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The Risk of In-Hospital Mortality in Elderly Patients with Pancreatic Pseudocyst Admitted Emergently is 4.5 Times Greater than that in Adults

Mackenzie Leonard[1] BS, Abbas Smiley[2] MD/PhD, Cailan L Feingold[1] BS, Rifat Latifi[3] MD, FACS, FICS, FKCS

[1]New York Medical College, School of Medicine, Valhalla NY, US
[2]School of Medicine, University of Rochester, Rochester, NY.
E-mail: *abbaset4@gamil.com*
[3]Adjunct Professor of Surgery, University of Arizona, Tucson, AZ, US

Corresponding Author:

RIFAT LATIFI, MD, FACS, FICS, FKCS

Adjunct Professor of Surgery, Trauma, Surgical Critical Care and General Surgeon, Tucson Medical Center and Professor of Surgery, University of Arizona, College of Medicine, Tucson, AZ
E-mail: *latifi@surgery.arizona.edu*

ABSTRACT

Background: Adult and elderly patients admitted emergently with the primary diagnosis of pseudocyst of the pancreas (PCP) have high of morbidity and mortality.

Objective: The aim of our study was to examine the risk factors associated with in-hospital mortality in both adult and elderly patients with PCP admitted emergently.

Design/Methods: Patients with PCP were analyzed using the National Inpatient Sample (NIS) database, 2005-2014. The clinical data, mortality, and demographics were collected and analyzed using stratified analyses and multivariable logistic regression model with backward elimination to find the factors associated with increased mortality.

Results: There were a total of 9,179 patients included in the study of which 6,769 (73.44%) were adults (age <65 years) and 2,410 (26.56%) elderly patients (age 65+ years). The mean (SD) age was 46 (11.4) years in the adult cohort and 74.5 (7.3) years in the elderly. Of the adult patients, 4,077 (60.2%) were male and 2,692 (39.8%) were female. The elderly patient cohort had 1,130 (48.3%) males and 1,208 (51.7%) females. Overall, mortality was 0.6% in adults and 2.7% in the elderly. 47.2% in adults and 41.3% in the elderly underwent surgical intervention. Age, hospital length of stay and comorbidities like respiratory diseases, coagulopathy, cardiac diseases, trauma, burns and poisons, and genitourinary system diseases were all significantly associated with increased odds of mortality.

Conclusions: In conclusion, our study stratified patient characteristics based on gender, mortality, and treatment type. Additionally, we found that age, hospital length of stay and multiple comorbidities are significantly associated with increased odds of mortality in PCP patients.

Introduction

A pseudocyst of the pancreas (PCP) is a collection of exocrine pancreatic fluid[1], most commonly caused by acute and chronic pancreatitis[2], but other etiologic factors such as gallstones, obesity, trauma, and some genetic diseases can also be associated with PCP[2]. The majority of PCP cases can be managed conservatively when the presentation is asymptomatic, or symptoms can be well-managed. Certain symptoms like vomiting, abdominal pain, obstructions, or infections can indicate a need for surgical decompression of the PCP[1,3,4]. The treatment for symptomatic PCP has evolved over the last few years and consists of endoscopic drainage, external drainage, cystogastrostomy, cystjejunostomy, or cystduodenostomy[5–10]. The optimal surgical management is not yet well defined. The most common complications of PCP are pseudocyst infection, hemorrhage, rupture of the pseudocyst, gastric outlet obstruction and or bile duct obstruction[11,12]. The emergent complications of PCP are very serious and have a high risk of morbidity and mortality[7,13]. Importantly, the difference in outcome between adults and elderly patients admitted emergently with complicated pseudocyst is not currently clear.

Our objective in this study was to examine the risk factors of in-hospital mortality in both adult and elderly patients emergently admitted with the primary diagnosis of pseudocyst of the pancreas using the National Inpatient Sample (2005-2014); in particular, the effect of age and time to operation once patients were admitted to the hospital.

Methods

This was a retrospective cohort study of NIS data on adult and elderly patients with the primary diagnosis of pseudocyst of the pancreas from the years 2005-2014. The ICD-9 code used to identify patients with pancreatic pseudocyst was 577.2. Information included within the NIS allows researchers to do large scale analyses that incorporate many biological, societal, and psychological factors. The following characteristics of patients and hospitals were collected and analyzed: age, gender, race, income quartile, primary diagnosis, hospital ownership (government vs. private), health care insurance (Medicare, Medicaid, private insurance, self-paid, and no charge), invasive diagnostic status, surgical procedure status, days to first procedure, hospital length of stay, total charges, and the associated comorbidities (deficiency anemias, chronic pulmonary disease, coagulopathy, hypertension, liver disease, fluid and electrolyte disorders, metastatic cancer, peptic ulcer, renal failure, and weight loss).

Modified 5-item frailty index was calculated according to the following characteristics: diabetes mellitus, hypertension, chronic pulmonary disease, congestive heart failure, and functional health status. Since the information for the latter was not recorded in the NIS database, the presence of renal failure, cancer, paralysis, coagulopathy or weight loss were considered partial or total loss of functional health status. The items were summed to create an estimated modified frailty index in which the scale ranged from 0 to 5, with 0 being not frail and 5 being very frail.

Statistical analysis

Following stratification, the data was further analyzed through complex investigations shown through the Tables to come. Findings are shown alongside the average, confidence interval set at 95% (CI), *P*-values (0.05 or less is considered significant), and standard deviation (SD). Univariable and multivariable logistic regression analyses were done to identify associations between mortality and the parameters of interest. A backward logistic regression analysis was done using stepwise backward elimination to evaluate mortality and risk factors while simultaneously controlling for extraneous variables. All analyses were completed using SPSS version 24 (SPSS Inc., Chicago, IL). R software (Foundation for Statistical Computing, Vienne, Austria) was used to assess possible nonlinear association of continuous variables with mortality through generalized additive model (GAM model).

