thrombosis, abdominal compartment syndrome, and alcohol withdrawal. For comparison, we also used investigations such as abdominal computed tomography, abdominal ultrasound, and abdominal magnetic resonance imaging and interventions such as intravenous antibiotics, total parenteral nutrition, nasogastric tube, nasojejunal tube, rectal tube, central line, endotracheal intubation, initiation of hemodialysis, initiation of peritoneal dialysis, cholecystectomy, common bile duct exploration, biliary stenting, ampullary surgery, and pancreatic surgery. We used NIS variables to identify patient's age, sex, race, and primary payer. Nationwide Inpatient Sample provides up to 25 diagnoses and 15 procedural diagnoses associated with the index admission. We used *ICD-9-CM* codes to identify these comorbidities, investigations, and interventions.

Outcomes

The primary outcomes evaluated in this study were in-hospital mortality rate, LOS, and hospitalization costs. Prolonged hospital stay was defined as a hospitalization duration of more than 4 days, and high hospitalization costs were defined as costs more than US $20,195. These cutoff values were determined against a normalized value of greater than or equal to the 50th percentile for prolonged LOS and higher hospitalization costs, which has been validated in prior studies.[17] Secondary outcomes included rates of complications (ARDS, pancreatic pseudocyst, sepsis, ascites, pleural effusion), interventions (intubation, total parenteral nutrition, enteral nutrition, intravenous antibiotics), and surgeries (biliary and pancreatic).

Statistical Analysis

Categorical variables were expressed as a percentage of the defined group, whereas continuous variables were reported as mean (standard deviation [SD]). Analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC). All P values were based on 2-sided tests and were considered statistically significant if $P < 0.05$. In univariate analysis, all categorical variables were compared with Pearson χ^2 test and continuous variables were analyzed with paired t-test. Hospital LOS and total hospitalization costs were also obtained. All results in the regression model were represented by an odds ratio (OR) and 95% confidence interval (CI). While adjusting for the covariates listed above, we used multivariate logistic regression to analyze the association between weekend admissions and categorical outcomes including in-hospital mortality, LOS, and hospitalization costs. We adjusted the logistic regression models for age (as a continuous variable), sex, race, payer, and confounding factors (as categorical variables) that were previously significant ($P < 0.05$) in univariate analyses. All regression models were performed separately. The charge information represents the amount that hospitals billed for services. We determined the national cost estimates by multiplying total charges by a hospital-wide cost-to-charge ratio per hospital, which was derived from the Centers for Medicare and Medicaid standardized hospital accounting reports.[18]

RESULTS

During the study period from 2005 to 2012, a total of 579,738 patients were admitted with a diagnosis of AP to the hospitals in the United States. Of these, 432,303 (74.6%) were weekday admissions and 147,435 (25.4%) were weekend admissions (Table 2).

TABLE 1. Inclusion and Exclusion Criteria

Inclusion Criteria	
Diagnosis	**ICD 9 Code**
AP	577.0
Age >18 y	
Exclusion Criteria	
Diagnosis	**ICD 9 Code**
CP	577.1
Other pancreatic disorders	577.8, 577.9
Other malignant pancreatic-biliary disorders	157.0, 157.1, 157.2, 157.3, 157.4, 157.8, 157.9, 155.0, 155.1, 155.2, 156.0, 156.1, 156.2, 156.8. 156.9

Baseline Characteristics

Demographic characteristics and comparison between the 2 groups is highlighted in Table 2.

Weekend Admissions

Patients with AP admitted during weekends were younger (54.86 [SD, 17.86] vs 54.95 [SD, 17.73] years, $P < 0.001$), obese (10.1% vs 9.7%, $P < 0.001$), and had a history of drug abuse (26.7% vs 26.5%, $P = 0.03$) and biliary tract disorders (33.4% vs 33.0%, $P = 0.01$) (Table 2).

