1-1-2021

Predictors and outcomes of acute respiratory failure in hospitalised patients with acute pancreatitis.

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Original research

Predictors and outcomes of acute respiratory failure in hospitalised patients with acute pancreatitis

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► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/flgastro-2020-101496).

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Received 8 April 2020
Revised 12 June 2020
Accepted 20 June 2020
Published Online First 28 July 2020

To cite: Gajendran M, Prakash B, Perisetti A, *et al*. *Frontline Gastroenterology* 2021;**12**:478–486.

ABSTRACT

Background and aim Acute pancreatitis (AP) is associated with organ failures and systemic complications, most commonly acute respiratory failure (ARF) and acute kidney injury. So far, no studies have analysed the predictors and hospitalisation outcomes, of patients with AP who developed ARF. The aim of this study was to measure the prevalence of ARF in AP and to determine the clinical predictors for ARF and mortality in AP.

Methods This is a retrospective cohort study using the Nationwide Inpatient Sample database from the year 2005–2014. The study population consisted of all hospitalisations with a primary or secondary discharge diagnosis of AP, which is further stratified based on the presence of ARF. The outcome measures include in-hospital mortality, hospital length of stay and hospitalisation cost.

Results In our study, about 5.4% of patients with AP had a codiagnosis of ARF, with a mortality rate of 26.5%. The significant predictors for ARF include sepsis, pleural effusion, pneumonia and cardiogenic shock. Key variables that were associated with a higher risk of mortality include mechanical ventilation, age more than 65 years, sepsis and cancer (excluding pancreatic cancer). The presence of ARF increased hospital stay by 8.3 days and hospitalisation charges by US$103 460.

Conclusion In this study, we demonstrate that ARF is a significant risk factor for increased hospital mortality, greater length of stay and higher hospitalisation charges in patients with AP. This underlines significantly higher resource utilisation in patients with a dual diagnosis of AP-ARF.

Significance of this study

What is already known on this topic

- Acute pancreatitis is associated with organ failures and systemic complications, most commonly acute respiratory failure and acute kidney injury. Population-based data on the effect of acute respiratory failure in acute pancreatitis are limited in terms of predictors and outcomes.

What this study adds

- We found that in a nationwide study, 5.4% of patients hospitalised with acute pancreatitis had acute respiratory failure, with a mortality rate of 26.5%. The presence of acute respiratory failure increased hospital stay by 8.3 days and hospitalisation charges by US$103 460. The significant predictors for acute respiratory failure include sepsis, pleural effusion, pneumonia and cardiogenic shock. Key variables that were associated with a higher risk of mortality include mechanical ventilation, age more than 65 years, sepsis and cancer (excluding pancreatic cancer).

How might it impact on clinical practice in the foreseeable future

- Concurrent acute respiratory failure in hospitalised patients with acute pancreatitis occurs at a perceptible prevalence with noticeable complications. This subgroup seems to have an overall poor prognosis and a more protracted clinical course compared with patients with acute pancreatitis with other organ failures. These results can be useful in allocating healthcare resources and counselling patients. Also, future scoring systems should consider giving more weightage for acute respiratory failure.

INTRODUCTION

Acute pancreatitis (AP) is one of the most common causes of gastrointestinal hospitalisation, with more than 200 000 hospitalisations a year in the USA, with an estimated expenditure of US$2.6 billion every year.[1] The incidence of AP has been shown to be increasing over the years, with a decrease in the mortality rates.[2 3] Based on the 1992 Atlanta classification, AP was classified into mild AP and severe AP. The 2012 revised Atlanta classification reclassified AP into mild acute, moderately severe and severe AP. Mild AP is self-limited without organ failure (OF) or complications; moderately severe AP can present with transient OF or complications that persist less than 48 hours and severe AP manifest with persistent OF that persists more than 48 hours.[4 5] Approximately 70%–80% of AP would take a mild course, and 15%–25% would have a severe course that usually occurs within the first 4 days.[6 7]