Results

Gender Differences

A total of 9,107 patients admitted emergently with the diagnosis of pseudocyst of the pancreas were included in the study. Of these patients, 6,769 (74.33 %) were adults (age <65 years) and 2,338 (25.67%) were elderly patients (age 65+ years). Of the adult patients, 4,077 (60.2%) were male and 2,692 (39.8%) were female. The majority of the adult patients were white, had private insurance, and were admitted to an urban teaching hospital (Table 1). Major comorbidities in adult pancreatic pseudocyst patients were alcohol abuse, deficiency anemias, chronic pulmonary disease (COPD), uncomplicated diabetes, hypertension, liver disease, and obesity. Adult males had higher comorbidity rates of AIDS, alcohol abuse, coagulopathy, uncomplicated diabetes, liver disease,

peripheral vascular disorders, and hypertension. Adult females had higher incidences of deficiency anemias, rheumatoid arthritis, COPD, depression, hypothyroidism, other neurological disorders, psychoses, valvular disease, and obesity (Table 1).

Within the elderly patient population, 1,130 (48.3%) were males and 1,208 (51.7%) were females. Most elderly patients were white, on Medicare insurance, and admitted to an urban teaching or non-teaching hospital. Major comorbidities in the elderly population were deficiency anemias, COPD, uncomplicated diabetes, hypertension, and weight loss (Table 1). Elderly males had higher rates of alcohol abuse, coagulopathy, metastatic cancer, peripheral vascular disorders, and valvular disease. Elderly females had higher comorbidity rates of rheumatoid arthritis, depression, and hypothyroidism (Table 1). Elderly males had higher rates of surgical procedures than elderly females, but there was no significant difference in rates of surgical procedures between adult males and females (Table 1). Within the adult age group, male patients were nearly 2 years older on average than female patients, while in the elderly group female patients were on average more than 2 years older than male patients. Adult women were more frail than adult men, but frailty was not significantly different among elderly patients. Elderly male patients had a longer hospital length of stay (HLOS), longer time to operation (TTO), and higher total cost than elderly female patients.

Table 1. Characteristics of emergency admitted patients with the primary diagnosis of pseudocyst of pancreas. Data was stratified according to sex categories, NIS 2005-2014.

		Adult, N (%)			Elderly, N (%)		
		Male	Female	*P*	Male	Female	*P*
All Cases		4,077 (60.2%)	2,692 (39.8%)		1,130 (48.3%)	1,208 (51.7%)	
Race	**White**	2,366 (67.4%)	1,523 (64.8%)	**0.004**	766 (78.1%)	804 (77.1%)	0.640
	Black	518 (14.8%)	385 (16.4%)		90 (9.2%)	97 (9.3%)	
	Hispanic	454 (12.9%)	282 (12.0%)		84 (8.6%)	84 (8.1%)	
	Asian/Pacific Islander	53 (1.5%)	51 (2.2%)		15 (1.5%)	23 (2.2%)	
	Native American	24 (0.7%)	32 (1.4%)		1 (0.1%)	4 (0.4%)	
	Other	95 (2.7%)	79 (3.4%)		25 (2.5%)	31 (3.0%)	
Income Quartile	**Quartile 1**	1,191 (30.1%)	798 (30.6%)	0.840	299 (26.9%)	348 (29.2%)	0.660
	Quartile 2	1,116 (28.2%)	709 (27.2%)		296 (26.7%)	310 (26.0%)	
	Quartile 3	937 (23.7%)	626 (24.0%)		268 (24.1%)	284 (23.8%)	
	Quartile 4	714 (18.0%)	478 (18.3%)		247 (22.3%)	250 (21.0%)	
Insurance	**Private Insurance**	1,706 (42.0%)	1,178 (43.8%)	**<0.001**	139 (12.3%)	83 (6.9%)	**<0.001**
	Medicare	555 (13.7%)	342 (12.7%)		958 (85.0%)	1,086 (90.0%)	
	Medicaid	825 (20.3%)	648 (24.1%)		15 (1.3%)	28 (2.3%)	
	Self-Pay	620 (15.3%)	339 (12.6%)		6 (0.5%)	3 (0.2%)	
	No Charge	70 (1.7%)	38 (1.4%)		2 (0.2%)	0 (0%)	
	Other	286 (7.0%)	143 (5.3%)		7 (0.6%)	6 (0.5%)	
Hospital Location	**Rural**	255 (6.3%)	158 (5.9%)	0.200	59 (5.2%)	68 (5.6%)	0.770
	Urban: Non-Teaching	1,214 (29.8%)	755 (28.0%)		376 (33.3%)	387 (32.0%)	
	Urban: Teaching	2,608 (64.0%)	1,779 (66.1%)		695 (61.5%)	753 (62.3%)	
Comorbidities	**AIDS**	34 (0.8%)	6 (0.2%)	**0.001**	0 (0%)	0 (0%)	
	Alcohol Abuse	1,376 (33.8%)	448 (16.6%)	**<0.001**	130 (11.5%)	35 (2.9%)	**<0.001**
	Deficiency Anemias	915 (22.4%)	723 (26.9%)	**<0.001**	309 (27.3%)	340 (28.1%)	0.670
	Rheumatoid Arthritis	51 (1.3%)	95 (3.5%)	**<0.001**	16 (1.4%)	47 (3.9%)	**<0.001**

