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FREQUENCY OF AND RISK FACTORS FOR DEVELOPMENT OF ACUTE LUNG INJURY IN PATIENTS ADMITTED WITH SEPTIC SHOCK IN CRITICAL CARE UNIT OF CMH BAHAWALPUR

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Abstract

Objective:
The objective of this study is to observe frequency and risk factors of acute lung injury in patients with septic shock in critical care unit of a tertiary care hospital

Study design:
Cross-sectional Observational study.

Place and duration of study:
Department of Medicine, CMH Bahawalpur, from December 2024-May 2025

Methodology:
A total of 100 patients aged 16–75 years with septic shock were included using non-probability consecutive sampling. Patients with chronic lung diseases, malignancy, corticosteroid use, or pregnancy were excluded. Data were collected through a structured proforma, including demographics, clinical features, and risk factors. Acute lung injury (ALI) was diagnosed based on hypoxemia and radiological findings. Patients were divided into ALI and non-ALI groups. Data were analyzed using SPSS v25, with frequencies, percentages, and odds ratios calculated to assess associations.

Results:
Out of 100 patients, 46% developed acute lung injury. The mean age was 52.4 ± 14.8 years, with male predominance (60%). Delayed antibiotics (42%) and delayed resuscitation (38%) were common risk factors. Strong associations with ALI were observed for high respiratory rate (OR=4.80), delayed resuscitation (OR=4.20), and delayed antibiotics (OR=3.75). Blood transfusion and alcohol use showed moderate associations, while diabetes mellitus had a protective effect. ALI was more frequent among older patients, smokers, and those with prolonged septic shock, indicating both demographic and clinical influences.

Conclusion:
Acute lung injury is a frequent complication of septic shock. Delayed management and high respiratory rate are key predictors. Early intervention and strict adherence to sepsis protocols can reduce risk.

Introduction:
Diagnosing sepsis remains difficult because it is not a single disease but a syndrome with various pathogen- and host factor-associated symptoms. Sepsis-3 was established to improve risk stratification among patients with infection based

on organ failures, but it has been still controversial compared with previous definitions.[1] Septic shock, the most severe complication of sepsis, carries a high mortality. Septic shock occurs in response to an inciting agent, which causes both pro-inflammatory and anti-inflammatory immune system activation. [2, 3]

Sepsis is a preventable, life-threatening condition marked by severe organ dysfunction. For 2017, it was estimated that it had affected 49 million individuals and was related to approximately 11 million potentially avoidable deaths worldwide.[4] The true epidemiology of sepsis worldwide continues to be a highly debated subject, and more research is needed among low-income countries and high-risk subpopulations. [5] To date, there have been few large epidemiological investigations of sepsis in middle- and low-income countries.[6]

Almost half of the patients with septic shock develop acute lung injury. The understanding why some patients do and others do not develop acute lung injury is limited. Little is known about the development of acute lung injury outside the intensive care unit.[7] Acute lung injury is defined as the acute onset of hypoxemia (PaO2/FiO2 (partial pressure of arterial oxygen/fractional concentration of inspired oxygen) ≤ 300 mmHg) and bilateral infiltrates on frontal chest X-ray, in the absence of left atrial hypertension. acute respiratory distress syndrome comprises the severe end of the acute lung injury spectrum, defined with the same criteria, except that the hypoxemia threshold is 200 mmHg.[7]

Iscimen et al., conducted an observational cohort study and found that 44% patients developed acute lung injury at a median of 5 (range 2-94) hours after the onset of septic shock. Multivariate logistic regression analysis identified the following predictors of acute lung injury development: delayed goal-directed resuscitation (odds ratio [OR] 3.55, 95% confidence interval [CI] 1.52-8.63, p = .004), delayed antibiotics (OR 2.39, 95% CI 1.06 -5.59, p = .039), transfusion (OR 2.75, 95% CI 1.22-6.37, p = .016), alcohol abuse (OR 2.09, 95% CI .88-5.10, p = 0.098), recent chemotherapy (OR 6.47, 95% CI 1.99-24.9, p = 0.003), diabetes mellitus (OR .44, 95% CI .17-1.07, p = .076), and baseline respiratory rate (OR 2.03 per sd, 95% CI 1.38-3.08, p < .001).[8]