Weekday Admissions

Patients with AP admitted during weekdays had more HIV (0.9% vs 0.8%, $P = 0.01$), anemia of chronic disease (1.8% vs 1.7%, $P = 0.01$), and ESRD (2.3% vs 2.2%, $P = 0.001$). They had a higher Charlson comorbidity index (CCI) (0.30 [SD, 0.28] vs 0.29 [SD, 0.27], $P = 0.001$); nevertheless, the average CCI values were low for both groups (Table 2).

Complications, Treatment, and Interventions

Weekend Admissions

Patients with AP admitted during weekends were more likely to develop ileus (4.1% vs 3.1%, $P = 0.04$) and alcohol withdrawal (5.9% vs 5.7%, $P = 0.001$). Similarly, they were more likely to develop ARDS (4.7% vs 4.4%, $P < 0.001$) and needed more endotracheal intubation (3.9% vs 3.6%, $P < 0.001$). They also received more cholecystectomies (17.2% vs 16.3%, $P < 0.001$) during the same admission (Tables 3, 4).

Weekday Admissions

Patients with AP admitted during weekdays developed more pancreatic pseudocysts (3.9% vs 3.5%, $P < 0.001$). They received more enteral nutrition (1.05% vs 0.9%, $P = 0.007$) and had higher rates of pancreatic interventions (0.1% vs 0.08%, $P < 0.001$), biliary stenting (2.6% vs 2.3%, $P \leq 0.001$), ampullary surgery (0.5% vs 0.4%, $P = 0.04$), and initiation of hemodialysis (3.1% vs 2.9%, $P = 0.001$) (Tables 3, 4).

TABLE 2. Baseline Demographics and Comorbidities

Variables	Weekend Admission, N = 147,435	Weekday Admission, N = 432,303	*P*
Age, mean (SD), y	54.86 (17.86)	54.95 (17.73)	**<0.001**
CCI, mean (SD)	0.29 (0.27)	0.30 (0.28)	**0.001**
Sex, n (%)			0.58
Male	72,846 (49.5)	213,239 (49.3)	
Female	74,464 (50.5)	218,701 (50.7)	
Race			**0.01**
White	79,635 (64.8)	234,902 (65.2)	
Black	18,673 (15.2)	54,936 (15.2)	
Hispanic	16,995 (13.8)	48,345 (13.4)	
Asian	2761 (2.2)	8236 (2.3)	
Native American	1007 (0.8)	2949 (0.8)	
Other	3767 (3.0)	10,915 (3.0)	
Payer			**<0.001**
Medicare	52,942 (36.0)	156,259 (36.2)	
Medicaid	21,289 (14.5)	60,031 (13.9)	
Private	47,229 (32.1)	142,182 (33.0)	
Self-pay	17,706 (12.0)	49,586 (11.5)	
No charge	1796 (1.2)	4996 (1.2)	
Other	6075 (4.1)	18,147 (4.2)	
Drug abuse	39,408 (26.7)	114,353 (26.5)	**0.03**
Alcohol abuse	19,652 (13.3)	57,665 (13.3)	0.92
Biliary tract disorders	49,278 (33.4)	142,693 (33.0)	**0.01**
Anemia of chronic disease	2481 (1.7)	7704 (1.8)	**0.01**
Hepatitis C	1960 (1.3)	5559 (1.3)	0.2
HIV	1219 (0.8)	3942 (0.9)	**0.01**
Obesity	14,902 (10.1)	41,753 (9.7)	**<0.001**
CLD	16,221 (11.0)	47,727 (11.0)	0.69
Hypercalcemia	876 (0.6)	2740 (0.6)	0.09
Hypertriglyceridemia	5517 (3.7)	16,103 (3.7)	0.77
Abdominal trauma	17 (0.01)	44 (0.01)	0.66
AKI	17,931 (12.1)	52,732 (12.2)	0.72
CKD	3744 (2.5)	11,112 (2.6)	0.51
ESRD	3233 (2.2)	10,148 (2.3)	**0.001**

Bold values are statistically significant.

CLD indicates chronic liver disease; AKI, acute kidney injury; CKD, chronic kidney disease.