		Adult, N (%)			Elderly, N (%)		
		Male	Female	*P*	Male	Female	*P*
All Cases		4,077 (60.2%)	2,692 (39.8%)		1,130 (48.3%)	1,208 (51.7%)	
Comorbidities	**Chronic Blood Loss**	48 (1.2%)	33 (1.2%)	0.860	19 (1.7%)	20 (1.7%)	0.960
	Congestive Heart Failure	111 (2.7%)	85 (3.2%)	0.300	139 (12.3%)	169 (14.0%)	0.230
	Chronic Pulmonary Disease	506 (12.4%)	420 (15.6%)	**<0.001**	252 (22.3%)	238 (19.7%)	0.120
	Coagulopathy	189 (4.6%)	88 (3.3%)	**0.005**	81 (7.2%)	43 (3.6%)	**<0.001**
	Depression	366 (9.0%)	430 (16.0%)	**<0.001**	92 (8.1%)	140 (11.6%)	**0.005**
	Diabetes, Uncomplicated	1,164 (28.6%)	598 (22.2%)	**<0.001**	385 (34.1%)	398 (32.9%)	0.570
	Diabetes, Chronic Complications	120 (2.9%)	73 (2.7%)	0.580	53 (4.7%)	47 (3.9%)	0.340
	Drug Abuse	238 (5.8%)	150 (5.6%)	0.650	11 (1.0%)	5 (0.4%)	0.100
	Hypertension	1,981 (48.6%)	1,147 (42.6%)	**<0.001**	787 (69.6%)	882 (73.0%)	0.070
	Hypothyroidism	93 (2.3%)	232 (8.6%)	**<0.001**	80 (7.1%)	230 (19.0%)	**<0.001**
	Liver Disease	429 (10.5%)	209 (7.8%)	**<0.001**	72 (6.4%)	58 (4.8%)	0.100
	Lymphoma	16 (0.4%)	6 (0.2%)	0.230	5 (0.4%)	2 (0.2%)	0.270
	Fluid/Electrolyte Disorders	1,224 (30.0%)	835 (31.0%)	0.380	389 (34.4%)	461 (38.2%)	0.060
	Metastatic Cancer	25 (0.6%)	15 (0.6%)	0.770	21 (1.9%)	9 (0.7%)	**0.017**
	Other Neurological Disorders	141 (3.5%)	131 (4.9%)	**0.004**	47 (4.2%)	72 (6.0%)	**0.048**
	Obesity	306 (7.5%)	357 (13.3%)	**<0.001**	65 (5.8%)	86 (7.1%)	0.180
	Paralysis	24 (0.6%)	24 (0.9%)	0.150	8 (0.7%)	11 (0.9%)	0.590
	Peripheral Vascular Disorders	123 (3.0%)	51 (1.9%)	**0.004**	111 (9.8%)	76 (6.3%)	**0.002**
	Psychoses	209 (5.1%)	173 (6.4%)	**0.023**	19 (1.7%)	38 (3.1%)	**0.022**
	Pulmonary Circulation Disorders	38 (0.9%)	36 (1.3%)	0.120	31 (2.7%)	43 (3.6%)	0.260
	Renal Failure	195 (4.8%)	112 (4.2%)	0.230	149 (13.2%)	147 (12.2%)	0.460
	Solid Tumor	48 (1.2%)	29 (1.1%)	0.700	40 (3.5%)	32 (2.6%)	0.210
	Peptic Ulcer	2 (0.0%)	3 (0.1%)	0.390	3 (0.3%)	2 (0.2%)	0.680
	Valvular Disease	46 (1.1%)	47 (1.7%)	**0.033**	48 (4.2%)	68 (5.6%)	0.120
	Weight Loss	751 (18.4%)	466 (17.3%)	0.250	285 (25.2%)	236 (19.5%)	**0.001**
Invasive Diagnostic Procedure		1,028 (25.2%)	708 (26.3%)	0.320	355 (31.4%)	411 (34.0%)	0.180
Surgical Procedure		1,957 (48.0%)	1,238 (46.0%)	0.100	516 (45.7%)	450 (37.3%)	**<0.001**
Invasive or Surgical Procedure		2,397 (58.8%)	1,568 (58.2%)	0.660	674 (59.6%)	679 (56.2%)	0.090
Deceased		24 (0.6%)	17 (0.6%)	0.830	35 (3.1%)	28 (2.3%)	0.240
		Mean (SD)	**Mean (SD)**	***P***	**Mean (SD)**	**Mean (SD)**	***P***
Age, Years		46.65 (10.75)	44.85 (12.18)	**<0.001**	73.30 (6.74)	75.80 (7.54)	**<0.001**
Modified Frailty Index Score		1.22 (0.99)	1.11 (1.03)	**<0.001**	1.85 (1.08)	1.78 (1.06)	0.090
Time to Invasive Diagnostic Procedure, Days		4.20 (6.20)	3.96 (5.66)	0.440	4.63 (6.62)	3.87 (4.87)	0.080
Time to Surgical Procedure, Days		4.02 (5.42)	3.97 (5.72)	0.840	4.77 (7.22)	3.93 (4.99)	**0.041**
Hospital length of stay, Days		8.89 (10.69)	8.78 (11.27)	0.680	9.73 (11.71)	8.80 (10.49)	**0.044**
Total Charges, Dollars		58,443 (90,714)	58,506 (87,781)	0.980	72,343 (124,132)	60,388 (85,757)	**0.008**

Mortality

Overall, the mortality of adult patients was 0.6%; within the adult cohort, 41.5% of the deceased were female and 58.5% of the deceased were male. The adult patients who died were on average more than 6 years older, had a higher modified frailty index, longer hospital length of stay, and greater time to surgical procedure. Deceased patients also had a higher likelihood of having surgical procedures. Those who died, also had higher rates of certain comorbidities: rheumatoid arthritis, congestive heart failure, coagulopathy, fluid and electrolyte disorders, metastatic cancer, paralysis, renal failure, and weight loss (Table 2). Within elderly patients with PCP, 2.7% died; of the 63 that died, 44.4% were females (Table 2). Specifically, the mortality rate among elderly females was 2.4% and among elderly males was 3.1%. Those who died had longer HLOS, higher total cost, and higher modified frailty indexes on average. The deceased cohort also displayed higher rates of chronic blood loss, congestive heart failure, COPD, coagulopathy, fluid and electrolyte disorders, renal failure, and weight loss (Table 2). The surviving cohort, on the other hand, had higher rates of hypertension (Table 2).

