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Spectrum of Pulmonary Dysfunctions in Acute Pancreatitis its Correlation with the Clinical Outcome - A Retrospective Study

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Abstract: ***Background**: Acute pancreatitis in its severe form may lead to systemic inflammatory response syndrome and multisystem organ dysfunction. Respiratory dysfunction precedes heart, liver and kidney failure and is responsible for early deaths in SAP. In the present study we intend to identify the spectrum of pulmonary complications at base line in patients with acute pancreatitis, correlate these with the outcome and define the significance of respiratory complications developing during the course of hospitalization. **Methodology**: This retrospective study was done on patients admitted in St Stephen's Hospital Tis Hazari Delhi during the period of January 2024 to July 2025. Patients were diagnosed of acute pancreatitis based on elevated serum amylase/ lipase level (elevated ≥ 3 times of the upper limit) level, clinical findings, and computed tomography (CT) were enrolled. Pancreatitis severity was evaluated based on computed tomography severe index (CTSI). All the patients underwent Chest X-rays and Arterial blood gas analysis. **Results**: The overall mean age was 38.96 ± 16.4 years with an age range 19-70 years. Fifty six patients were enrolled in the study among which 41[73.2%] males and 15 [26.8%] females. The most common etiology was alcohol in 24 patients (42.8%), gall stones in 19 (33.9%), idiopathic in 11 (19.6%) and iatrogenic in two cases. The CSTI mean value (mean ± SD) was 8.16±2.20. A significant positive correlation was observed between hypoxemia and severity of pancreatitis with all patients with CTSI above 9 having some degree of hypoxemia (p <0.001). In addition, the presence of pleural effusion, pneumonia, ARDS and respiratory failure but not atelectasis, were positively correlated with the severity of pancreatitis. **Conclusion**: Moderate to severe hypoxemia on presentation is a poor predictor of outcome in patients with acute pancreatitis as well as corelates with severity and progress of the disease. In addition, high CT severity index is found to be associated with pulmonary involvement and other organ dysfunctions. Early diagnosis and effective management of pulmonary complications is imperative to improve the outcome.*

Keywords: Acute Pancreatitis, Pulmonary dysfunction, ARDS, CTSI, Hypoxemia

1. Introduction

Acute pancreatitis is an inflammatory process caused by varying etiologies that involve the pancreas and extrapancreatic tissue. It is triggered by the autodigestion of the pancreas and extrapancreatic tissue by the inappropriately activated pancreatic enzymes[1]. This leads to necrosis of pancreatic as well as peripancreatic tissue. This necrotic and inflammatory process may also involve remote organs, leading to multiple organ failure.[2] Most common causes are cholelithiasis and alcohol abuse, accounting for 80-90% of cases and variety of other causes responsible for 10-20% of case.[3]

Severe acute pancreatitis (SAP) occurs in up to 20% of patients with acute pancreatitis (AP) and it has a high mortality rate. Furthermore, AP can be divided into an early and late phase. The early phase usually lasts for about one week and is characterized by systemic inflammatory response syndrome (SIRS), whereas the late phase is defined as persistent systemic inflammation or by local complications[4]. Organ failure can manifest in different systems, whereas respiratory failure is particularly common and associated with increased in-hospital mortality[5].

The incidence of pulmonary complications in acute pancreatitis patients varies widely, ranging from 15% to 55%.[6] The most common pulmonary complications are pleural effusion, atelectasis, acute lung injury (ALI) and acute respiratory distress syndrome (ARDS)[7]. Pulmonary dysfunction is the major factor of mortality in 22-25% and a contributing factor in an additional 30% of patients with AP[8]. Oxygen saturation of 92% or below is reported to be an independent predictor of the severity of AP and is reported in 44% of patients with SAP [6]. Pulmonary infiltrates, pleural effusion and hypoxemia are markers of SAP [7,9].

Previous studies suggested that chest pathologies such as pleural effusions and pulmonary infiltrations, detected radiographically in the first 24 hours of AP, might be associated with a necrotizing course of AP and increased mortality risk[8]. Pleural effusions, detectable in chest radiography, are included in the BISAP- and PANC 3-Score, predicting in-hospital mortality or severity of AP, respectively.[10] Due to the prognostic relevance of respiratory failure, this study aims to investigate the occurrence of early pleuropulmonary pathologies detected in contrast enhanced computed tomography (CECT) of patients with AP and correlate these with the outcome and define the significance of respiratory complications developing during the course of hospitalization.