AP has been associated with OFs and systemic complications, most commonly acute respiratory failure (ARF), and acute kidney injury.[8] Previous studies have revealed AP as a significant risk factor for ARF.[9–12] Severe AP predisposes to ARF, and ARF, in turn, adversely influences clinical outcome in AP.[11 12] Two principal forms of ARF are acute lung injury (ALI) and acute respiratory distress syndrome (ARDS), which are responsible for high mortality rates in severe AP.[13] ARDS is considered as the most severe form of ALI, and they can be distinguished based on arterial oxygen pressure and inspired oxygen concentration ratio (PaO_2/FiO_2).[14] The overall mortality rate due to ARDS and ALI is between 30% and 40% from all causes.[14] ARDS is characterised by diffuse alveolar damage, lung capillary endothelial injury and diffuse pulmonary oedema that impairs gas exchange.[15]

Population-based data on the effect of ARF in AP are limited. Previous studies are derived from single-tertiary care referral centres, which do not represent the community setting of all patients with AP but represent a 'sicker' group of patients.[16] Lastly, no studies have analysed the predictors and hospitalisation outcomes of patients with AP who developed ARF. The aims of this study are: (1) to measure the prevalence of ARF in AP (2) to determine the clinical predictors for ARF in patients with AP (3) to determine the clinical predictors for in-hospital mortality in patients with AP-ARF and (4) to measure the outcome comparisons such as in-hospital mortality, length of stay (LOS) and hospital charges for patients with and without ARF. Currently, there are no studies that have focused on these inquiries.

METHODS

This is a retrospective cohort study using the Nationwide Inpatient Sample (NIS) database from the year 2005 to 2014. The NIS database consists of a 20% stratified sample of all discharges from the participating hospitals with data on more than 8 million discharges per year. Each discharge is treated as a unique entry and is coded with one primary discharge diagnosis and up to 25 secondary diagnoses as well as 15 associated procedures coded using the International Classification of Diseases, Clinical Modification, ninth edition (ICD-9-CM Codes). The NIS is maintained as part of the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality (AHRQ).[17]

The study population consists of all hospitalisations of adult patients (>18 years) with a primary or secondary discharge diagnosis of AP queried using the ICD-9-CM code 577.0 which has been validated in various studies[18–21] (online supplementary table 1). Patients with ARF were identified using ICD-9 CM codes 518.5, 518.81 or 518.82, which has been validated in previous studies.[22–28] Patients with chronic pancreatitis, pancreatic cancer and missing mortality data were excluded. Our primary population of interest was patients with AP with ARF (AP-ARF group), whereas the patients with AP with no organ failure (AP-NOF) and patients with AP with other organ failure (AP-OOF) formed the control groups. AP-OOF is defined by the presence of acute renal failure or acute cardiac failure or both. The primary outcome is hospital mortality, and the secondary outcomes are hospital LOS and hospitalisation cost. Subgroup analysis was performed for patients with ARF as the primary diagnosis and in patients with multiorgan failure (MOF, defined by $\geq$2 OF).

Patients with AP with OF were classified into isolated ARF, renal failure, cardiovascular failure or MOF. We could only determine whether the patient had any OF or not, and how many OFs the patient had based on the ICD coding. However, it is not possible to determine whether the OF is transient or persistent due to the lack of this information in the dataset. This makes it difficult for us to determine whether the patient had moderately severe or severe AP. Comorbidity risk adjustment was performed using the AHRQ comorbidity measures based on the methods by Elixhauser *et al*.[29] We could not assess Ranson's criteria, Acute Physiology and Chronic Health Evaluation (APACHE)-II or Bedside Index for Severity in Acute Pancreatitis (BISAP) score due to the unavailability of the laboratory data. The information on race was missing in 14% of the patients and was treated as a separate category.

Descriptive summary statistics are presented as means with SD for continuous variables, and frequencies with percentages for categorical variables. Categorical and continuous variables were compared using χ^2 tests and t-tests, respectively. Multivariable logistic regression analysis was used to predict the risk factors for ARF and mortality. The clinically relevant variables with $p<0.05$ from univariate analysis were included in the multivariable analysis. The results in the regression models were represented by an OR and 95% CI. Data analysis was performed using IBM SPSS software V.24 (SPSS).