Table 2. Characteristics of emergency admitted patients with the primary diagnosis of pseudocyst of pancreas. Data was classified according to outcome categories, NIS 2005-2014.

		Adult, N (%)			Elderly, N (%)		
		Survived	Deceased	*P*	Survived	Deceased	*P*
All Cases		6,732 (99.4%)	41 (0.6%)		2,274 (97.3%)	63 (2.7%)	
Sex, Female		2,675 (39.8%)	17 (41.5%)	0.830	1,180 (51.9%)	28 (44.4%)	0.240
Race	**White**	3,870 (66.4%)	21 (63.6%)	0.150	1,525 (77.5%)	45 (81.8%)	0.160
	Black	894 (15.3%)	10 (30.3%)		184 (9.3%)	3 (5.5%)	
	Hispanic	735 (12.6%)	1 (3.0%)		163 (8.3%)	5 (9.1%)	
	Asian/Pacific Islander	104 (1.8%)	0 (0%)		38 (1.9%)	0 (0%)	
	Native American	56 (1.0%)	0 (0%)		4 (0.2%)	1 (1.8%)	
	Other	173 (3.0%)	1 (3.0%)		55 (2.8%)	1 (1.8%)	
Income Quartile	**Quartile 1**	1,975 (30.2%)	14 (35.0%)	0.870	630 (28.1%)	17 (27.9%)	0.280
	Quartile 2	1,818 (27.8%)	10 (25.0%)		597 (26.7%)	10 (16.4%)	
	Quartile 3	1,556 (23.8%)	8 (20.0%)		533 (23.8%)	18 (29.5%)	
	Quartile 4	1,185 (18.1%)	8 (20.0%)		480 (21.4%)	16 (26.2%)	
Insurance	**Private Insurance**	2,873 (42.8%)	12 (29.3%)	**<0.001**	215 (9.5%)	6 (9.5%)	0.980
	Medicare	883 (13.2%)	16 (39.0%)		1,988 (87.6%)	56 (88.9%)	
	Medicaid	1,466 (21.8%)	7 (17.1%)		42 (1.9%)	1 (1.6%)	
	Self-Pay	956 (14.2%)	4 (9.8%)		9 (0.4%)	0 (0%)	
	No Charge	108 (1.6%)	0 (0%)		2 (0.1%)	0 (0%)	
	Other	427 (6.4%)	2 (4.6%)		13 (0.6%)	0 (0%)	
Hospital Location	**Rural**	409 (6.1%)	4 (9.8%)	0.610	124 (5.5%)	3 (4.8%)	0.580
	Urban: Non-Teaching	1,960 (29.1%)	11 (26.8%)		745 (32.8%)	17 (27.0%)	
	Urban: Teaching	4,363 (64.8%)	26 (63.4%)		1,405 (61.8%)	43 (68.3%)	
Comorbidities	**AIDS**	39 (0.6%)	1 (2.4%)	0.220	0 (0%)	0 (0%)	
	Alcohol Abuse	1,812 (26.9%)	11 (26.8%)	0.990	159 (7.0%)	6 (9.5%)	0.440
	Deficiency Anemias	1,625 (24.1%)	14 (34.1%)	0.140	628 (27.6%)	21 (33.3%)	0.320
	Rheumatoid Arthritis	141 (2.1%)	5 (12.2%)	**<0.001**	60 (2.6%)	3 (4.8%)	0.240
	Chronic Blood Loss	80 (1.2%)	1 (2.4%)	0.390	35 (1.5%)	4 (6.3%)	**0.019**