2. Methodology

This retrospective study was done on patients admitted in St Stephen's Hospital Tis Hazari Delhi during the period of January 2024 to July 2025. Fifty six patients were enrolled in the study (41 males, 15 females; mean±SD age was 39.56±12.4 years with an age range 19-70 years).

AP was diagnosed following guideline recommendations if at least two of the following three criteria were met: 1. acute abdominal pain, 2. increased serum amylase/ lipase level (elevated ≥ 3 times of the upper limit) or 3. characteristic morphological findings of AP in imaging [11].

The following laboratory measurements were obtained in all patients at admission: serum amylase levels, white blood cell counts, hematocrit, electrolytes, blood glucose, serum creatinine, liver function tests (AST, ALT, and bilirubin) and coagulation profile. Baseline arterial blood gas analysis was recorded at room temperature and all patients had a routine chest X-ray at admission. Arterial oxygen pressure was monitored daily when respiratory insufficiency occurred. Chest X-ray was repeated periodically as per clinical observations. A contrast-enhanced CT (CECT) was performed on all patients, and the severity of the pancreatitis was established as per criteria suggested by Balthazar based upon the modified CT severity index CTSI [11].

Pleuropulmonary changes

To evaluate pleuropulmonary changes, caudal sections of the thorax captured on CECT of the abdomen were analyzed. Thorax CECTs were additionally screened for pathologies, when available. Images were analysed with the programmes PACS (Picture Archiving and Communication System). The scans were reviewed and following findings subsequently verified by an experienced radiologist: presence of pleural effusions (PEs) including localisation and amount, presence of atelectases, consolidation and or pulmonary infilterates.

Statistical analysis

The collected data was analysed using SPSS statistics software version 27 (IBM Inc., Armonk, NY, USA). Categorical variables were reported as frequency, percentages and continuous variables as median with interquartile range (IQR Q1 –Q3). Independent samples were compared applying the Mann-Whitney U or Pearson's chi-square test, as appropriate. To identify independent predictors of severe AP, potential variables with significant associations were identified in univariable analysis. A two-sided p-value <0.05 was considered statistically significant.

3. Results

The mean age was 38.96±16.4 years with an age range 19-70 years. Fifty six patients were enrolled in the study among which 41[73.2%] males and 15 [26.8%] females. The most common etiology was alcohol in 24 patients (42.8%), gall stones in 19 (33.9%), idiopathic in 11 (19.6%) and iatrogenic in two cases as shown in figure 1. The CSTI mean value (mean ± SD) was 8.16±2.20. Hypoxaemia at presentation was seen in 38 (67.8%) patients with mild (PaO2 between 60 and 79 mmHg), moderate (PaO2 between 40 and 59 mmHg), and severe (<40 mmHg) hypoxemia during presentation at hospital in 24 (42.8%), 9 (16.1%), and 5 patients (8.9%) respectively. Pleural effusion was the most prevalent respiratory complication found in 27 (48.2%) followed by atelectasis in 17 (30.3%) pneumonia/infilterates in 11 (19.4%) and ARDS in 9 (16.1%) patients. Demographic and clinical details are shown in Table-1

A significant positive correlation was observed between hypoxemia and severity of pancreatitis with all patients with CTSI above 9 having some degree of hypoxemia (p <0.001). In addition, the presence of pleural effusion, pneumonia, ARDS and respiratory failure but not atelectasis, were positively correlated with the severity of pancreatitis.