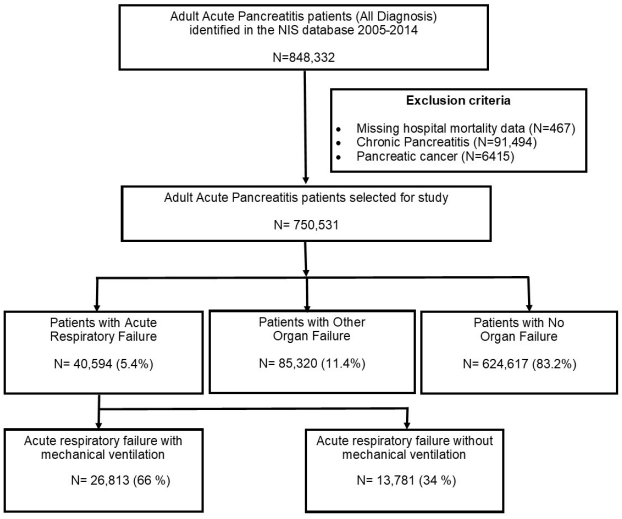

Figure 1 Study flow chart. NIS, Nationwide Inpatient Sample.

RESULTS

From 2005 to 2014, there were 750 531 hospitalisations for AP and 40 594 hospitalisations for AP-ARF (figure 1). The prevalence of ARF in AP was 5.4% in our study population, with a mortality rate of 26.5%. From 2005 to 2014, the prevalence of both AP hospitalisations and AP-ARF has increased, with a decrease in the mortality rates (figure 2, online supplementary table 2). The demographic characteristics of the AP-ARF group, compared with two control groups, AP-NOF and AP-OOF, have been outlined in table 1. One of the most striking findings of this study is the higher prevalence of sepsis in the AP-ARF group when compared with AP-OOF and AP-NOF (50.7% vs 16.6% vs 3.2%, p<0.001). A significant proportion of patients with AP-ARF also had coexisting OFs, with 12.6% of patients having isolated OF and 4.2% of the patients having MOF (table 2). Among the patients with isolated OF, the most common was an acute renal failure (9%) followed by ARF (2.1%) and acute cardiac failure (1.5%).

The in-hospital mortality occurred in 26.5%, 5.3% and 0.5% of AP-ARF, AP-OOF and AP-NOF, respectively. The mean LOS for patients in AP-ARF was significantly higher than the patients in the control groups, AP-OOF and AP-NOF (19.2 days vs 8.8 days vs 4.9 days p<0.001). After adjusting for age, gender, hospital characteristics, AP aetiology comorbidity burden and hospital complications, AP-ARF groups had an adjusted LOS increased by 8.3 days as opposed to those without ARF (8.3 days, 95% CI 8.2 to 8.4, p<0.001). Similarly, the hospital charges were significantly higher in the AP-ARF group when compared with the control groups, AP-OOF and AP-NOF (US$197 077 vs US$66 741 vs US$31 605, p<0.001). After adjusting with the above-mentioned variables, ARF in AP was associated with an additional cost of nearly US$100 000 (103 460; 95% CI 103 085 to 103 836, p<0.001).

Predictors of ARF in AP and predictors of mortality in AP-ARF are outlined in tables 3 and 4, respectively. Sepsis is the strongest predictor for developing ARF (OR 15, 95% CI 14.7 to 15.4), followed by pleural effusion (OR 4, 95% CI 3.9 to 4.2), pneumonia (OR 3.8, 95% CI 3.5 to 4.2), cardiogenic shock (OR 3.2, 95% CI 3.1 to 3.4) and alcohol aetiology (OR 2.3, 95% CI 2.2 to 2.4). The most important predictors of mortality in AP-ARF were mechanical ventilation (OR 14.2, 95% CI 13.6 to 14.8), age >65 (OR 5.0, 95% CI 4.6 to 5.4), sepsis (OR 5.1, 95% CI 4.9 to 5.3), cancer (OR 2.8, 95% CI 2.6 to 2.9), cardiogenic shock (OR 2.5, 95% CI 2.3 to 2.6) and alcohol aetiology (OR 2.2, 95% CI 2.1 to 2.4). The patients with pancreatic pseudocyst, smoking, obesity and diabetes mellitus had a lower risk of mortality in AP-ARF.

About 0.3% of the study population patients were admitted with a primary diagnosis of ARF (online supplementary table 3). This subgroup had ARDS in 72.8% of the patients, which is much higher than the rate of ARDS in the overall group (55.5%) and had sepsis in 26% of the patients, which is much lower than the overall sepsis rate of 50.7% in the AP-ARF group. Also, they had a mortality rate of 24.2%, which is lower than the overall mortality rate of 26.5 in the AP-ARF group. Patients with MOF had higher mortality rates than those with one OF or no OF (28% vs 6.5% vs 0.4%, p<0.001).