		Adult, N (%)			Elderly, N (%)		
		Survived	Deceased	*P*	Survived	Deceased	*P*
All Cases		6,732 (99.4%)	41 (0.6%)		2,274 (97.3%)	63 (2.7%)	
Comorbidities	**Congestive Heart Failure**	192 (2.9%)	4 (9.8%)	**0.030**	283 (12.4%)	23 (36.5%)	**<0.001**
	Chronic Pulmonary Disease	919 (13.7%)	7 (17.1%)	0.530	468 (20.6%)	21 (33.3%)	**0.014**
	Coagulopathy	268 (4.0%)	9 (22.0%)	**<0.001**	106 (4.7%)	18 (28.6%)	**<0.001**
	Depression	796 (11.8%)	1 (2.4%)	0.080	226 (9.9%)	6 (9.5%)	0.910
	Diabetes, Uncomplicated	1,755 (26.1%)	8 (19.5%)	0.340	765 (33.6%)	18 (28.6%)	0.400
	Diabetes, Chronic Complications	193 (2.9%)	1 (2.4%)	0.999	100 (4.4%)	0 (0%)	0.110
	Drug Abuse	387 (5.7%)	1 (2.4%)	0.730	16 (0.7%)	0 (0%)	0.999
	Hypertension	3,117 (46.3%)	14 (34.1%)	0.120	1,634 (71.9%)	35 (55.6%)	**0.005**
	Hypothyroidism	323 (4.8%)	2 (4.9%)	0.999	301 (13.2%)	9 (14.3%)	0.810
	Liver Disease	632 (9.4%)	6 (14.6%)	0.250	125 (5.5%)	5 (7.9%)	0.410
	Lymphoma	21 (0.3%)	1 (2.4%)	0.130	7 (0.3%)	0 (0%)	0.999
	Fluid/Electrolyte Disorders	2,036 (30.2%)	24 (58.5%)	**<0.001**	817 (35.9%)	33 (52.4%)	**0.007**
	Metastatic Cancer	38 (0.6%)	2 (4.9%)	**0.024**	28 (1.2%)	2 (3.2%)	0.190
	Other Neurological Disorders	269 (4.0%)	3 (7.3%)	0.230	116 (5.1%)	2 (3.2%)	0.770
	Obesity	661 (9.8%)	3 (7.3%)	0.790	149 (6.6%)	2 (3.2%)	0.430
	Paralysis	46 (0.7%)	2 (4.9%)	**0.034**	19 (0.8%)	0 (0%)	0.999
	Peripheral Vascular Disorders	173 (2.6%)	1 (2.4%)	0.999	179 (7.9%)	8 (12.7%)	0.160
	Psychoses	380 (5.6%)	2 (4.9%)	0.999	57 (2.5%)	0 (0%)	0.400
	Pulmonary Circulation Disorders	73 (1.1%)	1 (2.4%)	0.360	70 (3.1%)	3 (4.8%)	0.450
	Renal Failure	301 (4.5%)	7 (17.1%)	**<0.001**	280 (12.3%)	16 (25.4%)	**0.002**
	Solid Tumor	77 (1.1%)	0 (0%)	0.999	73 (3.2%)	0 (0%)	0.260
	Peptic Ulcer	5 (0.1%)	0 (0%)	0.999	4 (0.2%)	1 (1.6%)	0.130
	Valvular Disease	92 (1.4%)	1 (2.4%)	0.430	115 (5.1%)	0 (0%)	0.070
	Weight Loss	1,200 (17.8%)	18 (43.9%)	**<0.001**	489 (21.5%)	32 (50.8%)	**<0.001**
Invasive Diagnostic Procedure		1,724 (25.6%)	13 (31.7%)	0.370	744 (32.7%)	22 (34.9%)	0.710
Surgical Procedure		3,164 (47.0%)	33 (80.5%)	**<0.001**	927 (40.8%)	39 (61.9%)	**<0.001**
Invasive or Surgical Procedure		3,931 (58.4%)	36 (87.8%)	**<0.001**	1,309 (57.6%)	44 (69.8%)	0.052
		Mean (SD)	**Mean (SD)**	***P***	**Mean (SD)**	**Mean (SD)**	***P***
Age, Years		45.90 (11.37)	51.98 (9.58)	**<0.001**	74.54 (7.28)	76.05 (6.87)	0.110
Modified Frailty Index Score		1.18 (1.01)	1.49 (1.19)	**0.049**	1.80 (1.07)	2.30 (1.20)	**<0.001**
Time to Invasive Diagnostic Procedure, Days		4.04 (5.78)	12.73 (17.49)	0.130	4.04 (5.03)	11.41 (17.63)	0.100
Time to Surgical Procedure, Days		3.93 (5.40)	10.71 (11.65)	**0.005**	4.31 (6.17)	6.25 (9.09)	0.240
Hospital length of stay, Days		8.64 (9.92)	42.66 (49.31)	**<0.001**	9.00 (10.68)	18.22 (19.48)	**<0.001**
Total Charges, Dollars		56,847 (81,963)	320,357 (400,070)	**<0.001**	62,739 (97,310)	193,204 (249,983)	**<0.001**

Surgery vs No Surgery

Nearly half of 6,775 adult patients (47.2%) underwent an operation; 38.7% of the operative patients were female and 61.3% were male (Table 3). Most of the surgical patients were on private insurance and the majority of the surgeries were performed at urban teaching hospitals. Those who underwent an operation had a longer HLOS, longer time to invasive diagnostic procedure, and higher rates of invasive diagnostic procedures. In addition, mortality was higher in the surgical cohort than in the non-surgical cohort (1.0% vs. 0.2%). Non-surgical patients had a higher rate of alcohol abuse, hypothyroidism, and drug abuse; whereas surgical patients had higher rates of deficiency anemias, coagulopathy, fluid and electrolyte disorders, and weight loss (Table 3).

Within the elderly patients in this study, 41.3% of patients underwent an operation. Of this elderly operative group 46.6% were female and 53.4% were male. The majority of the surgical patients were admitted to urban teaching hospitals. Elderly surgical patients had a longer HLOS and time to invasive diagnostic procedures, as well as higher total cost as compared with elderly non-surgical patients (Table 3). Additionally, elderly surgical patients had higher rates of invasive diagnostic procedures. Elderly patients that underwent operation exhibited a significantly higher rate of mortality than those who did not undergo operation (4.0% vs. 1.8%). Comorbidities such as deficiency anemias, chronic blood loss, coagulopathy, complicated diabetes, fluid/electrolyte disorders, metastatic cancer, and weight loss were seen at higher rates in elderly surgical patients. Non-surgical elderly patients, on the other hand, had higher rates of congestive heart failure, hypothyroidism, other neurological disorders, and paralysis (Table 3).

Table 3. Characteristics of emergency admitted patients with the primary diagnosis of pseudocyst of pancreas. Data was stratified according to operation status, NIS 2005-2014.