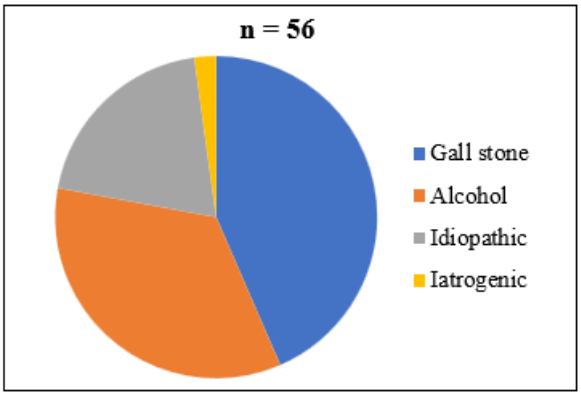

Figure 1: Distribution of causes

Table 1: Baseline characteristics of the study population (n= 56)

		Severity of acute pancreatitis		
	Total (n=56)	Mild n=5 (8.9%)	Moderate n=36 (64.2%)	Severe n= 15 (26.7%)
Gender				
Male	41	4	28	9
Female	15	1	8	6
Age				
Etiology				
Alcohol	24	3	16	5
Gall stone	19	2	10	7
Idiopathic	11	0	7	4
Others	2	0	1	1
Other organ failure	6	0	2	4

Table 2: Relationship between the frequency of Lung complications and severity of Pancreatitis as per modified CTSI

Respiratory involvement	CTSI ≤4 (n=2)	CTSI 5-8 (n=30)	CTSI >8 (n=24)	P value
Hypoxemia (PaO2 mmHg (mean)	Calculate mean ± SD	Calculate mean ± SD	Calculate mean ± SD	
Atelectasis Present Absent	 0 (0) 2 (100%)	 4 (13.33%) 26 (86.66%)	 13 (54.2%) 11 (45.8%)	0.019
Pleural effusion Present Absent	 0 (0) 2 (100%)	 10 (33.33%) 20 (66.66%)	 17 (70.83%) 07 (29.17%)	0.009
Pneumonia Present Absent	 0 (0) 2 (100%)	 04 (13.33%) 26 (86.66%)	 07 (29.16%) 17 (70.83%0	0.150
ARDS	0 (0) 2 (100%)	01 (3.33%) 29 (96.66%)	08 (33.33%) 16 (66.67%)	0.002
Respiratory failure	0 (0) 2 (100%)	01 (3.33%) 28 (96.66%)	13 (54.2%) 11 (45.8%)	<0.001

Table 2 presents the relationship between the frequency of pulmonary complications and the severity of acute pancreatitis as determined by the modified CT Severity Index (CTSI). Mean PaO_2 values demonstrated a clear inverse relationship with disease severity, with the highest mean PaO_2 in patients with CTSI ≤4 (89.00 ± 9.90 mmHg), intermediate values in the CTSI 5–8 group (72.80 ± 16.58 mmHg), and the lowest in CTSI >8 (57.46 ± 16.38 mmHg). This trend indicates that increasing radiological severity is associated with worsening hypoxemia.

Pleural effusion was the most frequent pulmonary complication, occurring in 70.83% of patients with CTSI >8, compared to 33.33% in CTSI 5–8, and absent in CTSI ≤4. The association between pleural effusion and CTSI category was statistically significant (p = 0.009). Atelectasis was observed in 54.2% of CTSI >8 cases, 13.3% in CTSI 5–8, and absent in CTSI ≤4, with a significant correlation to severity (p = 0.019). Pneumonia was present in 29.16% of CTSI >8 patients and 13.3% of CTSI 5–8, but not in CTSI ≤4; however, this association did not reach statistical significance (p = 0.150).

ARDS occurred in 33.33% of patients with CTSI >8, while it was absent in CTSI ≤4 and 5–8 groups, showing a highly significant correlation with severity (p = 0.002). Similarly, the need for invasive ventilation was markedly higher in the CTSI >8 group (45.8%) compared to no cases in CTSI ≤4 or CTSI 5–8, with this difference being highly significant (p < 0.001).