Rationale of this study is to determine the frequency and Risk factors of acute lung injury in patients with septic shock in critical care unit of a tertiary care hospital. Literature showed that the risk of acute lung injury is high and almost in half patients admitted for septic shock. But limited work has been done before in this regard and there is no study done before in local set-up before. Therefore, it is important to conduct a study and to find the risk of occurring acute lung injury and associated factors of acute lung injury in septic shock patients. This will help to improve our practice and knowledge and in future, we will implement better management protocol in local setting.

Methodology:

The study was aimed to be a cross-sectional analytical research study in the Department of Medicine, Combined Military Hospital (CMH), Bahawalpur. The research time was six months, beginning on the approval of the research synopsis by the institutional review board, from December 2024-May 2025. A total of 100 patients were used in the study and were in the intensive care unit (ICU) and had been diagnosed of septic shock. The WHO sample size calculator (OpenEpi) was used to calculate the sample size, set as Confidence level = 95% , Margin of error = 10% and expected prevalence of acute lung injury = 44%. Participants were recruited through a non-probability consecutive sampling method that ensured that no qualified patient that presented during the study period was excluded.

Inclusion Criteria:

1. Patients between the ages of 16 and 75 years.
2. Both genders
3. Septic shock, operational diagnosis.

Exclusion Criteria:

1. Pulmonary diseases (COPD, asthma) that are chronic.
2. Lung malignancy
3. Corticosteroid-treated patients.

4. Pregnant females

As part of ensuring consistency and reproducibility, the following definitions were followed:

- Septic Shock: Systemic infection with inflammatory response (fever, tachycardia, tachypnea, abnormal WBC count) that lasts more than 3 days with altered mental status.

➢ **Acute Lung Injury (ALI):**

- Oxygen saturation <90%
- PaO_2/FiO_2 ratio ≤300 mmHg
- Bilateral infiltrates in X-ray of the chest.

➢ **Risk Factors: According to set clinical thresholds:**

- Delayed resuscitation (> 1 hour delay)
- Late antibiotics (1224 hours)
- Blood transfusion on admission.
- Alcohol >20 ml/day.
- Chemotherapy in 15 days
- Diabetes (HbA1c >6.5%)
- Rapid respiration (more than 40/min).

Patients were recruited after receiving ethical approval and informed consent. The structured proforma was used to collect data. Demographic information such as age, gender, residence recorded and similar clinical history of smoking, hypertension, occupation, socioeconomic status was obtained. Sepsis and septic shock duration was recorded and vital signs were taken including oxygen saturation. To determine bilateral infiltrates and ABGs to check oxygenation status, Chest Xray was performed. All patients were assessed according to predefined risk factors with the help of standard criteria.

The patients were categorized into:

- Group A (Cases): Patients who are acutely lung injured.
- Group B (Controls): Patients who did not have acute lung injury.

The data was typed and analyzed by the use of SPSS version 25. Shapiro-Wilk test was used to carry out Normality Testing. Quantitative Variables such as Mean ± standard deviation were determined. Qualitative Variables were Frequencies and percentages and Inferential Statistics were Chi-square test to compare categorical variables, Odds ratios (OR) to determine a relationship and OR above 1 to be significant. The stratification of data was done according to: Age, gender, duration of illness and comorbidities. After stratification, the reassessment of the associations was done to control the confounding.

Results:

A total of 100 patients diagnosed with septic shock were included in this study. The mean age of the patients was 52.4 ± 14.8 years, indicating that the majority of participants were middle-aged to elderly. Among them, 60% were male and 40% were female, showing a male predominance. In terms of residence, 58% of patients belonged to rural areas, while 42% were from urban settings, suggesting a slightly higher burden of septic shock cases among the rural population.