TABLE 3. Difference in Rates of Complications

Complications	Weekend Admission, N = 147,435, N (%)	Weekday Admission, N = 432,303, N (%)	*P*
Alcohol withdrawal	8753 (5.9)	24,5541 (5.7)	**0.001**
Pleural effusion	107 (0.1)	324 (0.1)	0.77
ARDS	6944 (4.7)	19,150 (4.4)	**<0.001**
Respiratory failure	374 (0.2)	1140 (0.3)	0.51
Sepsis	3563 (2.4)	10,600 (2.5)	0.45
Severe sepsis	4276 (2.9)	12,171 (2.8)	0.09
Pseudocyst	5139 (3.5)	16,839 (3.9)	**<0.001**
Ascites	1400 (0.95)	4175 (0.97)	0.58
Toxic megacolon	493 (0.3)	1480 (0.3)	0.65
Bowel perforation	206 (0.2)	653 (0.1)	0.33
Mesenteric ischemia	934 (0.6)	2838 (0.7)	0.34
Intestinal obstruction	1920 (1.3)	5626 (1.3)	0.98
Ileus	6023 (4.1)	18,212 (3.1)	**0.04**
PVT	344 (0.2)	1129 (0.3)	0.07
Abdominal compartment syndrome	82 (0.1)	277 (0.1)	0.26

Bold values are statistically significant.
PVT indicates portal vein thrombosis.

In-hospital Mortality

On univariate analysis, there was no significant in-hospital mortality difference between the weekend and weekday admissions for AP (2.59% vs 2.57%; OR, 1.01; 95% CI, 0.97–1.05; $P = 0.54$) (Table 5).

On multivariate analysis, after adjusting for age, sex, race, payer, and other covariates that were significant on univariate analysis, there was, no in-hospital mortality difference between weekend and weekday admissions (adjusted odds ratio [aOR], 0.96; 95% CI, 0.91–1.0; $P = 0.07$) (Fig. 2).

LOS and Hospitalization Costs

On univariate analysis, the LOS (6.44 [SD, 5.64] days vs 6.21 [SD, 4.37] days; OR, 0.94; 95% CI, 0.93–0.95; $P < 0.001$) and

TABLE 4. Difference in Rates of Investigations, Interventions, and Procedures

Variables	Weekend Admission, N = 147,435, N (%)	Weekday Admission, N = 432,303, N (%)	*P*
Investigations			
CT abdomen	4184 (2.8)	12,074 (2.8)	0.37
US abdomen	2313 (1.6)	6682 (1.5)	0.54
MRI abdomen	1552 (1.1)	4352 (1.0)	0.13
Interventions			
Central venous access	1111 (0.7)	3362 (0.8)	0.36
Intravenous antibiotics	1081 (0.7)	3233 (0.8)	0.57
Nasogastric tube	1217 (0.8)	3196 (0.7)	**0.001**
Nasojejunal tube	156 (0.1)	499 (0.1)	0.34
Enteral nutrition	1383 (0.9)	4402 (1.0)	**0.007**
Total parenteral nutrition	3749 (2.5)	10,799 (2.5)	0.34
Endotracheal intubation	5697 (3.9)	15,394 (3.6)	**<0.001**
Initiation of hemodialysis	4334 (2.9)	13,562 (3.1)	**0.001**
Initiation of peritoneal dialysis	204 (0.1)	550 (0.1)	0.3
Biliary procedures			
Cholecystostomy	457 (0.3)	1378 (0.3)	0.6
Cholecystectomy	25,366 (17.2)	70,687 (16.3)	**<0.001**
Common bile duct exploration	356 (0.2)	1071 (0.3)	0.67
Biliary stent	3332 (2.3)	11,254 (2.6)	**<0.001**
Ampullary surgery	728 (0.4)	2324 (0.5)	**0.04**
Pancreatic procedures			
Pancreatic surgery	118 (0.08)	569 (0.1)	**<0.001**

Bold values are statistically significant.
CT indicates computed tomography; US, ultrasound; MRI, magnetic resonance imaging.