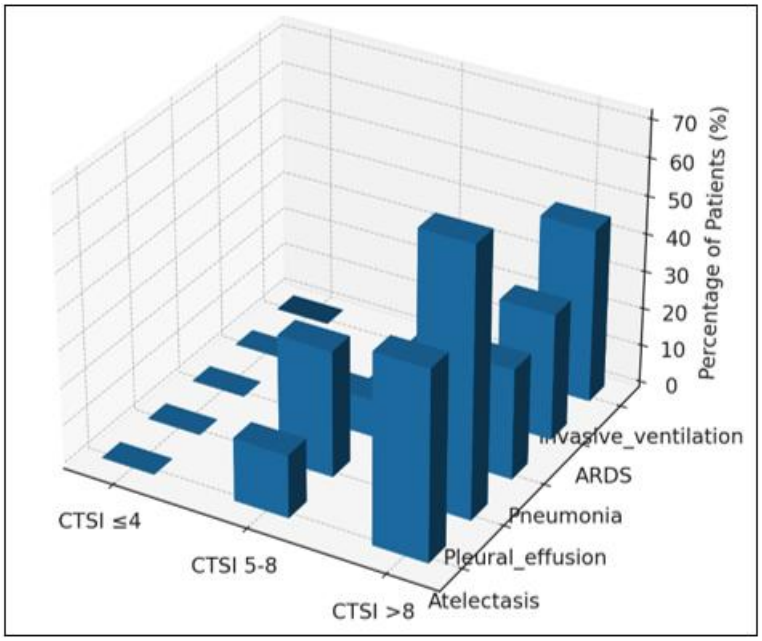

Figure 2: Three-dimensional bar chart illustrating the percentage of patients with specific pulmonary complications across different CT Severity Index (CTSI) groups.
Source: Author

The graphical representations in Figures 2 further illustrate the distribution of pulmonary complications in relation to disease severity. The 3D bar chart (Figure 1) demonstrates a clear gradient, with higher CTSI categories associated with an increased prevalence of pleural effusion, atelectasis, ARDS, and the need for invasive ventilation. The data indicate that higher CTSI scores are associated with more severe hypoxemia and an increased prevalence of major pulmonary complications such as pleural effusion, atelectasis, ARDS, and the need for invasive ventilation, highlighting the

prognostic significance of early radiological severity assessment in acute pancreatitis.

Table 3: Association of respiratory complication with the CTSI, hypoxemia (mean PaO2), respiratory failure, Length of hospital stay and mortality during the course of the disease

Respiratory complications at presentation	Status	CTSI Mean ± SD	Mean PaO_2 ± SD	Respiratory Failure & Need for Ventilation	Length of Hospital Stay (Mean ± SD)	Mortality
Atelectasis (n=17)	Present	8.71 ± 1.05	58.82 ± 12.97	10 (58.8%)	10.12 ± 3.59	6 (35.3%)
	Absent	7.54 ± 1.70	70.28 ± 19.30	7 (17.9%)	8.13 ± 3.61	11 (64.7%)
P value		0.0029	0.0127	0.0061	0.0676	0.2015
Pleural effusion (n=27)	Present	8.74 ± 0.94	59.78 ± 14.90	14 (51.9%)	10.07 ± 4.41	11 (40.7%)
	Absent	7.10 ± 1.72	73.34 ± 18.95	3 (10.3%)	7.46 ± 2.24	16 (59.3%)
P value		<0.0001	0.0043	0.002	0.009	0.0484
Consolidation (n=11)	Present	9.10 ± 0.88	49.80 ± 13.07	9 (90.0%)	11.80 ± 4.64	6 (54.5%)
	Absent	7.63 ± 1.62	70.50 ± 17.22	8 (17.4%)	8.07 ± 3.11	5 (45.5%)
P value		0.00049	0.00055	<0.0001	0.0338	0.0262
ARDS (n=9)	Present	9.75 ± 0.46	41.00 ± 8.35	8 (100.0%)	16.00 ± 2.67	7 (77.8%)
	Absent	7.58 ± 1.53	71.10 ± 15.78	9 (18.8%)	7.51 ± 2.04	2 (22.2%)
P value		<0.002	<0.004	<0.0026	<0.0019	<0.0004

Table 3 examines the association between specific respiratory complications at presentation and clinical severity markers in acute pancreatitis. For atelectasis, patients in the present group had significantly higher CTSI scores (8.71 ± 1.05) and lower mean PaO_2 (58.82 ± 12.97 mmHg) compared to those without atelectasis (7.54 ± 1.70 and 70.28 ± 19.30 mmHg, respectively). Respiratory failure requiring ventilatory support occurred in 58.8% of patients with atelectasis versus 17.9% without, a statistically significant difference ($p = 0.0061$). However, differences in hospital stay and mortality did not reach statistical significance.