		Adult, N (%)			Elderly, N (%)		
		No Operation	Operation	*P*	No Operation	Operation	*P*
All Cases		3,576 (52.8%)	3,199 (47.2%)		1,373 (58.7%)	966 (41.3%)	
Sex, Female		1,454 (40.7%)	1,238 (38.7%)	0.100	758 (55.2%)	450 (46.6%)	**<0.001**
Race	**White**	2,047 (65.7%)	1,845 (67.1%)	0.260	908 (76.8%)	662 (78.6%)	0.610
	Black	488 (15.7%)	416 (15.1%)		120 (10.1%)	68 (8.1%)	
	Hispanic	415 (13.3%)	321 (11.7%)		96 (8.1%)	72 (8.6%)	
	Asian/Pacific Islander	54 (1.7%)	50 (1.8%)		22 (1.9%)	16 (1.9%)	
	Native American	31 (1.0%)	25 (0.9%)		4 (0.3%)	1 (0.1%)	
	Other	82 (2.6%)	92 (3.3%)		33 (2.8%)	23 (2.7%)	
Income Quartile	**Quartile 1**	1,090 (31.2%)	900 (29.2%)	0.240	389 (28.8%)	258 (27.0%)	0.460
	Quartile 2	944 (27.0%)	884 (28.7%)		347 (25.7%)	260 (27.3%)	
	Quartile 3	835 (23.9%)	729 (23.6%)		313 (23.2%)	239 (25.1%)	
	Quartile 4	623 (17.8%)	570 (18.5%)		300 (22.2%)	197 (20.6%)	
Insurance	**Private Insurance**	1,431 (40.2%)	1,455 (45.6%)	**<0.001**	124 (9.0%)	98 (10.2%)	0.550
	Medicare	522 (14.6%)	377 (11.8%)		1,212 (88.4%)	833 (86.5%)	
	Medicaid	767 (21.5%)	706 (22.1%)		25 (1.8%)	18 (1.9%)	
	Self-Pay	555 (15.6%)	405 (12.7%)		4 (0.3%)	5 (0.5%)	
	No Charge	55 (1.5%)	53 (1.7%)		1 (0.1%)	1 (0.1%)	
	Other	234 (6.6%)	196 (6.1%)		5 (0.4%)	8 (0.8%)	
Hospital Location	**Rural**	297 (8.3%)	116 (3.6%)	**<0.001**	101 (7.4%)	26 (2.7%)	**<0.001**
	Urban: Non-Teaching	1,188 (33.2%)	783 (24.5%)		520 (37.9%)	243 (25.2%)	
	Urban: Teaching	2,091 (58.5%)	2,300 (71.9%)		752 (54.8%)	697 (72.2%)	

		Adult, N (%)			Elderly, N (%)		
		No Operation	Operation	*P*	No Operation	Operation	*P*
All Cases		3,576 (52.8%)	3,199 (47.2%)		1,373 (58.7%)	966 (41.3%)	
Comorbidities	**AIDS**	21 (0.6%)	19 (0.6%)	0.970	0 (0%)	0 (0%)	
	Alcohol Abuse	1,004 (28.1%)	820 (25.6%)	**0.024**	101 (7.4%)	64 (6.6%)	0.500
	Deficiency Anemias	776 (21.7%)	863 (27.0%)	**<0.001**	349 (25.4%)	300 (31.1%)	**0.003**
	Rheumatoid Arthritis	74 (2.1%)	72 (2.3%)	0.610	38 (2.8%)	25 (2.6%)	0.790
	Chronic Blood Loss	38 (1.1%)	43 (1.3%)	0.290	12 (0.9%)	27 (2.8%)	**<0.001**
	Congestive Heart Failure	101 (2.8%)	95 (3.0%)	0.720	202 (14.7%)	106 (11.0%)	**0.008**
	Chronic Pulmonary Disease	505 (14.1%)	421 (13.2%)	0.250	301 (21.9%)	189 (19.6%)	0.170
	Coagulopathy	123 (3.4%)	154 (4.8%)	**0.004**	57 (4.2%)	67 (6.9%)	**0.003**
	Depression	439 (12.3%)	358 (11.2%)	0.170	141 (10.3%)	91 (9.4%)	0.500
	Diabetes, Uncomplicated	959 (26.8%)	804 (25.1%)	0.120	449 (32.7%)	334 (34.6%)	0.340
	Diabetes, Chronic Complications	100 (2.8%)	94 (2.9%)	0.730	49 (3.6%)	51 (5.3%)	**0.044**
	Drug Abuse	224 (6.3%)	164 (5.1%)	**0.044**	6 (0.4%)	10 (1.0%)	0.080
	Hypertension	1,659 (46.4%)	1,472 (46.0%)	0.760	1,001 (72.9%)	669 (69.3%)	0.054
	Hypothyroidism	194 (5.4%)	131 (4.1%)	**0.011**	200 (14.6%)	110 (11.4%)	**0.026**
	Liver Disease	341 (9.5%)	297 (9.3%)	0.720	69 (5.0%)	61 (6.3%)	0.180
	Lymphoma	10 (0.3%)	12 (0.4%)	0.490	3 (0.2%)	4 (0.4%)	0.460
	Fluid/Electrolyte Disorders	1,016 (28.4%)	1,044 (32.6%)	**<0.001**	461 (33.6%)	389 (40.3%)	**<0.001**
	Metastatic Cancer	22 (0.6%)	18 (0.6%)	0.780	12 (0.9%)	18 (1.9%)	**0.036**
	Other Neurological Disorders	150 (4.2%)	122 (3.8%)	0.430	88 (6.4%)	31 (3.2%)	**<0.001**
	Obesity	346 (9.7%)	318 (9.9%)	0.710	80 (5.8%)	71 (7.3%)	0.140
	Paralysis	26 (0.7%)	22 (0.7%)	0.850	16 (1.2%)	3 (0.3%)	**0.032**
	Peripheral Vascular Disorders	96 (2.7%)	78 (2.4%)	0.520	115 (8.4%)	72 (7.5%)	0.420
	Psychoses	213 (6.0%)	169 (5.3%)	0.230	35 (2.5%)	22 (2.3%)	0.608
	Pulmonary Circulation Disorders	32 (0.9%)	42 (1.3%)	0.100	42 (3.1%)	32 (3.3%)	0.730
	Renal Failure	162 (4.5%)	146 (4.6%)	0.950	177 (12.9%)	120 (12.4%)	0.740
	Solid Tumor	38 (1.1%)	39 (1.2%)	0.540	35 (2.5%)	38 (3.9%)	0.060
	Peptic Ulcer	5 (0.1%)	0 (0%)	0.060	3 (0.2%)	2 (0.2%)	0.999
	Valvular Disease	50 (1.4%)	43 (1.3%)	0.850	67 (4.9%)	49 (5.1%)	0.830
	Weight Loss	467 (13.1%)	751 (23.5%)	**<0.001**	229 (16.7%)	292 (30.2%)	**<0.001**
Invasive Diagnostic Procedure		770 (21.5%)	967 (30.2%)	**<0.001**	387 (28.2%)	379 (39.2%)	**<0.001**
Deceased		8 (0.2%)	33 (1.0%)	**<0.001**	24 (1.8%)	39 (4.0%)	**<0.001**
		Mean (SD)	**Mean (SD)**	***P***	**Mean (SD)**	**Mean (SD)**	***P***
Age, Years		45.59 (11.50)	46.32 (11.21)	**0.009**	75.47 (7.52)	73.33 (6.70)	**<0.001**
Modified Frailty Index Score		1.15 (1.00)	1.21 (1.02)	**0.006**	1.79 (1.06)	1.84 (1.10)	0.240
Time to Invasive Diagnostic Procedure, Days		3.15 (3.45)	4.92 (7.41)	**<0.001**	3.23 (3.34)	5.26 (7.36)	**<0.001**
Hospital length of stay, Days		5.29 (5.47)	12.82 (13.75)	**<0.001**	5.98 (6.54)	13.89 (14.17)	**<0.001**
Total Charges, Dollars		31,760 (43,135)	88,291 (114,926)	**<0.001**	35,907 (40,368)	108,561 (147,362)	**<0.001**