TABLE 5. Univariate Analysis of Mortality, LOS, and Hospitalization Costs Difference Between Weekend and Weekday Admission

Variable	Weekend Admission	Weekday Admission	Univariate Analysis	
			OR (95% CI)	*P*
Mortality, %	2.59	2.57	1.01 (0.97–1.05)	0.54
LOS, mean (SD), d	6.21 (4.37)	6.44 (5.64)	0.94 (0.93–0.95)	**<0.001**
Hospitalization costs, mean (SD), US $	41,931 (32,459)	42,717 (37,931)	0.98 (0.96–0.99)	**0.01**

Bold values are statistically significant.

the hospitalization costs (US $42,717 [SD, 37,931] vs US $41,931 [SD, 32,459]; OR, 0.98; 95% CI, 0.96–0.99; $P = 0.01$) were higher in the AP group admitted during weekdays (Table 5).

On multivariate analysis, after adjusting for age, sex, race, payer, and other covariates that were significant on univariate analysis, there was no difference between weekend and weekday admissions for LOS (aOR, 1.01; 95% CI, 0.99–1.02; $P = 0.61$) and hospitalization costs (aOR, 1.01; 95% CI, 0.98–1.02; $P = 0.47$ (Figs. 3, 4). A list of factors that predict in-hospital mortality, hospital LOS, and hospitalization costs are also listed in Figures 2 to 4.

DISCUSSION

Using the NIS, our study is the first large scale study from the United States evaluating the outcomes of hospital admissions for AP based on the time of admissions. Our study highlights that patients admitted during weekends with AP are more likely to develop severe complications and thus are more prone to require intensive care. Despite the increase in complications, our analysis did not reveal an in-hospital mortality difference between the patients with AP admitted during weekends in comparison with patients with AP admitted during weekdays. Furthermore, weekend admissions for AP were not associated with longer LOS or higher hospitalization costs after adjusting for covariates.

It has been suggested and demonstrated through studies that there is a higher risk of mortality among patients admitted during weekends compared with weekdays. This has been attributed to reduction in hospital staffing and reduced access to diagnostic and therapeutic interventions during the weekend.[1–4] Moreover, studies have suggested that patients admitted during the weekends are sicker at baseline and may have a longer stay with increased utilization of resources.[4] In addition, Buckley et al[19] suggested higher rates of errors during the weekends. The weekend effect is an area of constant debate, and other newer studies suggest that this phenomenon may just be a result of selection bias and due to different patient cohorts.[20]

Acute pancreatitis is an inflammatory process in the pancreas which is associated with high mortality rates especially with a delay in treatment. Mortality rates are high with severe form of the disease, and these patients need early identification and management in the critical care setting.[9,12–14] Some of these patients may require invasive or minimally invasive interventions.[21] With this background, it is plausible to assume that patients with AP, particularly those with severe AP, may experience a delay in receiving care when admitted during weekends and thus have a risk of poor outcome.

There are only a few prior studies that have specifically analyzed the weekend effect for AP. Our findings are consistent with