DISCUSSION

In this study, we demonstrate that about 5% of all hospitalisations for AP were complicated by ARF. We identified that ARF is a significant risk factor for increased hospital mortality, LOS, mechanical ventilation and hospitalisation charges in patients with AP. This subgroup of patients with AP with ARF seems to have an overall poor prognosis when compared with the patients with other OFs and those without any OF. This study also confirms the increasing annual prevalence of total AP hospitalisations as well as the AP-ARF hospitalisations.

In our study, the hospitalisation rates of ARF in AP increased by 1% over the 10-year period, and

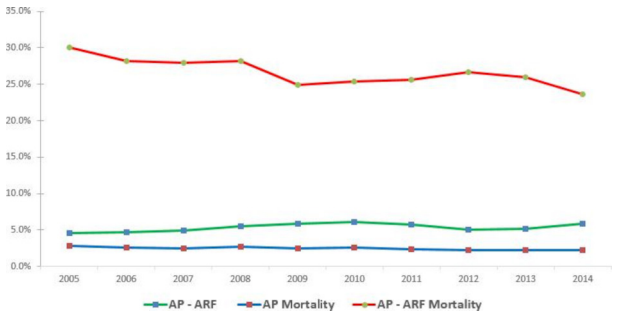

Figure 2 Trends in acute respiratory failure (ARF) and acute pancreatitis (AP). Red: AP mortality; blue: AP-ARF incidence; green: AP-ARF mortality.

Table 1 Demographic of the patients with acute pancreatitis

	AP-NOF	AP-ARF	AP-OOF	
N	n=624 617	n= 40594	n=85 320	
Factor	N (%)	N (%)	N (%)	P value
Age (years), mean (SD)	52.82 (18.14)	59.45 (17.22)	61.57 (17.27)	<0.001
Length of stay, mean (SD)	4.95 (5.31)	19.25 (20.06)	8.87 (10.99)	<0.001
Total charges, mean (SD)	31 605.1 (43 509.2)	197 077.1 (238 188.2)	66 741.3 (122 930.2)	<0.001
Gender: female*	323 511 (51.8%)	17 561 (43.2)	39 764 (46.6)	<0.001
Age cat				
18–35	120 593 (19.3)	4066 (10)	6831 (8)	<0.001
36–50	173 660 (27.8)	8327 (20.5)	15 966 (18.7)	<0.001
51–65	169 689 (27.2)	12 423 (30.6)†	25 774 (30.2)†	<0.001
>65	160 675 (25.7)	15 778 (38.9)	36 749 (43.1)	<0.001
Weekend admission	159 563 (25.5)	10 593 (26.1)	21 435 (25.1)	0.001
Race				
White	346 222 (55.4)†	23 881 (58.84)	47 357 (55.5)†	<0.001
Black	78 128 (12.5)	4768 (11.78)	14 315 (16.8)	<0.001
Hispanic	76 133 (12.2)	3773 (9.3)†	8145 (9.5)†	<0.001
Asian or pacific islander	11 820 (1.9)	1046 (2.5)†	2020 (2.4)†	<0.001
Native American	4623 (0.7)	262 (0.6)	558 (0.7)	0.65
Other	16 299 (2.6)	1225 (3.1)	2054 (2.4)	<0.001
Missing	91 392 (2.6)	5639 (13.9)	10 871 (12.7)	<0.001
Hospital bed size*				
Small (1–49)	98 735 (15.9)	4605 (11.4)	11 170 (13.2)	<0.001
Moderate (50–99)	167 098 (26.9)	9670 (24)	21 958 (25.9)	<0.001
Large (>100)	356 051 (57.3)	26 083 (64.6)	51 720 (61)	<0.001
Teaching status				
Rural	93 636 (15)	2971 (7.3)	9324 (10.9)	<0.001
Urban, non-teaching	281 246(45)	16 976 (41.8)	36 615 (42.9)	<0.001
Urban, teaching	247 002 (39.5)	20 411 (50.58)	38 909 (45.6)	<0.001
Payer*				
Medicare	203 981 (32.7)	18 755 (46.3)	43 317 (50.9)	<0.001
Medicaid	97 325 (15.6)	6027 (14.9)	11 351 (13.3)	<0.001
Private	211 485 (33.9)	10 870 (26.8)	20 396 (24)	<0.001
Uninsured/other	110 202 (17.7)	4868 (12)	10 082 (11.8)	<0.001
Disposition				
Routine	516 750 (82.7)	10 559 (26)	49 530 (58.1)	<0.001
Short-term hospital	17 030 (2.7)	2899 (7.16)	4062 (4.8)	<0.001
Facility (SNF, ICF)	36 275 (5.8)	11 534 (28.4)	15 086 (17.7)	<0.001
Home healthcare	33 121 (5.3)	4446 (11)	10 590 (12.4)	<0.001
Against medical advice	17 966 (2.9)	324 (0.8)	1465 (1.7)	<0.001
Died	3326 (0.5)	10 764 (26.5)	4518 (5.3)	<0.001
Other	149 (0)	68 (0.2)	69 (0.1)	<0.001
AHRQ—Elixhauser Comorbidity Index: >3††	237 992 (38.1)	28 106 (69.2)	61 034 (71.5)	<0.001
Pancreatitis aetiology				
Alcohol	122 972 (19.7)	8267 (20.4)	14 560 (17.1)	<0.001
Biliary	169 801 (27.2)	7272 (17.9)	16 877 (19.8)	<0.001
Both alcohol and biliary	10 240 (1.6)†	661 (1.6)†	1362 (1.6)†	0.95
Missing/unknown	321 603 (51.5)	24 394 (60.1)	52 521 (61.6)	<0.001
Pancreatic pseudocyst	23 077 (3.7)	3117 (7.7)	3404 (4)	<0.001
Pneumonia	1844 (0.3)	1004 (2.5)	583 (0.7)	<0.001
Pleural effusion	14 609 (2.3)	6537 (16.1)	4738 (5.6)	<0.001
Acute respiratory distress syndrome	0 (0)	22 513 (55.5)	0 (0)	<0.001
Sepsis	19 764 (3.2)	20 584 (50.7)	14 173 (16.6)	<0.001