Risk Factors of Mortality

The multivariable backwards logistic regression model for mortality was constructed to identify significant variables affecting mortality in patients emergently admitted with PCP (Table 4). Age, HLOS, respiratory diseases, coagulopathy, cardiac diseases, trauma, burns, and poisons, and genitourinary system diseases were all found to be significant variables impacting odds of mortality. In terms of age, every additional year increased the odds of mortality by 3.0%. Every additional day spent in the hospital increased the odds of mortality by 1.0%. Patients with respiratory diseases had about 5-fold higher risk of mortality than those without respiratory diseases. Similarly, coagulopathy and cardiac diseases both increased the odds of mortality by 2.35-fold and 2.87-fold, respectively. Patients with trauma, burns, and poisons had odds of mortality that were 3.72 times higher than those without these injuries. Genitourinary system diseases increased the odds of mortality by 87% (Table 4).

Table 4. Backward logistic regression analysis to evaluate the associations between mortality and different risk factors in patients emergently admitted with a primary diagnosis of cyst and pseudocyst of pancreas (NIS 2005-2014). Mortality was the dependent variable.

Patients' Characteristics	Mortality	
	N = 9,103	R^2 = 0.320
	OR (95% CI)	*P*
Number of Events	N = 104	
Age, Years	1.03 (1.01, 1.05)	**<0.001**
Hospital Length of Stay, Days	1.01 (1.00, 1.02)	**<0.001**
Respiratory Diseases	4.98 (2.79, 8.89)	**<0.001**
Coagulopathy	2.35 (1.46, 3.77)	**<0.001**
Cardiac Diseases	2.87 (1.76, 4.69)	**<0.001**
Trauma, Burns, and Poisons	3.72 (2.25, 6.16)	**<0.001**
Genitourinary System Diseases	1.87 (1.21, 2.91)	**0.005**
Bacterial Infections (Other than Tuberculosis)	1.59 (0.96, 2.64)	0.070
Invasive Procedure		
Surgical Procedure		
Sex, Female		
Peripheral Vascular Diseases		
Liver Diseases		
Fluid and Electrolyte Disorders		
Neoplasms		
Neurological Diseases		**Removed**
Platelet and White Blood Cell Diseases		**Via**
Cerebrovascular Diseases		**Stepwise**
Tuberculosis		**Backward**
Nonbacterial Infections		**Elimination**
Anemia and/or Hemorrhage		
Digestive Diseases other than Liver		
Diabetes		
Drug Abuse/Withdrawal/Dependence		
Alcohol Abuse/Withdrawal/Dependence		
Tobacco Use		
Hypertension		

Patients' Characteristics	Mortality	
	N = 9,103	R^2 = 0.320
	OR (95% CI)	*P*
Number of Events	N = 104	
Endocrine Diseases		
Nutritional/Weight Disorders		
Musculoskeletal System and Connective Tissue Diseases		
Psychiatric Diseases		Removed
Skin Diseases		Via
Long Term Medication Usage		Stepwise
Diseases of Oral Cavity, Salivary Glands, and Jaw		Backward
Sleep Disorders		Elimination
Lack of Physical Evidence		
Inappropriate Diet and Eating Habits		
High Risk Lifestyle Behaviors		
Social Factors		