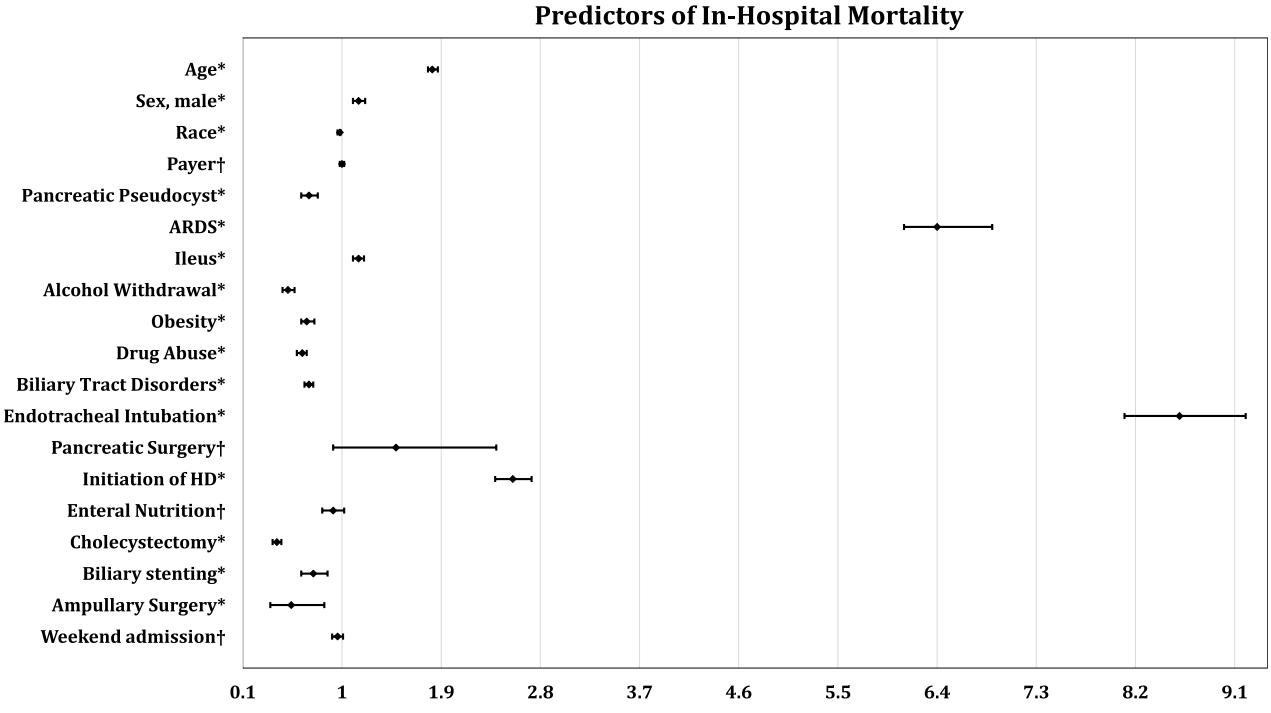

FIGURE 2. Multivariate analysis showing predictors of in-hospital mortality. Odds ratio: *significant; †nonsignificant. HD indicates hemodialysis.