Continued

Table 1 Continued

	AP-NOF	AP-ARF	AP-OOF	
N	n=624 617	n= 40594	n=85 320	
Factor	N (%)	N (%)	N (%)	P value
Acute renal failure	0 (0)	22 937 (56.5)	73 881 (86.6)	<0.001
Cardiogenic shock	0 (0)	4859 (12)	18 037 (21.1)	<0.001
Haematological dysfunction	27 357 (4.4)	7909 (19.5)	9630 (11.3)	<0.001
Metabolic dysfunction	1643 (0.3)†	69 (0.2)	213 (0.2)†	0.001
Hepatic dysfunction/acute liver failure	12 086 (1.9)	5651 (13.9)	4830 (5.7)	<0.001
Smoking	136 250 (21.8)	4952 (12.2)	12 469 (14.6)	<0.001
Obesity	69 312 (11.1)†	4972 (12.2)	9662 (11.3)†	<0.001
Congestive heart failure	29 578 (4.7)	7608 (18.7)	12 059 (24.5)	<0.001
Chronic pulmonary disease	84 760 (13.6)	8746 (21.5)	14 346 (16.8)	<0.001
Diabetes mellitus	142 173 (22.8)	10 519 (25.9)	27 946 (32.8)	<0.001
Chronic renal failure	36 723 (5.9)	7319 (18.0)	22 844 (26.8)	<0.001
Chronic liver disease	57 242 (9.2)	4647 (11.4)	8928 (10.5)	<0.001
Cancer	12 756 (2)	1484 (3.7)†	3259 (3.8)†	<0.001
Drug abuse	30 499 (4.9)	2114 (5.2)	3918 (4.6)	0.0025
Died	3326 (0.5)	10 764 (26.5)	4518 (5.3)	<0.001
Mechanical ventilation	2892 (0.5)	26 813 (66.1)	3494 (4.1)	<0.001

The superscript † in the table between two cells denotes that those two values were not statistically significant. The p value stated would be for the other values in that row.
*Missing variables (gender—0.1%; hospital bed—0.5%; primary payer—0.2%).
††The 29 Agency for Healthcare Research and Quality (AHRQ) comorbidity measures except alcohol abuse were used for risk adjustment based on the methods by Elixhauser *et al*.[29]
AP-ARF, acute pancreatitis with acute respiratory failure; AP-NOF, acute pancreatitis with no organ failure; AP-OOF, acute pancreatitis with other organ failure; ICF, intermediate care facility; SNF, skilled nursing facility.