Discussion

Age

Our results showed mortality rates of 0.6% and 2.7% in adult and elderly patients, respectively. Risk of mortality within the elderly population was 4.5 times higher than in the adult population. Additionally, in both surgical and non-surgical groups, mortality rates in the elderly cohort were higher than in the adult cohort (Table 3). Every additional year of age increased the odds of mortality by 3%. McVeigh et al., found that elderly patients are more likely to have comorbidities that can contribute to higher rates of morbidity and mortality when compared against younger patients[16], a few of the comorbidities that were significant in the elderly operational patients were: diabetes, fluid and electrolyte disorders, and metastatic cancer. All of these comorbidities can contribute to higher American Society of Anesthesiologist Physical Status (ASA) Classification, which communicates patients' pre-anesthesia risks and comorbidities and is useful for predicting mortality. Importantly, Merani et al. found that in emergency general surgery in the elderly population, ASA class was a significant independent predictor of postoperative mortality[17]. This demonstrates that age may be a significant risk factor for mortality in PCP patients due to the higher likelihood of elderly patients having comorbidities that put them at an increased risk of postoperative mortality. Wood et al. conducted a retrospective study looking at mortality in adult patients who had an emergency general surgery and found that increased age was a significant risk factor for mortality[18], which corroborates with our findings. Increased age is also associated with decreased pancreatic acinar cell function and a higher prevalence of chronic changes to the pancreas that can contribute to pancreatic pseudocyst development[19–21]. Therefore, older patients appear to already be at an increased risk of suffering from a PCP in addition to their elevated risk of complications and mortality from PCP. Thus, it is essential that more research be conducted to evaluate how physicians and patients can be proactive about working to reduce the risks of PCP development. Be preventing the development of the condition, especially for patient of older ages who may have more comorbidities, this will reduce morbidity and mortality.

Hospital Length of Stay

Hospital length of stay was a significant risk factor for mortality with each day in the hospital increasing the risk of mortality by 1%. The elderly population has a high rate of comorbidities and frailty; and the protocol for treating pancreatic pseudocysts is typically to avoid operation as pancreatic pseudocysts can resolve themselves and elderly-frail patients are at higher risk of surgical complications[5,6]. Van Vliet et al. found that a short hospital length of stay, 1-5 days, was optimal for treating elderly patients; while a longer hospital length of stay (>5 days) increased the risk of morbidity and mortality[22]. This is unsurprising given the known risks of hospital stays, including infections, adverse drug reactions, and ulcers.

Thus, the existing literature supports our findings which demonstrate that longer hospital stays are associated with poorer outcomes for pancreatic pseudocyst patients, especially elderly patients. This demonstrates the need to work to identify patients at risk of long hospital stays and work proactively to minimize the time PCP patients spend inpatient while still effectively treating their conditions. The general initially accepted treatment of a pancreatic pseudocyst is conservative management. Frey et al., reported that a delay in operation for emergency complications of pancreatic pseudocysts led to a higher risk of mortality in adult cases[7]. A pancreatic pseudocyst is a collection of pancreatic fluid that will, with time, mature or will resolve itself[3–5,23]. Additionally, Frey et al. found that the presence of multiple pseudocysts or a pseudocyst located very close to the duodenum leads to more deaths in the adult population[7]. Senol et al. also found that patients with a mean age of 55.7, depending on size: pseudocysts >6 cm have associated complications, early drainage or surgery improves the rate of serious complication[11]. They created a new scoring classification for pancreatic pseudocysts, by adding the element that would evaluate the chances of resolution. They found that elevated direct bilirubin level, elevated CEA, and cyst diameter all increased the rate of requiring surgical intervention[11]. Hospital length of stay and/or age were the risk factors of mortality for other emergently admitted surgical patients as well.[24-36]

Frailty

The modified frailty index score is a 5-point index score based upon the Subramaniam frailty score, it had to be modified as the National Inpatient Sample does not contain all of the necessary information for calculation. In the modified frailty index score the presence of at least one of the following comorbidities gave one point: solid tumor, renal failure, metastatic cancer, paralysis, lymphoma, coagulopathy, or weight loss. The other four points were given based on the presence of diabetes, chronic pulmonary disease, congestive heart failure, and hypertension. The initial protective nature of a delay in operation could be contributed to the very high risk of mortality associated with the modified frailty index score and undergoing a surgical procedure. McIsaac et al. reported that 30-50% of older patients who are undergoing a major surgery are living with frailty; and importantly, frailty is associated with a 2-fold increase in morbidity and mortality[14]. This massive increase in risk for operation in an elderly frail patient could explain why a delay in operation until the it becomes absolutely necessary is initially protective, because in elderly-frail patients, surgery is a great risk in itself. If there is any chance of resolution without surgery, avoiding surgery looks to be a safer route among frail patients. However, this needs to be balanced against the risks of longer inpatient stays, which as discussed, is a risk factor for morbidity and mortality in itself.

Strengths of this Study

The Healthcare Cost and Utilization Project (HCUP) was established to provide multistate, administrative, population-based data on patients in a uniform format. The data are designed for health services research to enhance health care provision. The National Inpatient Sample (NIS), a large administrative database produced by the Agency for Healthcare Research and Quality (AHRQ), has been progressively used publicly as a countrywide data source, holding much potential and support for the assessment of patterns of care and outcomes for research. It allows novel approaches to investigate disease conditions, optimal care, and patient outcomes. The analysis of the epidemiology of a large sample size of patients with pancreatic pseudocysts can provide additional insights. It is invaluable to have nation-wide data on pancreatic pseudocysts instead of data that is confined to small populations from single hospitals or geographic regions. This makes these findings very generalizable. The demographics and comorbidities that may impact the rate of mortality of pancreatic pseudocysts in the total population and its impact on morbidity and mortality have not been examined. Our study fills part of the gap in, expands the evidence base, and helps further our understanding of pancreatic pseudocysts both in the adult and elderly populations. The other strengths is rigorous statistical analysis and large sample size.

Limitations of this Study

A number of limitations must be acknowledged in this retrospective study. In future studies, it would be beneficial to know: the primary event that caused the pancreatic pseudocyst, size of the pseudocyst as larger pseudocysts are more likely to have complications, location of the pseudocyst on the pancreas as there are more dangerous locations on a pancreas to have a pseudocyst, the cause of the emergency admission, the patients' history of exocrine pancreatic diseases, and history of previous pancreatic pseudocysts. Additionally, there are several potentially

confounding variables in the data set including: type of operation performed, surgeon's level of training and experience, severity of the comorbidities the patient had, and cause of death.

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