In pleural effusion, the present group demonstrated significantly higher CTSI (8.74 ± 0.94 vs. 7.10 ± 1.72, $p < 0.0001$), lower PaO_2 (59.78 ± 14.90 vs. 73.34 ± 18.95 mmHg, $p = 0.0043$), higher rates of respiratory failure (51.9% vs. 10.3%, $p = 0.0020$), and longer hospital stay (10.07 ± 4.41 vs. 7.46 ± 2.24 days, $p = 0.0090$). Mortality was also significantly higher in the present group (40.7% vs. 14.8%, $p = 0.0484$).

For consolidation, CTSI and PaO_2 differences were marked ($p = 0.00049$ and $p = 0.00055$, respectively), with respiratory failure occurring in 90.0% of affected patients compared to 17.4% without consolidation ($p < 0.0001$). Length of stay was also significantly longer ($p = 0.0338$), and mortality was higher (54.5% vs. 45.5%, $p = 0.0262$).

ARDS was associated with the highest severity indices: CTSI 9.75 ± 0.46 vs. 7.58 ± 1.53 ($p < 0.0002$) and PaO_2 41.00 ± 8.35 vs. 71.10 ± 15.78 mmHg ($p < 0.004$). All patients with ARDS required ventilatory support compared to 18.8% in the absence of ARDS ($p < 0.0026$). ARDS was also linked with significantly prolonged hospitalization (16.00 ± 2.67 vs. 7.51 ± 2.04 days, $p < 0.0019$) and markedly higher mortality (77.8% vs. 22.2%, $p < 0.004$).

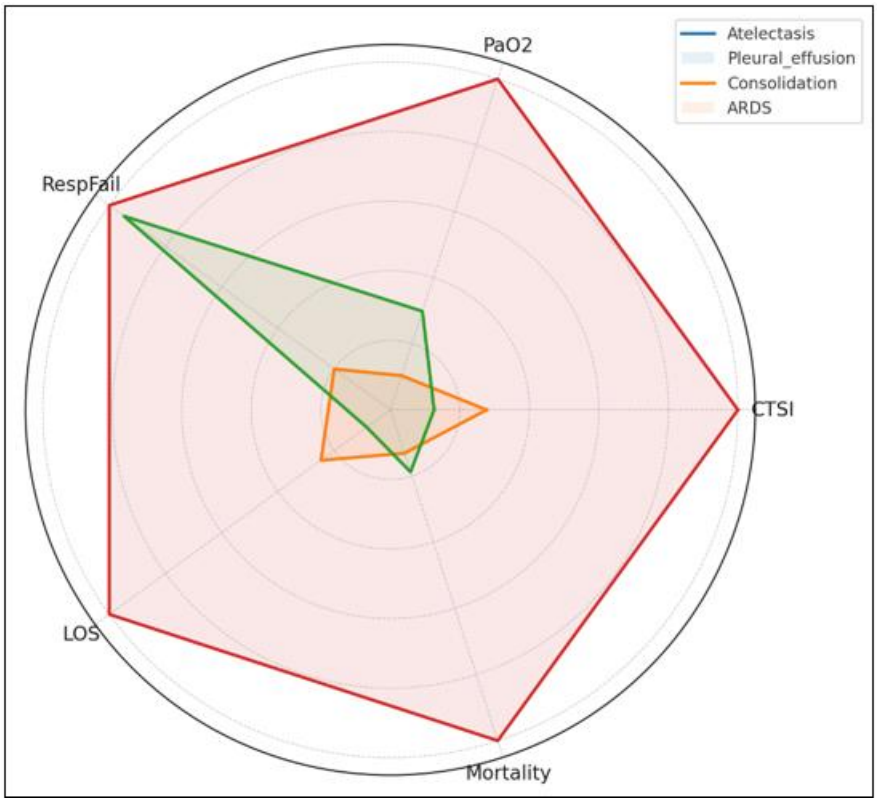

Figure 3: Radar chart displaying normalized significance profiles for respiratory complications.