the mortality rates decreased by 6.5% during the same period of time. This trend is consistent with the pattern of ARF in other conditions.[22 30] The potential explanations for the reduction in mortality rates include improvement in the management of the underlying aetiology and the ARF, with the increased use of non-invasive ventilation, and advances in critical care management.[31 32]

In our study, sepsis emerged as the top predictor of ARF in patients with AP with an OR of 15 (95% CI 14.7 to 15.4). Previous studies have shown that sepsis is the most common cause of ARDS, accounting for 25%–40% of the cases.[33] Uncontrolled systemic inflammatory response mediated by cytokines play a critical role in the pathogenesis of ARDS.[34] Alcohol abuse and smoking are known risk factors for ARF in AP.[35 36] However, in our analysis, patients with smoking history did not have a higher risk of ARF or mortality. Although several studies have reported an association between smoking and ARF,[37–39] this association was not replicated in some other studies.[40] A recent meta-analysis of 17 studies concluded that cigarette smoking was not associated with an increased risk of ALI in critically ill patients.[41] One plausible explanation could be that the impact of smoking could be negligible when compared with other precipitating factors. Also, there is a potential for coding error or undercoding in the database we used for the study.

Furthermore, diabetes mellitus was associated with decreased risk of ARF and mortality in our study. This finding is similar to a prospective multicentre study in the USA, which showed that patients with diabetes had a decreased incidence of ARDS and mortality in patients with septic shock.[42] The explanation for this could be related to the impaired neutrophil function in the diabetics, which may protect the lung by decreasing the ability of the neutrophils to migrate into the lung and their capacity to produce oxidant damage.[42]

The pathophysiology of the development of ARF in AP involves increased pulmonary microvascular permeability, which results in the spilling of protein-rich transudate into the alveolar spaces that decreases lung compliance. These are the hallmarks of ALI, which manifest clinically as progressive hypoxaemia with radiological evidence of diffuse infiltrates.[43] Once

Table 2 Organ failure in acute pancreatitis

Organ failure	N	Per cent (95% CI)
None	624 617	83.22 (82.89 to 83.55)
Isolated organ failure	94 760	12.63 (12.41 to 12.85)
Acute respiratory failure	16 038	2.13 (2.09 to 2.18)
Isolated renal failure	67 283	8.97 (8.77 to 9.17)
isolated cardiac failure	11 439	1.52 (1.49 to 1.56)
Multiple organ failure (2 or more organs)	31 154	4.15 (4.02 to 4.29)

Table 3 Multivariate analysis for predictors of acute respiratory failure in patients with acute pancreatitis

Factor (s)	OR	95% CI		P value
Gender: female	0.78	0.76	0.80	<0.001
Age cat				
18–35	Reference			
36–50	1.17	1.12	1.22	<0.001
51–65	1.40	1.33	1.45	<0.001
>65	1.42	1.36	1.48	<0.001
Hospital bed size				
Small (1–49)	Reference			
Moderate (50–99)	1.15	1.11	1.19	<0.001
Large (>100)	1.39	1.34	1.44	<0.001
Teaching status				
Rural	Reference			
Urban, non-teaching	1.61	1.55	1.68	<0.001
Urban, teaching	1.98	1.90	2.06	<0.001
Pancreatitis aetiology				
Biliary	Reference			
Alcohol	2.34	2.24	2.43	<0.001
Both alcohol and biliary	1.61	1.47	1.77	<0.001
Pancreatic pseudocyst	1.20	1.15	1.26	<0.001
Pneumonia	3.79	3.45	4.17	<0.001
Pleural effusion	4.03	3.88	4.18	<0.001
Sepsis	15.04	14.68	15.41	<0.001
Cardiogenic shock	3.24	3.11	3.37	<0.001
Smoking	0.67	0.65	0.69	<0.001
Obesity	1.29	1.24	1.37	<0.001
Congestive heart failure	2.23	2.16	2.31	<0.001
Chronic pulmonary disease	1.52	1.48	1.57	<0.001
Diabetes mellitus	0.89	0.86	0.91	<0.001
Chronic renal failure	1.22	1.18	1.26	<0.001
Chronic liver disease	1.06	1.02	1.10	0.002
Cancer	1.01	0.95	1.07	0.808
Drug abuse	1.27	1.20	1.33	<0.001

the process of decrease in lung compliance and impairment of gas exchange becomes clinically evident, the risk of progression to ARDS and, ultimately, multiple organ dysfunction syndrome (MODS) increases. Future research should focus on analysing the interplay between proinflammatory and anti-inflammatory cytokines to prevent pulmonary involvement.