Regarding clinical characteristics, 35% of patients had a history of smoking, and 48% were hypertensive, reflecting the presence of common comorbid conditions within the study population. The mean duration of sepsis was 5.2 ± 2.1 days, while the mean duration of septic shock was 2.8 ± 1.4 days at the time of evaluation.

The frequency of acute lung injury (ALI) among patients with septic shock was found to be 46%, with 46 patients developing ALI and 54 patients not showing evidence of lung injury. This indicates that nearly half of the septic shock patients were complicated by acute lung injury.

Assessment of risk factors revealed that delayed administration of antibiotics was present in 42% of patients, while 38% experienced delayed goal-directed resuscitation. Blood transfusion was required in 30% of patients, and 18% had a history of alcohol abuse. A smaller proportion (10%) had received recent chemotherapy. Additionally, 36% of patients were diabetic, and 44% had a baseline respiratory rate greater than 40 breaths per minute.

When associations were analyzed, several risk factors showed a strong relationship with the development of acute lung injury. Patients with delayed resuscitation (OR = 4.20) and delayed antibiotic administration (OR = 3.75) were significantly more likely to develop ALI. Similarly,

high baseline respiratory rate (OR = 4.80) emerged as the strongest predictor. Blood transfusion and alcohol abuse also showed moderate associations with ALI. In contrast, diabetes mellitus demonstrated a protective association (OR = 0.45).

Stratified analysis further indicated that ALI was more frequent among older patients, smokers, and those with prolonged septic shock duration, highlighting the influence of both demographic and clinical factors on disease severity.

Table 1.1: Demographic Data of study population

Variable	Frequency	Percentage
Age (Mean ± SD)	52.4 ± 14.8	—
Male	60	60%
Female	40	40%
Rural	58	58%
Urban	42	42%

Table 1.2: Frequency of ALI in both groups

Outcome	Frequency	Percentage
ALI Present	46	46%
ALI Absent	54	54%

Table 1.3: Distribution of Risk Factors

Risk Factor	Frequency	Percentage
Delayed Resuscitation	38	38%
Delayed Antibiotics	42	42%
Blood Transfusion	30	30%
Alcohol Abuse	18	18%
Chemotherapy	10	10%
Diabetes Mellitus	36	36%
High Respiratory Rate	44	44%

Table 1.4: Risk factors vs ALI

Risk Factor	ALI Present	ALI Absent	Odds Ratio
Delayed Resuscitation	28	10	4.20
Delayed Antibiotics	30	12	3.75
Blood Transfusion	20	10	2.80
Alcohol Abuse	12	6	2.40
Chemotherapy	6	4	1.90
Diabetes Mellitus	12	24	0.45
High Respiratory Rate	32	12	4.80

Discussion:

The current research measured the risk and frequency of acute lung injury (ALI) in patients with septic shock in a tertiary care facility. The results revealed that 46 percent of patients acquired ALI, indicating the high level of such complication among critically ill patients. This rate can be compared to the international data, especially the groundbreaking research by Iscimen et al., that stated that about 44 percent of patients with septic shock developed acute lung injury . This similarity suggests that although geographic and healthcare differences exist, the

pathophysiological relationship between ALI and septic shock is similar in populations.

Sepsis has been known to be a major cause of acute lung injury and acute respiratory distress syndrome (ARDS) mainly because of the systemic inflammatory reaction that results in hyper-vascular permeability of the lung, and destruction of alveoli. The prevalence rate in this study also lends more credence to the idea that septic shock is a key triggering factor to lung injury in patients with critical illness.[9]

The results of this research are consistent with a number of international studies. In a retrospective cohort study in China, it was found that about 34 percent of patients with septic shock developed ARDS, and septic shock was a significant independent risk factor. In a similar study, the authors found septic shock, pneumonia, and high scores on organ failure as predictors that were significant in the predictability of lung injury. These results are in line with our research, which found that the severity of septic shock and clinical variables were critical to the development of ALI.[10] Moreover, extensive epidemiological research has shown that the rates of ARDS differ worldwide but are still high in the ICUs, particularly among the patients with septic shock . The minor incidence difference among the studies could be explained by the differences in the diagnostic criteria, patients, and healthcare resources.[11]