Figures 3 provide a visual summary of the strength of associations between respiratory complications and clinical outcomes. The radar chart (Figure 3) illustrates the distinct "significance profiles" of each complication, with ARDS demonstrating uniformly high significance across all parameters, whereas atelectasis shows more selective associations. These findings indicate that pleural effusion, consolidation, and ARDS at presentation are strong predictors of increased disease severity, greater hypoxemia, higher rates of respiratory failure, prolonged hospital stay, and poorer survival in acute pancreatitis.

4. Discussion

The present study focused on the evaluation of spectrum of pulmonary dysfunction in acute pancreatitis patients, observed that hypoxemia at initial presentation is associated with disease progression, and is a poor prognostic indicator. Gallstones was the most prevalent etiology of AP. Individuals with over higher CTSI score reflecting greater necrosis experienced more severe pulmonary dysfunction and required ventilator support. Pulmonary dysfunction plays a significant role in multiple organ system failure (MSOF) and identification of early mortality severe acute pancreatitis. Awareness of these manifestations can assist in the identification of high-risk groups, enabling the implementation of supportive measures early stages of disease. Fei et al. [**12**] showed that an oxygen saturation level lower than 92% by itself indicates severity. Early detection of physiologic changes is important to reduce the increased mortality associated with pulmonary complications in AP and to maximize overall clinical outcomes. Maintaining adequate oxygenation empowers clinicians establishes basic standards. There is decreased saturated oxygen (SpO2) and increased respiratory rate are subtle indicators of clinical deterioration. This prompts clinicians to perform more invasive tests such as arterial blood gas testing to monitor partial oxygen tension (PaO2) and PaO2/FiO2 ratio, to aid in the early diagnosis of ARDS [13].

A recent single centre study of 309 consecutive AP patients analysed CECTs performed within the first two days after symptom onset and reported an occurrence of PEs and pulmonary consolidations in 40% and 48%, respectively, a finding closer to the prevalence rates observed in our cohort [13]. The presence of PEs was identified as a predictor in former works and this variable was included in prognostic tools such as the PANC3 and the BISAP score [14]. The underlying pathophysiology for respiratory impairment in AP might be systemic inflammation that leads to a release of vasoactive and pro-inflammatory substances promoting an increasing permeability of the lung barrier with leakage of fluid into the alveolar spaces [15] Acute respiratory distress syndrome (ARDS) has been documented to manifest in up to 15% of all persons with acute pancreatitis, with those experiencing exacerbations requiring prolonged hospitalization at high risk for pre-existing ARDS.[16] Pang et al. reported that early hypoxemia itself acts as a risk factor for ARDS [17], a finding that is consistent with our results.Although, several concepts for the development of pleuropulmonary pathologies in AP have been postulated, further research is needed to increase understanding of the underlying mechanisms.For the diagnosis and classification of PEs, the abdominal CECT seems practical, however, ultrasound is more readily available, safe, fast, and almost equivalent in terms of diagnostic accuracy [18].

5. Conclusion

In our study on patients with acute severe pancreatitis, patients with high CT severity index is found to be associated with pulmonary involvement and other organ dysfunctions. Moderate to severe hypoxemia on presentation, predicts a poor outcome. Among the Respiratory complications developing during the course of acute pancreatitis, consolidation and Acute Respiratory distress syndrome correlates with respiratory failure, while ARDS and Ventilator associated pneumonia leads to increased Length of hospital stay and poor survival.[19] We suggest assessing PEs by ultrasound in the early phase of AP routinely to substantiate the risk of a severe disease course. In addition, there may be therapeutic implications to improve the outcome: A consequent screening and drainage of larger PEs may reduce the rate of respiratory failure, however robust data in this regard is lacking and could be addressed by further investigations. The proposed impact of these pathologies on the severity of AP seems substantial, but needs to be investigated in larger prospective studies, that also evaluate the prognostic capacity of the correlations.

6. Limitations of our Study

Retrospective nature with a relatively small sample size. Also there might be a substantial selection bias, as only hospitalized patients with a CECT in the early phase of the disease were included. This selection might result in over-representation of severe AP cases in our study population and thereby overrate numbers of pleuro-pulmonary findings thereby increasing the complication rates and mortality.

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