The AP-ARF group had a mortality rate of 26.5%, and the presence of ARF alone increased the risk of mortality by four times. Furthermore, 55% of patients with ARF progressed to ARDS, and 66% required mechanical ventilation. Previous population-based studies have reported a mortality rate ranging from 20% to 50% in patients admitted with ALI from all causes.[44 45] In patients with AP, ALI is a major component of the MODS, which frequently requires mechanical ventilation and a significant cause of early death in severe AP.[46] The mortality in MODS increases with the number of involved organs.[47] In our study, we have reported that patients with MODS had a mortality rate of 28% when compared with 0.4% in those with no OFs. In a study by Li *et al*, the presence of acute renal failure in severe AP was associated with a significant increase in hospital LOS, intensive care unit LOS, infection rate and mortality rate.[48] In our study, the presence of ARF in AP increased the LOS by 8 days, and the hospital charges by US$100 000. Similarly, in a prospective study of trauma patients, patients with ALI/ARDS increased the cost by 30% and LOS by twofold.[49]

Some of the limitations in our study include coding errors, lack of laboratory or medication data, and possible unrecognised confounders associated with administrative databases. A significant proportion of patients in the AP-ARF cohort also had congestive cardiac failure and cardiogenic shock, which could suggest that the primary pathophysiology among these patients is pulmonary oedema from cardiac failure rather than inflammation-mediated ARF. Owing to all the above reasons, research using NIS data can never substitute a prospective randomised clinical study.

Table 4 Multivariate analysis for predictors of mortality in patients with acute respiratory failure and patients with acute pancreatitis

Factor (s)	HR	95% CI		P value
Gender: female	0.947	0.914	0.980	0.002
Age cat				
18–35	Reference			
36–50	1.508	1.390	1.635	<0.001
51–65	2.342	2.168	2.529	<0.001
>65	5.031	4.663	5.428	<0.001
Hospital bed size				
Small (1–49)	Reference			
Moderate (50–99)	1.089	1.027	1.155	0.004
Large (>100)	1.152	1.093	1.214	<0.001
Teaching status				
Rural	Reference			
Urban, non-teaching	0.989	0.934	1.048	0.706
Urban, teaching	1.103	1.041	1.168	0.001
Pancreatitis aetiology				
Biliary	Reference			
Alcohol	2.243	2.101	2.394	<0.001
Both alcohol and biliary	1.293	1.098	1.523	0.002
Pancreatic pseudocyst	0.622	0.572	0.677	<0.001
Pleural effusion	0.946	0.890	1.006	0.076
Sepsis	5.064	4.872	5.263	<0.001
Cardiogenic shock	2.467	2.338	2.603	<0.001
Smoking	0.666	0.627	0.708	<0.001
Obesity	0.769	0.722	0.819	<0.001
Congestive heart failure	1.378	1.315	1.444	<0.001
Chronic pulmonary disease	1.030	0.985	1.076	0.192
Diabetes mellitus	0.750	0.720	0.781	<0.001
Chronic renal failure	1.536	1.470	1.605	<0.001
Chronic liver disease	1.681	1.593	1.773	<0.001
Cancer (not pancreatic cancer)	2.801	2.616	2.999	<0.001
Drug abuse	0.853	0.775	0.939	0.001
Mechanical ventilation	14.221	13.664	14.800	<0.001

In summary, concurrent ARF in hospitalised patients with AP occurs at a perceptible prevalence with noticeable complications. This subgroup seems to have an overall poor prognosis and more protracted clinical course compared with patients with AP-OOF. These results can be useful in allocating healthcare resources and counselling patients.

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Funding Intramural funding by Texas Tech University Paul L. Foster School of Medicine through Scholarly Activities Research Project. Provided to Mahesh Gajendran and Laura Collins.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The study was approved by the Institutional Review Board of the Texas Tech University Health Sciences Center El Paso.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. All data relevant to the study are included in the article or uploaded as supplementary information. The NIS database is available through AHRQ / HCUP agency.

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