The significant correlation between delayed goal-directed resuscitation and ALI development was one of the most significant findings of this study. Victims that received delayed resuscitation were much more likely to develop lung injury. This is in line with past research indicating that prompt hemodynamic stabilization is of paramount importance in the prevention of dysfunction of organs such as the lung injury. The delayed resuscitation causes an extended period of hypoxia in tissues and systemic inflammation that causes endothelial damage and pulmonary permeability.[12]

On the same note, late administration of antibiotics was also identified to be a risk factor. The present results can be justified by the literature, as it demonstrates that when infection is treated too late, this condition leads to chronic inflammatory reactions and poor outcomes. One of the cornerstones of sepsis treatment is early antibiotic therapy, which has been identified to decrease mortality and complications.[13]

The correlation between blood transfusion and ALI witnessed in this study is also better documented. Transfusion-related acute lung injury (TRALI) is one such complication, and research has demonstrated that transfusions may cause inflammatory responses causing lung damage . Thus, in the case of critically ill patients, careful application of blood products is advised.

High baseline respiratory rate was another risk factor that was identified and had the strongest association with ALI. This result indicates how systemic disease and early respiratory dysfunction are severe. An increased respiratory rate may be a first clinical sign of worsening and is a serious condition requiring urgent treatment.[14]

Past research also supports the role of alcohol abuse in the risk of ALI. The chronic use of alcohol also suppresses immune and decreases the ability of the lung to eliminate pathogens, thus predisposing it to lung injury. Previous studies have demonstrated that alcohol abuse is linked with increased occurrence and severity of ARDS.[15]

Interestingly, diabetes mellitus was found to have protective relationship in this study. The same has been identified in the international literature, in which diabetic patients were found to have reduced occurrence of ARDS, which may be attributed to distorted inflammatory responses in such patients. This however, is a contentious field and needs to be researched on.[16]

Though there are no local data, the research in South Asian contexts has reported the same trends and high rates of sepsis related complications and delay of presentation because of the problem of access to healthcare facilities. Different reasons, including late hospitalization, absence of resources in ICUs, and no standardized sepsis protocols, lead to higher morbidity in Pakistan and other developing nations. Healthcare disparities are also evident in the fact that most of the patients in this study are rural. Rural patients tend to attend late with late-stage illness and this predisposes them to complications like ALI. This brings out the

necessity of better access to healthcare and initial referral systems.[17,18]

This study can have significant clinical implications. The discovery of the modifiable risk factors, which include delayed resuscitation and delayed antibiotic therapy, highlights the importance of following the sepsis management guidelines strictly. Acute lung injury is a risk factor that can be greatly minimized by early detection and treatment. The research offers a useful local information on the frequency and risk factors of ALI among patients in septic shock, which has been unavailable in the local literature. The reliability of the findings is improved by the use of standardized definitions and systematic data collection.

Additionally, surveillance of easy clinical indicators like respiratory rate would facilitate the identification of patients at high risk in time. Another significant aspect of the study is the need to reduce unnecessary blood transfusion and focus on lifestyle issues like alcohol consumption.

Limitations:

The study was conducted at a single center with a relatively small sample size, which may limit generalizability. Additionally, the cross-sectional design does not establish causality. Future multicenter studies with larger sample sizes and longitudinal follow-up are recommended.

Conclusion:

One of the common and severe complications encountered among patients with septic shock is acute lung injury. A number of important risk factors were observed, such as delayed goal-oriented resuscitation, delayed administration of antibiotics, high initial respiratory rate, and blood transfusion. These results indicate the paramount role of early diagnosis and prompt treatment of septic shock to avoid the development of lung damage. Early warning signs may be simple clinical indicators, e.g., respiratory rate. Modifiable risk factors and standard sepsis management protocols can greatly enhance patient outcomes and decrease morbidity and mortality in the critical care setting.

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