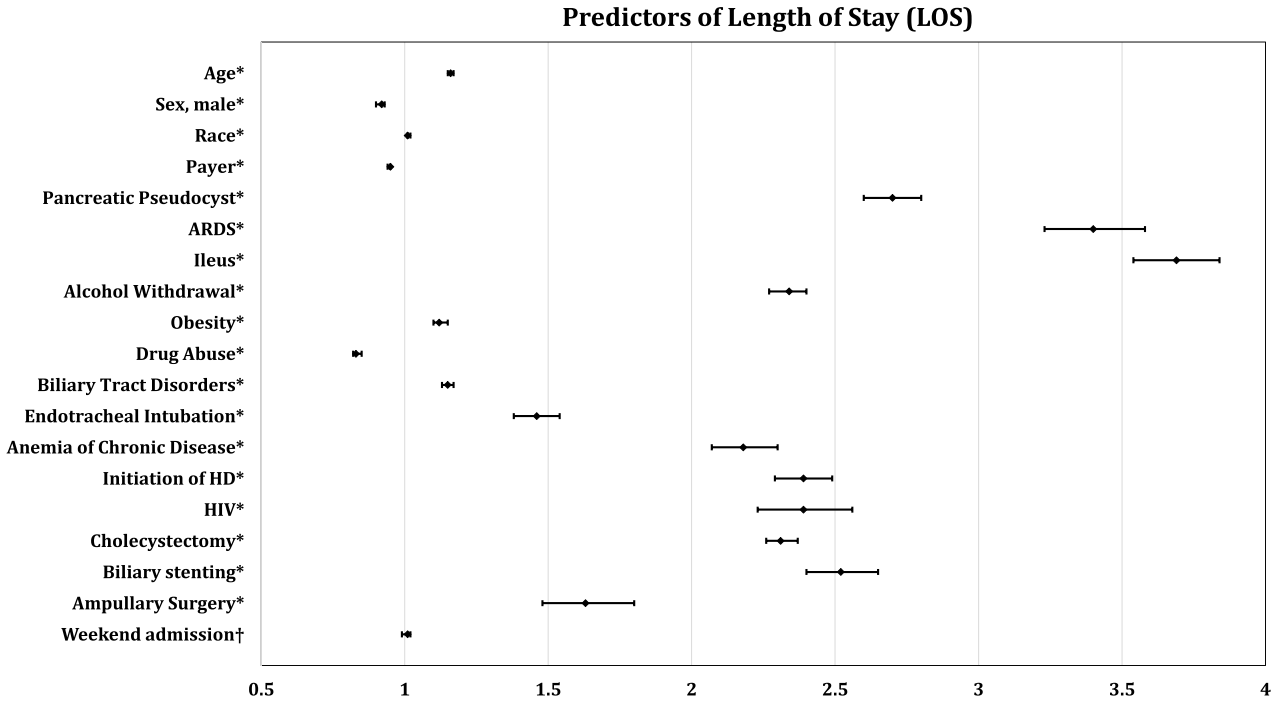

FIGURE 3. Multivariate analysis showing predictors of LOS. Odds ratio: *significant; †nonsignificant.

other studies from the United Kingdom and Japan. In a study by Roberts et al[22] that analyzed about 10,000 admissions for AP in the UK, the authors did not note an increase in mortality for weekend admissions. Another study from Japan also aimed to answer the same research question, where Hamada et al[23] evaluated 8328 patients during a 4-year period, who were admitted to hospitals in Japan with a diagnosis of severe AP. No significant difference was seen for in-hospital mortality, LOS, and hospitalization costs between the patients admitted during weekends compared with the weekday admissions.[23] Both studies were based on inpatient administrative database and were limited owing to unavailability of essential information such as etiology of pancreatitis, acuity of presentation, and standard classification of severity. Our findings are consistent with theirs in terms of

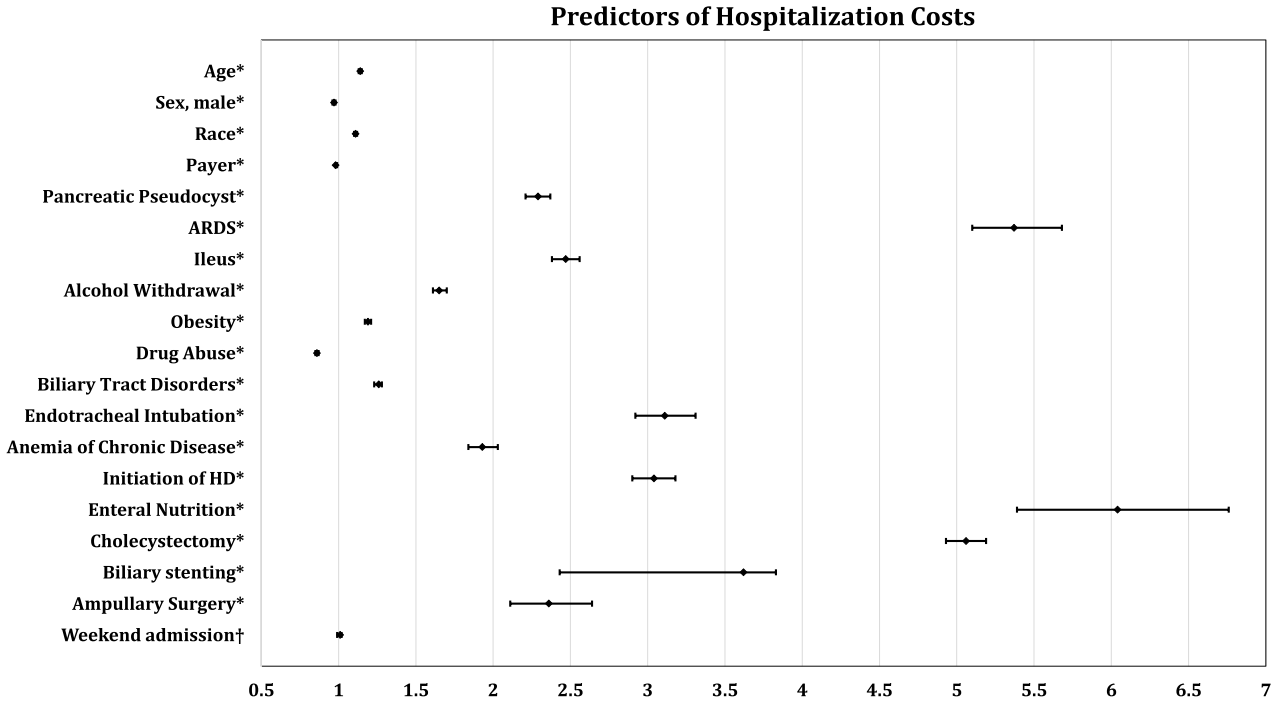

FIGURE 4. Multivariate analysis showing predictors of hospitalization costs. Odds ratio: *significant; †nonsignificant.

mortality. However, contrary to their findings, patients in our cohort admitted during weekdays had a longer LOS and higher associated hospitalization costs on univariate analysis, which was not seen in multivariate analysis.

We also noted that patients admitted during weekends were more likely to have a history of opioid abuse and biliary tract disorders. They had higher requirements for intensive care and also higher rates of complications such as alcohol withdrawal and ARDS. This, however, did not influence the in-hospital mortality between patients with AP admitted on weekends compared with those admitted during weekdays, and there was no significant difference in terms of predictors of in-hospital mortality between the 2 groups. It is still possible that these patients with higher complications have worse long term consequences from AP-related admissions. Because NIS only provides information on inpatient care, this will need to be analyzed in future studies that provide information on patient care after discharge from the hospital.

We believe that our findings can help and guide policy makers to prioritize healthcare resources in the treatment of AP. Despite the popular belief that limited resources during the weekend can lead to poor outcomes, our study shows a contradictory finding for treatment of AP, which is consistent with results from similar studies outside the United States. Our findings on univariate analysis that patients admitted during weekdays stayed longer in the hospital with associated higher hospitalization costs may suggest a tendency among hospital staff to provide inadvertent interventions and care to this patient cohort prolonging their stay in the hospital.

We acknowledge several limitations in our study. The retrospective and observational design of this study using a large national database subjects it to potential bias associated with such a format. The Nationwide Inpatient Sample is based on *ICD-9-CM* coding and is dependent on proper coding techniques. Lack of data on laboratory values and medications usage further limits our ability to properly assess the outcomes. Furthermore, we are able to evaluate in-hospital outcomes but long-term outcomes after discharge from the hospital cannot be assessed using this inpatient database. Using NIS, we are also unable to determine the severity of pancreatitis. This database also does not keep track of disparity in availability of medical staff and consultants based on the time of patient's hospitalization. Similarly, we cannot determine if the patients were admitted to general medical floors versus intensive care units at the time of their presentation. We also assumed that patients required intensive care support based on the fact that they required intubation. There is also a possibility that some of our findings are results of data artifact and coincidence as a result of our inclusion of an exhaustive list of covariates.

Despite these limitations, ours is the largest study on this topic, using a national representative sample across various ethnic and socioeconomic groups. To the best of our knowledge, this is the first study from United States reporting this issue. Our study may serve as a guide for future studies and for healthcare policy makers in making decisions in resource utilization and distribution.

In conclusion, patients admitted during weekends for AP develop more severe complications requiring intubation and possibly intensive care. These outcomes may solely be related to patient characteristics rather than hospital, staff, and consultants. Patients with history of drug abuse were more likely to get admitted during weekends with AP, who may be sicker at baseline and thus be at a higher risk of complications. Despite this, there was no weekend effect in terms of in-hospital mortality for AP-related hospital admissions. Future studies stratifying the patient population based on severity will further help confirm our findings.

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